Artvin Çoruh Üniversitesi
Doğal Afetler Uygulama ve Araştırma Merkezi
Doğal Afetler ve Çevre Dergisi

Artvin Çoruh University
Natural Hazards Application and Research Center
Journal of Natural Hazards and Environment

Araştırma Makalesi / Research Article, Doğ Afet Çev Derg, 2025; 11(2): 418–427, DOI: 10.21324/dacd.1601245

Evaluating the Impact of Naturel Disaster Costs on Macroeconomic Indicators: Evidence from BRICS-T Countries

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Abstract

Natural disasters vary in their impact and shape. Following a calamity, countries may incur social, economic, and political losses. Losses have both short- and long-term consequences that affect a wide range of topics. This study attempted to evaluate the theoretical and empirical influence of costs incurred during natural catastrophes on macroeconomic indices. The study used macro indicators such as growth, unemployment, inflation, expenditure, and payment. Each variable was treated as its own model. The study covered the years 2000 to 2022. The association between natural disaster expenses and macroeconomic variables was investigated using panel analysis. Firstly, descriptive statistics for the variables were used in the analysis. The next step was to do the required causality test using horizontal section and delta tests. In accordance with the findings, the Kónya causality test was used. This test reveals a one-way relationship between the natural disaster variable and the growth variable, a one-way relationship from the natural disaster variable to the unemployment variable, a bidirectional relationship between the natural disaster and investment expenditure variables, a one-way relationship between the natural disaster variable and the expenditure variable, and a unidirectional relationship between the natural disaster variable and the It was established that a directional connection existed.

Keywords
Natural Disaster, Macro Economic Indicators, BRICS-T

Doğal Afet Maliyetlerinin Makro Ekonomik Göstergeler Üzerindeki Etkisinin İncelenmesi: BRICS-T Ülkelerinden Kanıtlar

Özet

Doğal afetler etkisi ve oluşum biçimiyle farklılık göstermektedir. Yaşanan afetler sonrasında yaşanan gelişmeler sosyal, ekonomik ve siyasi açıdan ülkelerin kayıplar yaşamasına yol açabilmektedir. Kayıpların kısa ve uzun dönemli etkileri birçok alanda ve başlıkta etkisini göstermektedir. Bu çalışmada doğal afet sonrasında oluşan maliyetlerin makro ekonomik göstergeler üzerindeki etkisi hem teorik hem de ampirik olarak araştırılmaya çalışılmıştır. Makro değişken olarak çalışmada büyüme, işsizlik, enflasyon, harcama ve ödeme değişkenleri kullanılmıştır. Her değişken için ayrı ayrı modeller oluşturulmuştur. Çalışmada 2000-2022 yılları baz alınmıştır. Panel analiziyle doğal afet maliyetlerinin makro değişkenler arasındaki ilişkisi incelenmiştir. Analizde ilk olarak değişkenlere ilişkin tanımlayıcı istatistiklere yer verilmiştir. Sonrasında yatay kesit ve delta testi yapılarak uygun nedensellik testinin yapılması amaçlanmıştır. Çıkan sonuçlar doğrultusunda Kónya nedensellik testi yapılmıştır. Bu test sonucunda doğal afet değişkeni ile büyüme değişkeni arasında tek yönlü, doğal afet değişkeninden işsizlik değişkenine doğru tek yönlü, doğal afet ile yatırım harcaması değişkenleri arasında çift yönlü, doğal afet değişkeni ile harcama değişkeni arasında tek yönlü ve doğal afet değişkeni ile enflasyon değişkeni arasında tek yönlü bir bağlantının olduğu belirlenmiştir.

Anahtar Sözcükler
Doğal Afet, Makro Ekonomik Göstergeler, BRICS-T

1. Introduction

A natural disaster, by definition, has a structure that can have a detrimental impact on people's lives by causing physical, economic, and social damage. Furthermore, natural catastrophes are viewed as unexpected, sudden, and unusual events for which society's coping capacity is insufficient due to their structural characteristics. There are several types of natural disasters. But when we examine how it happens, we find that geological events like earthquakes and landslides, as well as meteorological phenomena like storms and floods, seem to be the beginning. Natural disasters can strike rapidly, sometimes without notice. This disaster might develop gradually over several days, weeks, months, or even years (Dikmen, 2019). Although natural disasters have different causes, their effects on the economy are long-lasting and effective.

