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KEYWORDS	ABSTRACT
GDP per capita, Total Damages, Human Capital Index, Method of Moments quantile regression (MMQR), Bootstrap Quantile Regression (BSQR).	Natural disasters have become a major challenge for developing countries because disaster events hamper economic growth and reduce the economic capacity of these economies. The economic and social vulnerabilities are high in low- and middle-income developing countries, the adverse effects of disaster events are more pronounced where human capital, investment, trade, institutional and productive capacity remain limited. This study aims to examine the influence of natural disasters on economic growth in developing countries using panel data over the period 2000 to 2024. For empirical estimation, this study employs second-generation econometric techniques such as the Method of Moments quantile regression (MMQR), which captures heterogeneous effects across the quantile distribution. Moreover, to account for the robustness of the estimated relationship between variables, this study employs Bootstrap Quantile Regression (BSQR). The study findings indicate a negative and statistically significant relationship between natural disasters and economic growth. Natural disasters lower domestic and foreign investment in the economy and also destroy natural resources and output. Furthermore, natural disaster-related damages affect supply chain networks and transportation activities, causing a higher cost of production and shortages of goods in these countries. These events raise the prices of goods and services and lower aggregate demand and consumption, which harm the economic growth of developing economies. The study suggested that policy makers, official organizations and government institution should focus more on increasing economic growth activities and reducing the severe impact of natural disaster events in developing economies.
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Introduction

The natural disaster events such as extreme temperatures caused by the increasing number of total affected people, are estimated to have affected 167.2 million people. The record-breaking severe temperatures and extreme heat waves reflect that Asia has become one of the top 10 deadliest regions. Moreover, extreme drought conditions severely affected African countries and tropical storms devastating impact on the USA. The death proportion by continents from natural disasters in 2024 compared to the period from 2004 to 2023. In 2024, in Africa and Oceania, the total death percentage increases due to natural disaster events. Furthermore, the total number of affected people by disasters was 168.7 million during 2004-2023 and decreased to 167.2 million in 2024. Over the past two decades, overall disaster-related damages have been more costly in 2024, according to the Emergency Events Database (EM-DAT) from the Centre for Research on the Epidemiology of Disasters (CRED, 2025). The economic growth has potential that determined the social problems poverty and inequality and major cause to increases the total wealth of the country. The economic growth of every developing nation cannot be same in every time due to many social, demographic and environmental issues especially natural disasters that cause the unsustainable output of various countries according to their circumstances. Some nation achieved the growth at the cost of many unfavorable economic factors such as overconsumption, higher inflation rate, grater unemployment, rising inequality and corruption that actually leads to human, societal environmental and economic losses (Soubotina, 2004).

Climate and weather-related hazards destroy crops and have long-lasting effects at the domestic, regional, community, national, and even international levels of economic growth of developing nations. Because many developing economies rely on agriculture-related goods, the devastating impact of disasters and the cascading nature of systemic risks lead to increased vulnerability and diminish the coping capacity of individuals and whole economic systems (FAO, 2023). The severe impact of the Pakistan floods in 2022 on countries economic growth, the country faces many challenges as an adverse effect on crop production in the coming production seasons, low wheat production can be anticipated this year, and critical damage to canals, drains, deterioration of livelihoods, employment, and agriculture-related income, also reduced the exports of important crops such as sugar cane, rice, and cotton (IPCC, 2022; Rehmat et al., 2023). Many factors are playing the vital role in rising the development and well-being of the country such as good health, nutrition, quality schools, healthy nutrition infrastructure, and technology. The transformation of local product by using latest modern technological instruments leads to generate the employment opportunities which expand the economic growth and development of the economy (Mazibuko, 2023).

The weather disruption caused food prices to rise and leading to a boost in the inflation rate in developing Asian economies. The unpredicted inflation rate may have indirect effects on consumer and investor sentiment, as well as import demand. This rising inflation rate also affects local government revenues and leads to significant impacts on the overall economic activity of developing Asia. In African economies, after preventing disaster-related climate change issues,

establishing strong economic growth potential requires creating an enabling agribusiness environment, reducing post-harvest waste and loss, and catalyzing the development of effective input distribution systems (ADB, 2024; Adhikari, R. B., 2024). Over the last three decades, the occurrence of different disasters between 1970 and 2002, an estimated 6436 natural disasters or around 77%, were found in the developing world. Developing countries seem to bear the brunt of these events, which ultimately limit the whole economy's output (Strobl, 2012). Disaster impact is found both in developed and developing regions, but low-income countries ever afflicted by natural disasters and bear many challenges such as loss of human and physical capital, job destruction, increase in outward migration, poverty, high inflation, and unemployment rate, which leads to declines in growth that persist for ten years after the disaster (Joseph, 2022).

