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Management of Natural Disaster and Its Influence on Economic–Environmental Performance: Fresh Evidence From BRICS

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Previous literature documented the importance of natural disasters and their impact on economic performance, but it ignored the effects on the environment. This study examines the effect of natural disasters on the economic and environmental performance of BRICS economies over the period 1995–2019. This study applies panel autoregressive distributed lag (ARDL) and panel quantile regression approaches. The empirical findings show that natural disasters decrease economic growth but increase CO_2 emissions. The findings of panel quantile regression display a significant negative impact of natural disasters on economic growth from the middle (30th) to higher (80th) quantiles. However, natural disasters significantly increase carbon emissions from the middle (50th) to higher (95th) quantiles. This study suggests the importance of proper planning for the management of natural disasters.

Keywords: natural disasters, economic growth, CO_2 emissions, BRICS, ARDL-PMG model

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INTRODUCTION

Over the last three decades, the world has witnessed some of the biggest natural catastrophes including the 2001 earthquake of 9.0 magnitude in Japan and the resulting tsunami, the 2010 earthquakes in Haiti and Chile, the 2005 earthquake in Pakistan and Hurricane Katrina, and the 2004 tsunami in the Indian Ocean, which caused massive economic losses alongside a large number of human deaths. In the meantime, the world has also experienced upward trends in economic growth at a fast pace, particularly in some of the emerging economies (Asif and Muneer, 2007; Ullah et al., 2020). However, the traditional concept of economic growth has overlooked the serious concern of environmental degradation due to the rise in economic activities worldwide. The recent trend in environmental protection is not good for economic development (Usman et al., 2021; Sohail et al., 2022). Hence, the balance should be maintained between the goals of environmental protection and long-term economic growth.

In this era, two major threats to attaining the target of sustainable economic development are natural calamities and global warming. In addition to sustainable development, natural disasters and climate change are the major cause of the depletion of natural capital stock. According to an estimate since 1970, the world has seen 13,386 natural disasters in which almost 3.6 million people died and 7.7 billion people were affected. Furthermore, the financial price that the world has to pay was about US$ 3.3 trillion (Fang et al., 2019). These calamities do not limit to one or two catastrophes but include floods, droughts, epidemics, storms, land sliding, and earthquakes, among others. The piles of natural capital are at higher risk in the emerging economies as compared to developed economies because they are less equipped to fight natural disasters and the effects are more long-lasting in the emerging economies. Similarly, climate change and global warming also are major hurdles in the way of sustainable economic growth and the environment in emerging economies. Tol (2009) highlighted that carbon emission due to deforestation has increased manifold and it has reached 100 tons of average carbon discharges per hectare, whereas the economic cost of these emissions has also soared to about $50 per ton of carbon emissions. In this regard, a widely recognized source of environmental degradation is carbon emission which negatively affects human health, food security, and ecological balance.

The United Nations has constructed an Inclusive Wealth Index which is used to measure economic sustainability. The Inclusive Wealth Index analyzed three types of capital assets including natural, human, and produced capitals (Cheng et al., 2022; Sohail et al., 2022a). Among these, natural capital is most susceptible to natural calamities and weather fluctuations. Nations that are heavily dependent on natural capital for long-term economic growth are more likely to fall into the trap of the "natural resource curse." According to the Inclusive Wealth Report, 127 out of 140 selected countries are reported to be deficient in natural capital.

The theoretical and empirical literature suggests that natural disasters can have either positive or negative effects on sustainable economic development. According to Benson and Clay (2004) and Xiao (2011), natural disasters and low economic growth rates are linked to each other. Household consumption is badly affected by the natural disaster for a long period of time, without any hope of improvement, and it is a big chunk of a country's national income (Dercon, 2004; McDermot et al. 2014; Huang et al, 2022). As a result, natural disasters negatively impact the per capita income in the long-run (Raddatz, 2009), which in turn leads to the reduction of the overall welfare of the nation (Guo et al., 2015), escalates socioeconomic unpredictability (Porfiriev, 2012), and causes poverty traps (Hallegatte and Dumas, 2009). It is also observed that natural disaster not only spurs poverty by 1.5%–3.6% in developing economies but also significantly and negatively affects the development of human capital (Rodriguez-Oreggia et al., 2013; Sohail et al., 2014).