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Gönderim Tarihi / Received : 13/12/2024
Kabul Tarihi / Accepted : 07/05/2025

The first effect that natural disasters are thought to have on the economy is growth. Natural disasters can cause a drop in supply as well as an increase in demand for certain items. This may result in disasters having a short-term impact on local prices. This circumstance, and its consequences in the short term, can harm productive physical and human resources. As a result, the economy's growth rate is likely to slow down (Dikmen, 2019). Nonetheless, a variety of macroeconomic indices may be impacted by natural disasters. Unemployment is one of these. Natural disaster losses are one example of market-based adverse economic impacts. Classifying these losses reveals that they are composed of two types of consequences: direct effects, which include the actual physical damage of structures, goods, and natural resources, and indirect effects, which include economic interruptions and temporary unemployment brought on by this destruction (National Research Council, 1999).

Natural disasters can happen in a variety of ways. These occurrences demonstrate the immediate and long-term impacts on living things, nations, and economies of natural disasters including earthquakes, volcanic eruptions, severe temperatures, droughts, floods, and tsunamis brought on by geophysical, meteorological, hydrological, and climate change. Thus, both present and future generations are impacted by natural disasters in both the short and long term. Natural catastrophes, losses, and developments have been found to affect the nation's economies in areas including poverty, development, and economic growth. Due to globalization, these consequences have started to spread quickly around the world. Consequently, it calls into question whether natural disasters have an impact on national economy, particularly budget balances (Keyifli, 2021). Expenses to make up for the material losses and destruction that occur following natural catastrophes rise, leading to a growth in the amount of money paid to cover the losses. Government monetary and fiscal indicators show this state of affairs.

It would create a significant incentive for politicians to stimulate the economy by enacting more expansionary fiscal and monetary policies following a catastrophe. To do this, governments can exert enormous political pressure on the central bank to loosen monetary policy following a natural calamity. However, in countries with an independent central bank, monetary policy must withstand political pressure. As a result, in countries with an autonomous central bank, much of the disaster impact is absorbed through lower output, which then stabilizes the price level. whereas in countries with a central bank that is more susceptible to political influence, output would be encouraged more due to electoral considerations, resulting in a higher short-term price level. The problem of monetary policy delegation is framed as a two-part game between the government and the central bank. During the first step, the government selects the institutional design of the central bank. The second stage involves the implementation of real monetary and fiscal policies. However, delegating monetary policy to an independent central bank might result in a conflict of interest between monetary authorities and the central government, as economic goals are not always congruent. It becomes particularly evident following a negative supply shock, such as a natural disaster. Supply shocks enhance producers' marginal costs, resulting in short-term output shortages. For electoral reasons, the administration wishes to pursue an expansionary monetary policy in order to boost economic recovery following the shock. As a result, the majority of the supply shock will be mitigated by a rise in inflation. In contrast, the central bank chooses to pursue a more contractionary policy to keep prices stable and low following a natural disaster since it is thought to be more conservative than the government in preserving low inflation. As a result, a sufficiently independent central bank will absorb the shock mostly through a reduction in output. The outcome of this policy shift is ultimately determined by the degree of devolution of monetary authority and the central bank governors' stance toward inflation (Klomp & Sseruyange, 2021).

In the present investigation, we attempted to investigate the economic consequences of natural disasters. The first portion of the study, which is divided into three parts, attempts to contain conceptual definitions and theoretical material. The second component of the investigation includes subject-specific literature research. In the final section, the research was experimentally evaluated and the findings were interpreted. The study sought to explore natural disasters both conceptually and empirically, using broad categories rather than a single economic consequence. The study is intended to contribute to the literature because of how it is conducted, the methods employed, and the extent of the variables.

2. Literature Review

Noy (2009) investigated the macroeconomic consequences of natural disasters in his research. In his research, he discovered that it had a statistically significant negative influence on the macroeconomy in the short run. He also discovered that more costly occurrences cause large output slowdowns. Interestingly, developing countries and smaller economies experience considerably greater output drops following a disaster of comparable size than industrialized countries or larger economies.