This study is unique because it found the influence of natural disasters on economic growth using recent twenty-first-century data for developing countries, covering the period between 2000 to 2024. The significance of this study also shows that earlier studies used only 1st generation econometric techniques, but this research employed third-generation advanced econometric methods, the Method of Moments quantile regression (MMQR), Bootstrap Quantile Regression (BSQR), to examine the relationship between natural disasters and economic growth. This study is organized in the following sections: Section 2 demonstrates the literature review of prior studies done in the past, which is an indispensable part of the research activity. Section 3 deals with model specification, sources of data and research methodology. Section 4 presents the detailed findings of the natural disasters and economic growth using MMQR and BSQR-based analysis. Section 5 contains the conclusion and policy implications, along with future recommendations for future research.

Review of Literature

A considerable body of previous studies has found the relationship between natural disasters and economic growth across different countries of the world. This section of the study discussed in the literature over the past decades, critically analyzing the findings of existing studies and highlights the gaps in this research. The main goal of this research is to determine the influence of natural disasters on economic growth, specifically in developing countries.

This section provides several studies that have determined the impact of natural disasters on economic growth. Kawasaki & Shimomura (2024) analyzed the impact of floods on economic activity in Japan. The empirical estimation of both the 2011 and 2018 flood events caused the deterioration of the country economic growth and moved the people into a poverty trap. Furthermore, recurrent floods have less effect on the non-poor as compared to the poor causing the accelerated widening disparity between them and facing many challenges including inflation, unemployment, lost savings and investment, inability to build assets, emotional and mental health issues. The findings of Gyamfi Ackomah et al. (2024) revealed that the positive impact of disasters event on economic growth in the long run due to reconstruction activities, which cause the growth rate to rise. Also, all other explanatory variables increase the economic growth except the non-life

insurance, which showed no significant impact on economic growth. Joseph (2022) examined the influence of natural disasters on the economic growth of Haiti. The empirical estimation showed that natural disasters caused setbacks and collapsed Haiti economic development. Furthermore, climate change produces long-lasting impacts on the growth rate and destroys the fiscal and external balance of the country. Also, the aftermath impact of natural disasters such as the earthquake in Haiti includes destroying marketplace infrastructure, decline in output, and killing or injuring a population, causing social, economic, and household loss.

Owusu-Sekyere et al. (2021) tested the association between natural disasters and the economic growth rate in Southern Africa Development Community countries. The findings of this study indicated that the negative impact of natural disasters on economic growth after a year, this impact turns positive on economic growth. Furthermore, by employing recovery and reconstruction measures they mitigate the initial negative damage caused by the natural disaster events. Douenne (2020) explored the impact of disaster risks and strikes on economic growth and welfare in the United States. The empirical estimation of the authors revealed that efficient saving is less likely to find a positive relationship between economic growth, disaster, and welfare. Moreover, the natural disaster events badly influenced the economic growth rate and caused a reduction in the economic welfare in the United States. Boustian et al. (2020) investigated the impact of natural disasters on economic activity. The findings of this study revealed that severe disaster events caused to increase the net migration rate and a decline in housing prices or rent. Furthermore, the natural disasters produced a negative impact on labor demand and local productivity. de Andrade Lima & Barbosa (2019) examined the impact of natural disasters on economic growth. The results of this study revealed that flood disasters hurt the economic sectors including agriculture, manufacturing, and services. Furthermore, the flash floods have a bad impact on the economic output and also, directly and indirectly, put the spillover effect in neighboring areas. Tang et al. (2019) founded that the impact of natural hazard induced disasters on macroeconomic growth and economic development. The results of this study indicated that disaster-related events such as droughts and extreme temperatures hurt the macroeconomic growth rate and some regions of China face loss of growth cause not enjoy the high growth except Shanghai. Moreover, the earthquake also the major cause of the dropping in the output of western and eastern China and destroyed the human and financial capital.

To explore the influence of natural disasters on economic growth, Panwar and Sen (2019) examined the impact of natural disasters on economic activities in developed OECD and non-developed OECD developing economies. The empirical estimations indicated that severe and moderate normal disaster events caused positive and negative impact on economic growth of the developing and developed countries. Moreover, the severe floods, storms and drought lead to damages the agriculture crops and significant decreases the GDP of the developing nations economies. Botzen et al. (2019) determined the effects of natural disasters event on economic growth in developed and developing countries. The study estimation of both models showed that the natural disaster events caused the badly impact on economic growth. Also, the growth model showed the natural disaster events both direct and indirect impact on economic growth as loss of the output and capital. Zhao et

al. (2018) tested the association between natural disasters, economic aid, and economic growth. The empirical estimation of this study stated that disaster does not hinder economic growth according to the DID method. Furthermore, the natural disaster-related events like earthquakes reduce the GDP in affected areas of China city. The authors findings also indicated that national aid promotes economic recovery and GDP growth. Mukherjee and Hastak (2018) analyzed the link between natural disasters and country regional level economic growth. The findings of this study showed that disasters related events have not statistically significant effect on economic growth. Moreover, after employed random parameter model state heterogeneity that cause difficult to access the relationship between disaster related event specially (floods) and economic growth.