Conversely, after natural disasters, the process of rebuilding and recovery starts which leads to an improvement in economic growth, agricultural outputs, real estate development, and the process of capital formation (Skidmore and Toya, 2002; Shabnam, 2014; Cavallo and Noy, 2011; Sohail et al., 2019). These positive effects are envisaged due to the fact that, after a natural disaster, the new technology is installed to initiate the recovery process and to speed the post-disaster rebuilding phase, thereby improving overall economic development. On the basis of Schumpeter's view of creative destruction, Skidmore and Toya (2002), natural calamities provide the opportunities to reinvest in capital and also allow the society to adopt new disaster management techniques through the introduction of new technologies. They further suggested that people will start investing more in human capital in the post-disaster recovery period, a key to the long-run and sustainable economic development because natural disasters reduce the rate of return on physical capital which is an invitation for people to invest in human capital (Cappelli et al., 2021; Sohail et al., 2020).

A growing body of literature has assessed the economic effects of natural disasters by employing vast ranges of empirical and modeling approaches. Literature has found the direct and indirect impacts of natural disasters on economic and environmental performance. The direct effect of natural disasters on economic performance belongs to the loss of physical assets, while on environmental performance, these effects occur in the form of rising greenhouse gas emissions. Moreover, indirect economic damages contain the destruction of productive capital, businesses, residential areas, infrastructure, livestock, and crops and most importunately mental and physical health. Garcia et al. (2020) noted that natural disasters and economic–environmental performance are inextricably linked. Huang et al. (2020) reported that natural disasters have a detrimental influence on agricultural production as well as economic development in China, but the size of their impact is different in each province. Natural disasters adversely influence each sector of the economy. Similar results are reported by Kusano and Kemmelmeier (2018) for global-level analysis. Several studies have explored the driving forces of economic and environmental performance in BRICS (Pao and Tsai, 2010; Dingru et al., 2021; Zhao et al., 2021; Li and Ullah, 2022; Naseem et al., 2022; Wahab et al., 2022), but none of the studies incorporate natural disasters variable in their models in the case of BRICS.

The growing body of literature on disaster management has confirmed that extreme weather conditions and other natural calamities such as floods, droughts, storms, heatwaves, rising sea levels, and hurricanes are due to the increased emissions of greenhouse gases (Trinh et al., 2021). Extreme weather can lead to natural disasters, and developing economies are the most vulnerable to such disasters; therefore, the attention of the policymakers and empirics has shifted toward the question of how people and societies can equip them to fight against natural disasters (Baccini and Leemann, 2021). Furthermore, it is also pertinent to analyze the role of natural disasters in the context of sustainable development of emerging economies.

The main motivation for selecting BRICS nations is that the intensity and frequency of natural disasters have increased significantly in recent years. The BRICS economies have the most experience of natural disasters in 2020 (Emergency Events Database, 2021). It is expected that this trend will continue in the future due to the intensification of climate change. According to the estimates of the World Bank (2020), the collective GDP of BRICS economies is approximately US$19.6 trillion (Wahab et al., 2022). Moreover, BRICS economies consist of 23 percent of worldwide GDP, 42 percent of the global population, and 18 percent of world trade. BRICS economies are considered among highly polluted economies. More specifically, Russia, India, and China are among the top four highly polluted economies of the world (Dingru et al., 2021; Naseem et al., 2022).

Consistent with this view, the main aim of this study is to explore the role of disaster management in analyzing the economic and environmental performance of BRICS economies. Our research contributes to the existing body of literature in the following ways. This study assesses the economic impacts of natural disasters in the case of BRICS economies that have not been assessed previously. This study is added to environmental literature through its novel contribution as it explores the impact of natural disasters on environmental conditions as well. This study provides the short-run and long-run parameters considering the impact of natural disasters on economic and environmental performance. Our study delivers important policy directions for environmentalists and economists while formulating and implementing their policy implications. The findings of this study will help in developing natural disaster resilience plans and setting priorities and policies at the provincial, regional, and national levels.