Akar (2013) conducted study on the influence of natural catastrophes on Türkiye macroeconomics and public finances. His research revealed that natural disasters have a significant economic impact. Furthermore, the study determined that earthquakes were the primary cause of natural disasters' economic impact in Türkiye.

Klomp and Valchx (2014) investigated the association between per capita economic growth and natural disasters using over 750 projections. The study performed a meta-regression analysis. The investigation revealed that natural disasters have a negative and genuine effect on economic growth, which has increased over the analyzed time. However, variations were found between the catastrophes included in the analysis and the country sample used. Climate disasters in poor countries have been determined to have the most detrimental influence on economic growth.

Klomp (2016) investigated the effects of large-scale natural disasters on economic development. The analysis was complicated by the poor quality of data on GDP per capita in low-income nations, as well as the fact that these countries account for more than 90% of all disasters that occur globally. To address this issue, data from satellite photos of night light intensity in a certain country or region was employed, which has been proven to be substantially linked with per capita income. The analysis revealed that the majority of the economic repercussions of natural disasters were explained by regional effects, but this influence faded over time.

Strulik and Trimborn (2018) explored how natural disasters affect the economy. According to the findings of the study, when natural disasters damage durable consumer goods (cars, etc.), GDP grows above its pre-shock levels.

Panwar and Sen (2019) revisited the link between natural disasters and economic growth in their research. They wanted to contribute to a relatively restricted literature on the short- to medium-term economic and sectoral impacts of natural catastrophes (up to 5 years). They also investigated if disaster impacts vary with a country's level of development. Using panel data from 102 (29 developed and 73 developing) nations from 1981 to 2015, the growth effects of four types of natural catastrophes, namely flood, drought, storm, and earthquake, were explored using the system generalized method of moments (GMM) technique. Pursuant to the study's findings, natural catastrophes have varying economic repercussions across economic sectors depending on the type and severity of the event.

Keyifli (2021) evaluated the economic impact of natural disasters in OECD countries. A study on the association between budget deficits and natural disasters was undertaken from 2000 to 2018. The analysis revealed no significant link between the existing factors.

Cavallo et al. (2022) looked into the economic consequences of devastating natural disasters in their study. The study included an investigation of the years 1970 to 2019. An analysis was performed on the panel data set. According to the findings of the study, the impact of natural catastrophes on growth is an economic development issue, with impoverished countries suffering the most.

Güneş (2023) evaluated the influence of natural disasters on the direct, indirect, and macroeconomic levels. His research found that the expenses and damages caused by natural disasters had a detrimental impact on economic growth, spending, and international trade.

Marangoz & İzci (2023) investigated the impact of natural disasters on society, economy, and the environment. His research looked into the developments that occurred following the Kahramanmaraş earthquake on February 6, 2023, as well as the impact of these developments. The investigation yielded outcomes that were beneficial across all of the areas mentioned.

When looking at the literature on the relationship between natural disasters and growth, it is clear that not only a single country, but also groupings of countries, are considered. In the studies, the natural disaster variable was investigated utilizing variables such as the number of persons, costs, and impacts. The association between natural disasters and growth was studied in this study using the variable for natural disaster-related costs. Given the findings, the study is likely to contribute to the literature in terms of time period, current analysis methodologies, and approach to the issue.

3. Data Set, Method, and Methodology

The study's goal is to look at the association between macroeconomic variables and the expenses of natural disasters in BRICS-T countries from 2000 to 2022. The models that will be investigated in this context are the following:

Model 1: $LNGDP_{it} = \beta + \beta_1 LNDISASTER_{it} + e_{it}$
Model 2: $LNUNEMPLOYMENT_{it} = \delta + \delta_1 DISASTER_{it} + u_{it}$
Model 3: $LNEXPENSE_{it} = \gamma + \gamma_t DISASTER_{it} + v_{it}$
Model 4: $LNIPAYMENTS_{it} = \theta + \theta_t DISASTER_{it} + w_{it}$
Model 5: $LNINFLATION_{it} = \alpha + \alpha_t DISASTER_{it} + \varepsilon_{it}$