Choi (2016) determined the association between disaster damages, urbanization and economic growth in OECD countries. Estimation of this research s revealed that disaster damages not rise the economic growth but it causes to 50% reduce the economic growth of the OECD countries. Furthermore, the natural disasters events related damages caused the severe impact on economic development and IPAT model estimation suggested that positive population and affluent effect and negative technology effect are mostly faced by OECD countries. Shaari et al. (2016) determined the effect of floods on economic growth in Malaysia. The empirical estimations founded a significant and positive association between their variables, which showed the positive impact of the flood of GDP. Furthermore, the flood-affected areas and the occurrence of damage costs due to disaster-related events strongly affected the long-run economic growth of the country. Alano and Lee (2016) shows the study discussed disasters related events specifically (typhoons and drought) that produce severe impact on the region economic growth. The empirical estimation indicated that negative effect of drought and typhoon on growth of the region. Furthermore, climate change events produced a severe impact in agriculture, tourism, development gain, and cause to rise the inequality. Shabnam (2014) explored the associations between variables. The empirical outcomes showed that natural disaster event flood leads to significant negative effect on economic growth rate of developing countries. Moreover, the severe intensity of floods leads to increases in the death toll of people and destroys the houses, which ultimately reduces the economic growth. The study investigated the influence of natural disaster and credit constraints on economic growth in developing countries. The empirical estimations indicated that natural disasters events negatively influenced economic growth. Furthermore, less developing countries face more challenges due to occurrence of natural disaster event as compare to developed nation that replaced the capital that has been badly affected by disaster event and produced new items through innovations. This research studied the two-tale earthquakes impact on economic growth and institution. The empirical findings showed that the two earthquakes caused the negative influenced on one region. Also, other faces negative shock that leads to decreases the total factor productivity (Barone and Mocetti 2014 and McDermott et al. 2014).

Yamamura (2013) presented the decomposition influence of disaster events on economic growth. The empirical estimation stated that the natural disaster effect varies in French and non-French region such as boost the technological progress and raise the capital accumulation in non-French region as compare the French region have not affected by these disaster events. Cavallo et al.

(2013) estimated the causal influenced of natural disaster event on economic growth. The empirical findings of this study revealed natural disaster events floods earthquakes, and storms sever badly. Fomby et al. (2013) explored the impact of natural disaster events on long run growth. the stronger impact of natural disaster event like drought caused the negative impact on economic growth of the developing nation. Also, not all natural disasters events posited negative some disaster events put the positive impact on economic growth especially in developed countries. Loayza et al. (2012) showed that natural disaster event impact differ in different sector in developed and developing economies. Moreover, the severe disaster more badly impacts on lower income economies and moderated disaster caused the positive impact on developed economies. Strobl (2012) reveled that the hurricane caused to decline the output level. Furthermore, many form of hurricanes like rainfall, flooding, storms and strong wind damage the infrastructure and crops that caused the reduce the economic growth. Based on the empirical outcomes. Bergholt and Lujala (2012) showed that the climate related natural disaster events caused the negative influence on the economic growth in the short time period. Furthermore, the disaster events caused to developed the serious economic concerned and damages the infrastructure and crops but they not caused the armed conflicts. Jaramillo (2009) depicted that natural disaster events cumulative significant positive impact on economic growth in large number of developing countries.

Model, Data, and Methodology

In this section, the study specifies the model, discusses credible data sources and reliable estimation techniques that provide valid and appropriate results. The researchers found the relationship between natural disasters and economic growth in developing countries. These variables explain the fundamentals of our research work and build the frameworks that help in interpreting the results.

Model 4: Natural Disasters and Economic Growth

The functional form of natural disasters and economic growth model is given as

$$GDPPC = f(LFPR, GFCF, HCI, ND, ODA, TRADE, NRR)$$

$$GDPPC_{it} = a_0 + a_1 LFPR_{it} + a_2 GFCF_{it} + a_3 HCI_{it} + a_4 ND_{it} + a_5 ODA_{it} + a_6 TRADE_{it} + a_7 NRR_{it} + \varepsilon_{it}$$

The econometric form of the model is given as

Data: Description and Measurement

Table 1 reports the description of all concerned variables, along with their measurement units and respective sources of data where data were obtained.

Table 1: Variables, Description, Unit of Measurement and Sources

Variables	Description	Unit of Measurement	Sources
HCI	Human capital index	Index constructed through PCA	WDI
GDPPC	GDP Per Capita Growth	(Annual % growth)	
LFPR	Labor Force Participation Rate	(% of total population ages 15-64)	
GFCF	Gross Fixed Capital Formation	(Annual %)	
TRADE	Trade	(% of GDP)	
ODA	Net ODA Received	(% of GNI)	
NRR	Total Natural Resource Rent	(% of GDP)	
ND	Natural Disasters	Total affected Population in Natural Disasters (persons)	EM-DAT from the Centre for Research

Data and Methodology

In this study, to conduct data for the empirical investigation, data have been collected from four main sources such as EM-DAT from the Centre for Research on the Epidemiology of Disasters (CRED) and the World Development Indicators (WDI) database. The data on natural disasters (total affected population and total damage) were obtained by EM-DAT from the Centre for Research on the Epidemiology of Disasters (CRED). The data on economic growth variables were collected from the World Bank Indicators. This study covers recent first-century data collected from 2000 to 2024. This research collected data of 129 developing countries on relevant variables, using World Bank's country classification includes 25 low-income countries, 50 lower-middle-income countries and the others 54 are upper-middle-income countries. By conducting data from different sources and using an extensive period, these sources facilitate the construction of a comprehensive panel data set. Also, this is helpful in empirically analyzing the linkages between their related variables across developing countries.

In empirical investigations, data and methodological framework play a crucial role in empirical results and are also considered the backbone of research practices. The comprehensive view of the methodological framework used for determining the relationship between natural disasters and economic growth. In this research, the researchers used Method of Moments Quantile Regression (MM-QR) to examine the association between the concerned variables. The basic Method of Moments Quantile Regression (MM-QR) is the most appropriate method of panel quantile regression. The quantile regression provides a better estimate to determine how independent variables affect various parts of the distribution at different levels and this regression provides more robust estimates in case of the occurrence of outliers. Moreover, BSQR is robustness checking of different parts of the distribution such as the impact of natural disasters on economic growth, which

may significantly differ between low-growth and high-growth economies, especially in developing countries. When the results of BSQR are consistent with MM-QR findings, it strengthens the researcher’s confidence in the policy-relevant empirical results.

Results and Discussion

Summary Statistics and Correlation Analysis

This section of the study shows the summary statistics of key variables. Table 2 shows the results of descriptive statistics using the years 2000 to 2024. The two variables GDPPC and GFCF show the highest mean values and TAP and TD show the lowest mean values. In this table, the findings also indicate that GDPPC has the highest standard deviation value, reflecting a significantly large variation in the data. The results of TAP and TD present the lowest value of standard deviation, indicating low variation from the central tendency. The skewness indicated the asymmetry of the distribution. The results show that GDDPC, LFPR, ODA, TR, NRR, and HCI values represent a positively skewed distribution, indicating a longer right-tail distribution. Whereas, TD and GFCF values suggest a negatively skewed distribution.

Table 2: Summary Statistics of Key Variables

	Mean	Median	Maximum	Minimum	Std.Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
GDPPC	5.97	4.318	4231.72	-50.33	80.09	48.10	2446.85	810000000	0.00
TAP	10.80	10.71	19.65	0.00	2.75	-0.05	3.07	2.22	0.32
TD	11.52	11.71	18.52	0.69	2.44	-0.50	3.41	99.38	0.00
GFCF	10.87	7.38	884.50	-938.99	41.43	-0.55	215.16	5157937.00	0.00
LFPR	59.93	60.25	229.06	2.26	16.52	1.40	14.69	18363.94	0.00
ODA	6.75	3.26	87.13	-8.18	10.01	3.21	17.28	33239.88	0.00
TR	78.20	72.06	457.30	0.59	42.04	2.71	18.99	35639.80	0.00
NRR	8.63	3.85	88.59	0.00	11.79	2.31	9.16	7863.58	0.00
HCI	0.77	0.47	55.50	0.05	3.70	12.76	165.96	3116705.00	0.00

Moreover, only one variable TAP value shows a distribution that is approximately symmetric because this variable value is close to zero. Regarding kurtosis values, only TAP value is close to 3, confirming a normal (mesokurtic) distribution. The value of all other variables lies above three, suggesting a heavy right tail and a leptokurtic distribution. The Jarque Bera test statistic shows that all variables P-value is significant except TAP, implying that the distribution is not normal.

Table 3 presents the pairwise correlation between economic growth and natural disasters. The correlation analysis reports the strength of the variable as either weak, moderate, or strong. There is a weak positive relationship between GDP per capita with GFCF, TAP, LFPR, ODA, TR and NRR.