The study's growth and disaster variables were logarithmically transformed. The reason for taking the logarithm is that taking the logarithm of an exponentially growing series results in linear growth. Taking the logarithm stabilizes the variance and reduces the effects of outliers. (Türe & Akdi, 2005). Table 1 provides detailed information on the variables studied within the scope of the models:

Table 1: Variables and sources

Sembol	Variables	Sources
$LNGDP$	GDP (Constant 2005 $)	World Bank
$UNEMPLOYMENT$	Unemployment, Total (% of Total Labor Force)	World Bank
$EXPENSE$	Expense (% of GDP)	World Bank
$IPAYMENTS$	Interest Payments (% of Expense)	World Bank
$INFLATION$	Annual (%)	World Bank
$LNDISASTER$	Total Cost of Damage Due to Disaster (Million $)	EM-DAT

Table 2 shows the descriptive statistics of the series studied in the models:

Table 2: Descriptive statistics

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
$LNGDP$	27.752	27.668	1.049	0.826	3.235	16.027	0.000***
$UNEMPLOYMENT$	10.173	8.002	6.930	1.340	3.671	43.912	0.000***
$EXPENSE$	28.603	30.671	7.388	-0.581	2.368	10.054	0.006***
$IPAYMENTS$	12.011	10.800	7.104	0.844	3.274	16.822	0.000***
$INFLATION$	9.701	7.351	11.017	4.574	31.518	5157.885	0.000***
$LNDISASTER$	26.393	25.220	2.922	1.220	3.356	34.975	0.000***

*Note: If the skew value is < 0; skewed to the left, if the Skewness value is > 0; is skewed to the right. If the kurtosis value is < 3; flattened, if kurtosis value is > 3; is upright. The threshold of significance level at the 1% level is indicated by the *** character.*

Pursuant to the descriptive statistics, $INFLATION$ and $UNEMPLOYMENT$ variables stand out for their significant variation and right-skewed distributions, whereas $LNGDP$ and $LNDISASTER$ have a narrower range and closer to symmetrical distributions. The expense variable stands out from others due to its negative skewness and flat distribution. The Jarque-Bera test results show that the distributions of each variable are not normal.

The research endeavor began by determining the cross-sectional dependencies of the variables through analysis. In accordance with the findings, the goal was to determine the link between the variables and the direction of that relationship. For this objective, the Kónya (2006) causality test was used.

Kónya (2006) created this assessment, which leverages Zellner's (1962) seemingly unrelated regression (SUR) estimation approach to examine simultaneous correlations like cross-section dependency. This test offers bootstrap critical values, independent of unit root and cointegration, and individual discoveries through the Wald test. In other words, results are collected for both individuals and the entire panel. Given the assumption that the panel is diverse, Granger causality analysis can be performed individually for each member. This test does not require a shared hypothesis for all panel units, nor does it require any previous knowledge other than the amount of lags (Kónya, 2006). The SUR structure utilized for this test is as follows:

$$Y_{1,t} = \alpha_{1,1} + \sum_{l=1}^{mly_1} \beta_{1,1,l} Y_{1,t-l} + \sum_{l=1}^{mlx_1} \delta_{1,1,l} X_{1,t-l} + \varepsilon_{1,1,t} \quad (1)$$

$$Y_{2,t} = \alpha_{1,2} + \sum_{l=1}^{mly_1} \beta_{1,2,l} Y_{2,t-l} + \sum_{l=1}^{mlx_1} \delta_{1,2,l} X_{2,t-l} + \varepsilon_{1,2,t} \quad (2)$$

$$Y_{N,t} = \alpha_{1,N} + \sum_{l=1}^{mly_1} \beta_{1,N,l} Y_{N,t-l} + \sum_{l=1}^{mlx_1} \delta_{1,N,l} X_{N,t-l} + \varepsilon_{1,N,t} \quad (3)$$

$$X_{1,t} = \alpha_{2,1} + \sum_{l=1}^{mly_2} \beta_{2,1,l} Y_{1,t-l} + \sum_{l=1}^{mlx_2} \delta_{2,1,l} X_{1,t-l} + \varepsilon_{2,1,t} \quad (4)$$

$$X_{2,t} = \alpha_{2,2} + \sum_{l=1}^{mly_2} \beta_{2,2,l} Y_{2,t-l} + \sum_{l=1}^{mlx_2} \delta_{2,2,l} X_{2,t-l} + \varepsilon_{2,2,t} \quad (5)$$

$$Y_{N,t} = \alpha_{2,N} + \sum_{l=1}^{mly_2} \beta_{2,N,l} Y_{N,t-l} + \sum_{l=1}^{mlx_2} \delta_{2,N,l} X_{N,t-l} + \varepsilon_{2,N,t} \quad (6)$$