Table 3: Correlation Analysis

	GDPPC	GFCF	TAP	TD	HCI	LFPR	ODA	TR	NRR
GDPPC	1.00								
GFCF	0.26	1.00							
TAP	0.06	-0.03	1.00						
TD	-0.08	-0.10	0.17	1.00					
HCI	-0.01	-0.03	-0.01	-0.19	1.00				
LFPR	0.07	0.04	0.12	-0.12	0.02	1.00			
ODA	0.09	0.11	-0.06	-0.23	0.07	0.23	1.00		
TR	0.13	0.09	-0.15	-0.09	0.07	0.04	0.15	1.00	
NRR	0.06	0.18	-0.09	-0.16	-0.06	-0.08	0.15	0.03	1.00

Also, a negative weak correlation was found in GDPPC with TD and HCI. GFCF weakly positively correlated with LFPR, ODA, TR and NRR. TAP and TD are weakly negative related to HCI, LFPR, ODA, NRR and TR, suggesting higher disaster damages cause lower human capital, labor force participation and trade leading to declining economic growth. The values of HCI and LFPR shows that both variables are weakly positive related with ODA, TR except NRR. The ODA weakly positive with TR and NRR, whereas TR also positive related to NRR.

Table 4 reports the results of the cross-sectional dependence test. This study employs a second-generation cross-sectional test is Pesaran Cross-Sectional Dependence (CD) Test. The statistical findings of Pesaran Cross-Sectional Dependence (CD) Test suggested that highest value of GDPPC and NRR, implying that strong cross-country dependence between variables.

Table 4: Cross-Sectional Dependence Test

Variables	CD-Test	P-value
GDPPC	102.88	0.00
TAP	11.89	0.00
TD	21.37	0.00
HCI	27.38	0.00
GFCF	29.57	0.00
LFPR	-1.90	0.05
ODA	47.61	0.00
TR	35.95	0.00
NRR	79.02	0.00

The study also show that all variables are statistically significant and the CD test confirm cross-sectional dependence across countries and units. The economic growth, natural disasters and social indicators exhibit a strong cross-country dependence, which shows countries are socially, environmentally and economically interconnected.

Table 5 exhibit the result of slope homogeneity means that in panel data models, all cross-sectional units yield the same slope coefficients. This study employs two slope homogeneity tests including the Delta test and the HAC Robust Delta test. In our model, the Delta test findings reveal that results are statistically significant which means we reject the null hypothesis and accept the alternative hypothesis.

Table 5: Slope Homogeneity Tests

(Pesaran and Yamagata, 2008)				(Blomquist and Westerlund, 2013)			
Delta Test		HAC Robust Adjusted Delta Test					
Adjusted	p-value	Unadjusted	p-value	Adjusted	p-value	Unadjusted	p-value
-13.68	0.00	-10.58	0.00	-3.03	0.00	-2.34	0.01

The findings suggest that slope heterogeneity exists among variables. Furthermore, HAC Robust Delta test results also indicate that they possess less than 0.05% p value, represent that model shows highly significant test statistics. This means that results exhibit strong slope heterogeneity where explanatory variables differ across the country. Therefore, both test s are confirm that slope heterogeneity is present in our model.

Table 6 illustrate the findings of second-generation panel unit tests. This study incorporates advanced panel unit root test including Maddala and Wu panel-unit root test and the Im-Pesaran-Shin (CSDIPS) panel unit root test.

Table 6: Results of Second-Generation Panel Unit Root

Second-Generation Panel Unit Root Tests												
Maddala and Wu (1999) Panel Unit Root test (MW)							Pesaran (2007) Panel Unit Root test (CIPS)					
Variables	Without Trend			With Trend			Without Trend			With Trend		
	Lags	Zt Statistics	P-value	Lags	Zt Statistics	P-value	Lags	Zt Statistics	P-value	Lags	Zt Statistics	P-value
GDPPC	0	1725.51	0.00	0	1529.22	0.00	0	-27.52	0.00	0	-25.03	0.00
TAP	0	1058.01	0.00	0	1040.02	0.00	0	-17.89	0.00	0	-18.57	0.00
TD	0	756.43	0.00	0	695.56	0.00	0	-15.85	0.00	0	-14.11	0.00
HCI	0	138.48	0.29	0	182.79	0.00	0	4.07	1.00	0	2.59	0.99
GFCF	0	1332.00	0.00	0	1218.48	0.00	0	-20.99	0.00	0	-18.79	0.00
LFPR	0	480.45	0.00	0	489.60	0.00	0	-1.31	0.09	0	-2.19	0.02
ODA	0	674.03	0.0	0	601.41	0.00	0	-10.66	0.00	0	-11.27	0.00
TR	0	281.409	0.028	0	342.265	0.000	0	2.245	0.998	0	-0.984	0.163
NRR	0	316.068	0.001	1	279.080	0.035	0	-0.737	0.231	1	-0.693	0.244

The result of Maddala and Wu panel-unit root test at without trend and with trend shows all variables are stationary with order $I(0)$ except NRR in with trend. Im-Pesaran-Shin (CSDIPS) panel unit root test findings at without trend indicated that HCI and NRR are non-stationary others all variable are stationary. At with trend, the findings of Im-Pesaran-Shin (CSDIPS) panel unit root test suggests that all variables are statistically significant and stationary with order $I(0)$ except TR and NRR.

Table 7 illustrates the findings of the panel cointegration tests that confirms of long run relationship among variables. The study used three cointegration tests namely, the test, Kao test, Pedroni test. The Westerlund test is further divided into four test statistics as group-based statistics (Gt and Ga) and panel-based statistics (Pt and Pa), with null hypothesis of no cointegration and an alternative hypothesis of the existence of cointegration. Regarding the Kao test, five test statistics are given, i.e. Modified Dickey-Fuller, Dickey-Fuller, Augmented Dickey-Fuller, Unadjusted Modified Dickey, and Unadjusted Dickey-Fuller. Furthermore, three test statistics of the Pedroni test are employed in this study including the Modified Phillips-Perron test, the Phillips-Perron test and the Augmented Dickey-Fuller test. These eleven statistics examine the long-run equilibrium relationship among variables.

Table 7: Panel Cointegration Tests

Westerlund Test	Gt	Ga	Pt	Pa
	-1.405 (0.145)	-2.531 (0.000)	-11.010 (0.000)	-8.738 (0.000)
Kao Test	Modified Dickey-Fuller	Dickey-Fuller	Augmented Dickey-Fuller	Unadjusted Dickey-Fuller
	2.045 (0.020)	-0.365 (0.357)	1.090 (0.138)	-2.765 (0.006)
Pedroni Test	Modified Phillips-Perron	Phillips-Perron	Augmented Dickey-Fuller	
	5.510 (0.000)	-6.050 (0.000)	-5.760 (0.000)	

In the case of the Westerlund test, the findings show that, except for Gt, all other test statistics are significant, indicating that long-run cointegration exists in this model. The Kao test results indicate that none of the test statistics are significant, confirming that there is no cointegration. Moreover, the results of the Pedroni test are significant in all models and reject the null hypothesis of no cointegration. These findings conclude the majority of test statistics results confirm the existence of long-run equilibrium relationship among variables and reject the null hypothesis.

Table 8: MM-QR Estimates of Natural Disasters and Economic Growth

Variables	Location	Scale	(Q0.10)	(Q0.25)	(Q0.50)	(Q0.75)	(Q0.90)
LFPR	0.232 (0.233)	0.234 (0.260)	-0.0729 (0.295)	0.0829 (0.202)	0.135 (0.196)	0.216 (0.216)	0.462 (0.406)
GFCF	0.0469 (0.109)	-0.00525 (0.122)	0.0538*** (0.143)	0.0503*** (0.0991)	0.0491*** (0.0958)	0.0473*** (0.106)	0.0418*** (0.198)
HCI	0.114 (0.212)	0.0569 (0.237)	0.0398*** (0.278)	0.0778*** (0.192)	0.0905*** (0.186)	0.110*** (0.204)	0.170*** (0.383)
TD	-2.434* (1.471)	-3.120* (1.647)	-1.629*** (1.620)	-0.450*** (1.084)	-1.145*** (1.048)	-2.225*** (1.159)	-5.512*** (2.228)
TAP	-1.713* (1.545)	-2.644* (1.729)	1.731*** (1.707)	-0.0312** (1.149)	-0.621*** (1.111)	-1.536*** (1.228)	-4.322* (2.358)
ODA	0.0834 (0.414)	0.139 (0.463)	0.0971 (0.543)	0.00473 (0.375)	0.0262 (0.362)	0.0741 (0.399)	0.220 (0.748)
TR	0.0824 (0.0839)	0.110 (0.0939)	0.0606*** (0.104)	0.0126*** (0.0710)	0.0371*** (0.0687)	0.0751*** (0.0757)	0.191*** (0.143)
NRR	-0.115 (0.225)	-0.115 (0.252)	-0.0347 (0.293)	-0.0419 (0.202)	-0.0675 (0.195)	-0.107 (0.215)	-0.228 (0.404)
Constant	-9.564 (23.69)	-1.335 (26.51)	-7.826 (31.14)	-8.715 (21.51)	-9.013 (20.81)	-9.475 (22.91)	-10.88 (42.94)
Observations	1,643	1,643	1,643	1,643	1,643	1,643	1,643

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

MMQR and BSQR Results of Economic Growth

This section illustrates MMQR estimates of natural disasters and economic growth in developing countries. This research examines how natural disaster events influence people lives and destroy infrastructure and food supply chain networks which mainly cause to decline in the economic growth of the developing economies. Understanding the influencing factors of natural disasters on economic growth in developing countries is crucial for researchers to understand how to reduce their impact on economic development. Furthermore, this study discussed the BSQR findings of natural disasters and economic growth for a robustness check.