The term l refers to the length of the delay. The Granger causality test is performed in the SUR system. Each equation is from a different country and was determined with distinct samples. All equations use the same variables, but the observations vary. Cross-sectional dependence tests possible linkages between individual regressions (Konat & Fendoğlu, 2021).

4. Findings

For method selection in panel data analysis, cross-sectional dependence and homogeneity must be determined. In this study, Breusch-Pagan LM test was used since T>N for BRICS-T countries. For homogeneity, the Adjusted Delta (Δ_{adj}) test was preferred to test homogeneity for annual data between 2000-2022. Table 3 illustrates the results of the cross-sectional dependency test for the variables studied:

Table 3: Cross-section dependency results of variables

		Statistical Value	Prob.
$LNGDP$	Breusch-Pagan LM	317.802	0.000***
	Pesaran scaled LM	55.284	0.000***
	Bias-corrected scaled LM	55.147	0.000***
	Pesaran CD	17.82	0.000***
$UNEMPLOYMENT$	Breusch-Pagan LM	58.568	0.000***
	Pesaran scaled LM	7.954	0.000***
	Bias-corrected scaled LM	7.818	0.000***
	Pesaran CD	0.969	0.332
$EXPENSE$	Breusch-Pagan LM	105.47	0.000***
	Pesaran scaled LM	16.517	0.000***
	Bias-corrected scaled LM	16.381	0.000***
	Pesaran CD	5.544	0.000***
$IPAYMENTS$	Breusch-Pagan LM	56.823	0.000***
	Pesaran scaled LM	7.636	0.000***
	Bias-corrected scaled LM	7.499	0.000***
	Pesaran CD	1.559	0.118
$INFLATION$	Breusch-Pagan LM	37.4	0.000***
	Pesaran scaled LM	4.09	0.000***
	Bias-corrected scaled LM	3.953	0.000***
	Pesaran CD	4.418	0.000***
$LNDISASTER$	Breusch-Pagan LM	250.033	0.000***
	Pesaran scaled LM	42.911	0.000***
	Bias-corrected scaled LM	42.775	0.000***
	Pesaran CD	15.665	0.000***

*Note: The threshold of significance level at the 1% level is indicated by the *** character.*

When Table 3 is reviewed, the variables exhibit cross-sectional dependence. Table 4 shows the delta test results for cross-sectional dependency and homogeneity testing of the models developed within the scope of the study.

Table 4: Cross-section dependency and test results of models

			Test Statistics	Prob.
Cross-Section Dependency	$LNGDP_{it} = f(LNDISASTER_{it})$		7.817	0.000***
	$UNEMPLOYMENT_{it} = f(LNDISASTER_{it})$		8.595	0.000***
	$IPAYMENTS_{it} = f(LNDISASTER_{it})$		8.199	0.000***
	$EXPENSE_{it} = f(LNDISASTER_{it})$		2.581	0.009***
	$INFLATION_{it} = f(LNDISASTER_{it})$		12.147	0.000***
Delta Test	$LNGDP_{it} = f(LNDISASTER_{it})$	Δ	19.791	0.000***
		Δ_{adj}	21.224	0.000***
	$UNEMPLOYMENT_{it} = f(LNDISASTER_{it})$	Δ	8.998	0.000***
		Δ_{adj}	9.649	0.000***
	$IPAYMENTS_{it} = f(LNDISASTER_{it})$	Δ	8.058	0.000***
		Δ_{adj}	8.641	0.000***
	$EXPENSE_{it} = f(LNDISASTER_{it})$	Δ	15.53	0.000***
		Δ_{adj}	16.654	0.000***
	$INFLATION_{it} = f(LNDISASTER_{it})$	Δ	10.402	0.000***
		Δ_{adj}	10.431	0.000***

*Note: The threshold of significance level at the 1% level is indicated by the *** character.*

When Table 4 is reviewed, it is clear that the models exhibit cross-sectional dependence and heterogeneity. Following the cross-sectional dependence and Delta tests, the Kónya causality test was used. This test requires a common hypothesis for all panel units and can be done without prior knowledge of unit root or cointegration. Tables 5–9 reflect the results of the Kónya causality analysis.