Table 8 reports empirical estimates that demonstrate the impact of natural disasters on economic growth. The findings also present a positive and statistically insignificant relationship between labor force participation rate (LFPR) and economic growth across all quantiles. The insignificant relationship suggests that due to structural constraints and limited job opportunities in low-income developing nations, an increase in labor force participation does not raise economic growth. The greater labor force participation leads to expanded firm production and strengthens the aggregate supply capacity of the countries. Furthermore, LFPR reduces unemployment, poverty and closing the gender gap can substantially improve economic performance and lead to stable economic growth (Fitri and Yuli, 2025). Our estimation results are consistent with these findings Mahbuba & Setyowati (2024), Cai & Kaiser (2023) and Yakubu & Akanegbu (2020). Our results regarding the effect of gross fixed capital formation on economic growth present a positive and statistically significant impact on economic growth of developing countries. The gross fixed capital formation

consists of large-scale investment projects such as infrastructural development projects, constructions of roads, highways, waterways, bridges and technological formation contribute to increasing the economic growth rate of the developing countries (Olabisi & Akeju, 2025). Our results support a lot of previous researchers, who present a positive and significant relationship between gross fixed capital formation and economic growth (Bakare, 2011; Gibescu, 2010; Y. Kong et al. 2020; Ugwuogbe & Uruakpa, 2013; Yalezo & K. 2018).

Similar to gross fixed capital formation (GFCF), the human capital index (HCI) is also positively linked with economic growth. Moreover, the empirical findings also reveal the results are statistically significant across all quantiles. according to Gary Becker's human capital theory, our estimation supports the idea that an educated human labor force has the potential to accelerate productivity, creating innovative activities, also they use advanced technologies and influence the economic growth of the region (Becker, 1992). The empirical findings of our study are linked with the results of prior studies (Arabi & Abdalla, 2013; Pelinescu, 2015; Wilson & Briscoe, 2004). The study findings indicate a negative and statistically significant relationship between total damages caused by natural disasters and economic growth. natural disaster events such as floods, earthquakes, and storms badly damage infrastructure and the lives of the population. Moreover, the impact of disaster events has the potential to damage crucial sectors such as tourism, manufacturing, and agriculture, especially in developing countries. In many developing countries, higher destruction of capital stock and technological instruments may lead to economic burden on households and firms and weaken economic performance (Klomp & Valckx, 2014). The results of increasing natural disaster damages lead to a severe impact on economic growth, which is relevant to the findings of (Boustan et al., 2020; Cavallo et al., 2013; Cavallo & Noy, 2009; Idroes et al., 2023b; Yamamura, 2013) shows the notable influence on the economic performance of the developing countries.

The study provides valuable insights into the relationship between the total affected people by natural disasters and economic growth. In this analysis, the researcher found a negative and statistically significant association between the two variables in developing countries. People affected by natural disasters (earthquakes and floods) lose their jobs and businesses due to workplace destruction, which may also reduce human capital and labor productivity, especially in low-income developing countries. Many people are becoming injured and homeless because they are physically disabled and produce less output in the economy and leading to macroeconomic instability in their countries (Shabnam, 2014b). The number of other studies (Albala-Bertrand, 1993; Felbermayr & Gröschl, 2014b; Jaramillo, 2009b; Khan et al., 2023; Loayza, Olaberria, et al. 2012). The results demonstrate a positive relationship between official development assistance (ODA) and economic growth in developing countries. official development assistance supports disaster-affected economies by building infrastructure such as bridges, roads, highways and by maintaining energy systems. This aid helps in constructing capital stock, which boosts capital formation and economic growth (Cavallo, 2011). Several studies report the positive impact of official development assistance (ODA) on economic growth in developing countries (Erkinharju, 2021; Omenda & Urbanus, 2022; Refaei & Sameti, 2015; Truong et al., 2026; Zardoub & Sboui, 2023).

Our results reveal a positive and statistically significant association between trade and economic growth in developing economies. the Hecksher-Ohlin theory suggests that trade allows countries to export those goods that are intensively abundant and relatively cheaper in production, such as labor in developing countries and capital in developed countries. This increases income, productivity and export performance, leading to sustainable economic growth (Baldwin, 2008). Previous studies (Afonso, 2001; Bajona & Kehoe, 2006; Dodaro, 1991; Watson, 2017) findings relevant to our study estimation result. Present study found a negative impact of natural resource rent on economic growth in developing countries. The study also found that the results are statistically insignificant throughout the quantiles. the natural resource curse theory supports our estimation, which is developed by Richard Auty. This theory states that many developing countries have a huge number of natural resources but they achieve lower economic growth due to many factors. These factors including overdependence on natural resources, less focus on innovative activities and technological progress, economic and fiscal instability and price volatility tend to lower economic growth (Ahmed et al. 2016). Several studies emphasize the allocation of natural resources by individuals and firms and their impact on economic growth (Gylfason, 2001; Mehlum et al., 2006; Ofori & Grechyna, 2021; Rahim et al., 2021; Sachs & Warner, 2001).

Table 9: BS-QR Estimates of Natural Disasters and Economic Growth

Variables	(Q 0.10)	(Q 0.25)	(Q 0.50)	(Q 0.75)	(Q 0.90)
LFPR	0.0720 (0.0271)	0.0466 (0.0144)	0.0310 (0.00536)	0.0134 (0.00521)	0.00103 (0.0109)
GFCF	0.0548*** (0.0193)	0.0538*** (0.0135)	0.0702*** (0.00785)	0.0769*** (0.0108)	0.0816*** (0.0133)
HCI	0.0411*** (0.0267)	0.0178*** (0.0122)	0.00812*** (0.0108)	0.0235*** (0.0126)	0.0450*** (0.0136)
TD	-0.102*** (0.125)	-0.0794*** (0.0561)	-0.0367*** (0.0371)	-0.00981*** (0.0427)	-0.0780*** (0.0408)
TAP	-0.323*** (0.110)	-0.201*** (0.0394)	-0.156*** (0.0345)	-0.163*** (0.0257)	-0.125*** (0.0568)
ODA	0.0456 (0.0546)	0.0510 (0.0250)	0.0132 (0.0130)	0.0380 (0.0243)	0.116 (0.0528)
TR	0.000994*** (0.0115)	0.00539*** (0.00615)	0.00855*** (0.00321)	0.00993*** (0.00268)	0.0175*** (0.00733)
NRR	-0.0391 (0.0370)	-0.000309 (0.0210)	-0.000910 (0.00970)	-0.0155 (0.0129)	-0.0314 (0.0212)
Constant	-7.189 (2.948)	-2.423 (1.882)	0.124 (0.767)	1.878 (0.703)	3.147 (0.813)
Observations	1,643	1,643	1,643	1,643	1,643

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The linkage between natural disasters and economic growth in developing countries. Considering the close linkage between natural disaster shocks and economic growth, MMQR estimates may cause biased coefficients. To limit this problem, researchers applied the BSQR findings for a robustness check. The empirical results confirm that BSQR outcomes are closely consistent with those presented in Table 8.

Conclusions and Policy Recommendations

The basic objective of this study is to identify and examine the driving contributing factors of natural disasters influence on economic growth of across developing countries. This research gathered data from 2000 to 2024. This study concludes the empirical findings of natural disaster indicators and economic growth in developing countries. The study used two econometric techniques including Method of Moments-Quantile Regression (MMQR) and Bootstrap Quantile Regression (BSQR). MMQR used for detecting heterogenous impact of variables across different level of macroeconomic variables and also BSQR used for robustness check. The estimated coefficients labor force participation rate (LFPR), gross fixed capital formation (GFCF), human capital index (HCI), official development assistance (ODA) and trade (TR) are positively correlated with economic growth. The results demonstrate that all factor contribute economic growth and raises the income of the developing economies. This income level raises human capital, knowledge spillover, increasing investment in technological instruments and infrastructure development project lead to increasing productivity and total output of the economy. Results show that other variables such as total affected people (TAP), total damages (TD) and natural resource rent (NRR) have posit the negative influence on economic growth which means stronger strategies and policies reduce the severe impact of natural disaster events on people lives and damages to household infrastructure and fostering sustainable economic growth in developing countries. Finally, also, it offers key policy implications for policymakers to draw more attention to improving the welfare and living conditions of people, especially in low-income developing economies. These recommendations encourage researchers to address development challenges and help improve people's well-being.

This study presents empirical results into practical policy insights, offering a forward-looking perspective for achieving resilient and inclusive economic systems.

- The labor force participation rate is positively related to economic growth. From a policy perspective, skill development, employment recovery and vocational training programs should be encouraged to enhance workforce productivity.
- Government and non-governmental organizations should increase investment in disaster-resilient infrastructure that minimizes disruption to trade, transportation, and industrial production. This diversification can stimulate economic growth and reduce economic volatility.

- The government may establish policies and programs for human capital development and should focus on improving access to quality education and healthcare.
- Policy makers are encouraged to promote national disaster management funds in disaster-affected areas to reduce disaster-related disruptions and support rapid recovery and reconstruction.
- Special fiscal and monetary policy measures are used to decrease economic shocks caused by natural disasters in developing countries. Moreover, well-designed policies establish a balanced tax structure and an institutional framework that promotes international trade.
- The official development assistance and foreign aid improve economic growth. The government should focus on development-oriented aid programs and also improve transparency and accountability in the management of foreign aid.
- The implementation of these policy recommendations can support developing countries in establishing disaster management strategies, early warning systems and efficient logistics systems that promote economic growth. Governments must embed these strategies into their policymaking frameworks; these measures are essential for developing efficient and sustainable practices that reduce the impacts of natural disasters in developing countries.

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