Table 5: Causal relationship between economic growth and natural disaster

H_0	Country	Wald Statistics	Prob.	Critical Values 1%	5%	10%	Panel Fisher Statistics
$LNDISASTER \nrightarrow LNGDP$	Brazil	17.331	0.009***	9.842	7.199	6.28	25.299 (0.025)**
	Russia	3.402	0.569	12.178	9.197	7.694	
	India	0.592	0.809	10.054	5.68	4.109	
	China	51.139	0.025**	67.913	47.494	40.385	
	South Africa	0.347	0.921	15.755	10.178	7.288	
	Türkiye	0.105	0.972	22.037	14.539	11.605	
$LNGDP \nrightarrow LNDISASTER$	Brazil	0.014	0.932	6.862	4.346	3.19	7.687 (0.809)
	Russia	1.097	0.876	15.708	10.573	8.747	
	India	3.086	0.151	11.487	7.107	4.709	
	China	1.854	0.495	25.956	14.995	10.267	
	South Africa	9.692	0.109	23.422	13.259	10.252	
	Türkiye	8.323	0.212	19.184	13.577	10.751	

*Note: ** and *** represent significance at the 5% and 1% levels, respectively.*

Table 5 illustrates that there is unidirectional causality between the natural catastrophe variable and the growth variable. When evaluated individually, it is clear that there is a one-way causal relationship between the natural catastrophe variable and the growth variable in both Brazil and China. Economic activity may be disrupted due to the destruction or damage of assets such as infrastructure, houses, workplaces, and agricultural land. Damage to production facilities and supply lines causes output losses. Similarly, consumer purchasing may be interrupted by a calamity. Increased expenses following natural disasters may encourage people and institutions to save. Experiencing costs may slow growth rates.

Table 6: Causal relationship between unemployment and natural disaster

H_0	Country	Wald Statistics	Prob.	Critical Values 1%	5%	10%	Panel Fisher Statistics
$LNDISASTER \nrightarrow UNEMPLOYMENT$	Brazil	2.010	0.128	5.339	3.265	2.396	24.462 (0.018)**
	Russia	15.567	0.005***	12.192	7.201	5.705	
	India	3.590	0.106	7.020	4.635	3.674	
	China	0.722	0.489	7.122	3.952	2.920	
	South Africa	2.484	0.250	10.211	6.035	4.387	
	Türkiye	0.297	0.588	5.567	3.266	2.336	
$UNEMPLOYMENT \nrightarrow LNDISASTER$	Brazil	0.000	0.997	4.718	3.047	2.350	7.346 (0.834)
	Russia	13.499	0.139	24.216	17.804	14.851	
	India	0.396	0.598	4.139	2.903	2.082	
	China	2.730	0.657	14.390	10.058	8.182	
	South Africa	0.315	0.474	4.768	2.518	1.754	
	Türkiye	0.001	0.984	8.705	4.715	3.548	

*Note: ** and *** represent significance at the 5% and 1% levels, respectively.*

Table 6 illustrates that there is unidirectional causality from the natural catastrophe variable to the unemployment variable. When evaluated separately, it is clear that there is a one-way causal relationship between the natural catastrophe variable and the unemployment variable in Russia. Closing or damaging workplaces during a natural disaster may raise unemployment rates. This can lead to lower household incomes and a reduction in overall economic activity.

Table 7: Causal relationship between investment expenditures and natural disaster

H_0	Country	Wald Statistics	Prob.	Critical Values 1%	5%	10%	Panel Fisher Statistics
$LNDISASTER \nrightarrow IPAYMENTS$	Brazil	2.248	0.356	12.587	8.116	5.749	42.476 (0.000)***
	Russia	0.605	0.495	6.396	3.84	2.82	
	India	10.931	0.017**	13.906	5.289	2.186	
	China	26.337	0.000***	15.774	9.263	6.834	
	South Africa	7.015	0.010**	6.986	4.018	2.763	
	Türkiye	0.084	0.962	12.605	7.68	6.059	
$IPAYMENTS \nrightarrow LNDISASTER$	Brazil	1.944	0.135	5.906	3.466	2.387	32.469 (0.009)***
	Russia	1.676	0.060*	3.142	1.865	1.283	
	India	0.039	0.917	15.915	10.531	8.058	
	China	0.197	0.784	16.313	9.443	6.909	
	South Africa	0.419	0.354	3.263	2.037	1.361	
	Türkiye	0.004	0.951	5.198	2.908	2.035	

*Note: ** and *** represent significance at the 5% and 1% levels, respectively.*

Table 7 shows that there is a bidirectional causal relationship between the natural catastrophe and investment expenditure variables. When evaluated individually, it is clear that the natural disaster variable has a unidirectional causal relationship with the investment spending variable in India, China, and South Africa. In Russia, there is one-way correlation between investment expenditures and natural disasters. Following natural disasters, significant investment may be necessary to rebuild the devastated areas. The calamity requires the reconstruction of investments, infrastructure, housing, public services, and workplaces. This condition produces an increase in investment expenditures.

Table 8: Causal relationship between expenditure and natural disaster

H_0	Country	Wald Statistics	Prob.	Critical Values 1%	5%	10%	Panel Fisher Statistics
$LNDISASTER \nrightarrow EXPENSE$	Brazil	1.112	0.278	6.949	4.151	2.922	17.251 (0.084)*
	Russia	1.750	0.211	8.438	4.595	3.033	
	India	0.200	0.687	9.06	4.563	2.95	
	China	0.004	0.967	11.633	7.165	4.843	
	South Africa	2.148	0.387	10.261	5.684	4.631	
	Türkiye	0.666	0.394	7.943	3.999	2.537	
$EXPENSE \nrightarrow LNDISASTER$	Brazil	8.787	0.31	31.69	18.736	15.078	10.203 (0.598)
	Russia	10.029	0.158	21.57	14.273	11.708	
	India	1.376	0.284	15.895	6.547	3.603	
	China	3.387	0.649	20.554	13.555	10.318	
	South Africa	0.457	0.704	10.518	6.025	4.393	
	Türkiye	0.002	0.958	5.963	3.565	2.432	

*Note: * represent significance 10% level.*

Table 8 illustrates that there is unidirectional causality between the natural catastrophe variable and the expenditure variable. To mitigate the effects of natural disasters, public, business, and personal expenses may rise. Short and long-term expenditures may be increased to compensate for the consequent output and resource losses.

Table 9: Causal relationship between inflation and natural disaster

H_0	Country	Wald Statistics	Prob.	Critical Values 1%	5%	10%	Panel Fisher Statistics
$LNDISASTER \nrightarrow EXPENSE$	Brazil	1.246	0.279	9.699	5.091	3.142	17.251 (0.084)*
	Russia	2.082	0.285	13.981	7.641	5.130	
	India	1.568	0.596	21.974	13.552	10.149	
	China	0.294	0.644	12.669	6.523	4.154	
	South Africa	3.565	0.273	17.434	10.489	7.433	
	Türkiye	26.333	0.000***	3.901	2.144	1.440	
$EXPENSE \nrightarrow LNDISASTER$	Brazil	1.089	0.426	10.482	6.129	4.466	10.203 (0.598)
	Russia	1.074	0.551	20.128	9.793	6.759	
	India	4.156	0.285	15.345	9.540	7.688	
	China	0.329	0.617	7.835	4.352	3.206	
	South Africa	3.423	0.491	23.210	12.701	10.098	
	Türkiye	1.759	0.138	5.358	2.927	2.110	

*Note: The threshold of significance level at the 1% level is indicated by the *** character.*

Table 9 illustrates that there is unidirectional causality between the natural catastrophe variable and the inflation variable. When studied separately, it is clear that there is a unidirectional causality between the natural catastrophe variable and the inflation variable in Türkiye. Following natural disasters, production facilities, agricultural fields, and supply systems may suffer damage. This may cause a decline in the supply of goods and services. The supply shock in the economy has the potential to produce rapid price increases in important sectors such as energy and construction materials, particularly the food industry. Furthermore, rehabilitation and repair activities following natural catastrophes may enhance demand for specific goods and services based on need. More specifically, demand for construction supplies, gasoline, and labor may surge, causing costs to soar.

5. Conclusion

Natural disasters differ in terms of how they happen. These disparities have various implications for the social structure and economy. Following natural disasters, several negative emotions arise, both personally and socially. Individuals and institutions face quick and long-term challenges as a result of the costs incurred, which vary according to the magnitude of the destruction. These impacts cause social, political, and economic concerns. In this work, we attempted to investigate the economic consequences of natural disaster costs. The study attempted to analyze the effect of the costs incurred as a result of natural disasters on chosen macro variables using both theoretical and empirical methodologies. The investigation, which conducted a panel analysis on BRICS-T countries, covered the years 2000 to 2022. The evaluation of the research began with descriptive statistics on the variables. The next step was to do the required causality test using horizontal section and delta tests. In accordance with the findings, the Kónya (2006) causality test was used. This test revealed that the natural disaster variable had a unidirectional relationship with growth, unemployment, expenditure, and inflation variables, as well as a bidirectional relationship with investment expenditure variables.

Natural disasters are a phenomenon that occurs for geopolitical causes and necessitates early planning because the time is unpredictable. As a result, countries must perform preliminary research on the solution to the problem within the context of their particular structural peculiarities. Problems must be detected and mitigated through proactive safeguards and structural adjustments. Natural disaster costs have a direct and indirect impact on the country's economy. To mitigate this impact, countries should include essential steps in their reports and future plans. Preventative measures will save money and reduce physical damage. Precaution strategies should be created and implemented in collaboration with specialists to avert natural disasters. The construction of earthquake-resistant buildings, the closure of flood and landslide-prone areas, the preservation of forests, and measures against widespread disasters should all be implemented when the causes of natural disasters have been identified.

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Appendix 1: CADF-CIPS Unit Root Tests Results

Variables	Countries	Lags	CADF Stat.		CIPS Stat.	
			I(0)	I(1)	I(0)	I(1)
LNGDP	Brazil	5	-3.525	-6.519**	-2.557	-8.32***
	Russia	2	-2.047	-5.456**		
	India	2	-1.029	-7.082**		
	China	4	-3.19	-4.038***		
	South Africa	2	-2.906	-6.945**		
	Türkiye	2	-2.646	-7.879***		
UNEMPLOYMENT	Brazil	2	-1.834	-5.083**	-1.883	-6.614***
	Russia	3	-1.923	-5.614**		
	India	2	-2.497	-6.325**		
	China	2	-3.428	-5.593**		
	South Africa	4	-1.437	-5.284**		
	Türkiye	5	-0.179	-6.784**		
EXPENSE	Brazil	5	-1.486	-5.834**	-2.123	-5.175***
	Russia	2	-1.468	-4.911**		
	India	2	-3.326	-5.111**		
	China	2	-1.95	-4.068*		
	South Africa	2	-2.337	-4.671*		
	Türkiye	2	-2.173	-5.556**		
IPAYMENTS	Brazil	5	-1.99	-6.903**	-2.362	-8.396***
	Russia	3	-1.481	-5.333**		
	India	2	-6.815	---		
	China	4	-1.891	-6.327**		
	South Africa	2	-1.645	-6.896**		
	Türkiye	3	-0.35	-10.752***		
INFLATION	Brazil	2	-3.17	-5.143**	-2.83*	---
	Russia	3	-2.86	-5.296**		
	India	2	-2.87	-6.642**		
	China	5	-0.841	-5.171**		
	South Africa	3	-4.000	----		
	Türkiye	2	-3.27	-5.723**		
LNDISASTER	Brazil	2	-1.397	-5.391**	-1.554	-4.532***
	Russia	2	-0.873	-5.772**		
	India	2	-5.373	---		
	China	2	-2.207	-5.721**		
	South Africa	5	0.709	-9.185***		
	Türkiye	3	-0.185	-4.367*		

*Note: *, ** and *** represent significance at 10%, 5% and 1% levels, respectively.*