Model and Methods

In several possible scenarios of the macroeconomic impacts of natural disasters, we begin with a basic economic growth model to clarify the empirical link between natural disasters and economic–environmental performance (Salai-Martin and Barro, 1995; Hallegatte et al., 2016, Dingru et al, 2021). Natural disasters may also significantly affect economic and environmental progress. Following previous literature (Klomp and Valckx, 2014; Sloggy et al., 2021), we begin with the following economic growth and CO_2 emission models:

$$GDP_{it} = \pi_0 + \pi_1 ND_{it} + \pi_2 Techno\log y_{it} + \pi_3 FD_{it} + \pi_4 FDI_{it} + \pi_5 Trade_{it} + \varepsilon_{it} \quad (1)$$

$$CO_{2,\,it} = \pi_0 + \pi_1 ND_{it} + \pi_2 Techno\log y_{it} + \pi_3 FD_{it} + \pi_4 FDI_{it} + \pi_5 Trade_{it} + \varepsilon_{it} \quad (2)$$

where GDP_{it} and $CO_{2,\,it}$ are GDP growth and CO_2 emissions, which are assumed to depend on natural disasters (ND), technological progress (Technology), financial development (FD), foreign direct investment inflow (FDI), and trade openness (Trade). In both equations, i denotes the country, t denotes the time period, π_0 is the constant term, while ε_t shows the error term. Natural disasters reduce economic growth dramatically in the short-run and long-run, and an estimate of π_1 should be negative. Similarly, an increased natural disaster frequency is to increase climate change, and an estimate of π_1 should be negative. **Eqs 1**, **2** are a long-run model, and estimates of π_1–π_5 reflect long-run effect of focused and control variables on CO_2 emissions and economic growth. The short-run dynamic effects are also important; thus, we follow Pesaran et al.'s (2001) ARDL approach to estimate the long- and short-run effects in one step. Thus, we can re-express both basic equations in an error correction format, as follows:

$$\begin{aligned}\Delta GDP_{it} = {} & \pi_0 + \sum_{k=1}^{n} \beta_{1k} \Delta GDP_{it-k} + \sum_{k=0}^{n} \beta_{2k} \Delta ND_{it-k} \\ & + \sum_{k=1}^{n} \beta_{3k} \Delta Techno\log y_{it-k} + \sum_{k=0}^{n} \beta_{4k} \Delta FD_{it-k} \\ & + \sum_{k=1}^{n} \beta_{5k} \Delta FDI_{it-k} + \sum_{k=1}^{n} \beta_{6k} \Delta Trade_{it-k} \\ & + \pi_1 GDP_{it-1} + \pi_2 ND_{it-1} + \pi_3 Techno\log y_{it-1} \\ & + \pi_4 FD_{it-1} + \pi_5 FDI_{it-1} + \pi_6 Trade_{it-1} + \lambda .\, ECM_{it-1} \\ & + \varepsilon_{it},\end{aligned} \quad (3)$$

$$\begin{aligned}\Delta CO_{2it} = {} & \pi_0 + \sum_{k=1}^{n} \beta_{1k} \Delta CO_{2,it-k} + \sum_{k=0}^{n} \beta_{2k} \Delta ND_{it-k} \\ & + \sum_{k=1}^{n} \beta_{3k} \Delta Techno\log y_{it-k} + \sum_{k=0}^{n} \beta_{4k} \Delta FD_{it-k} \\ & + \sum_{k=1}^{n} \beta_{5k} \Delta FDI_{it-k} + \sum_{k=1}^{n} \beta_{6k} \Delta Trade_{it-k} + \pi_1 CO_{2,it-1} \\ & + \pi_2 ND_{it-1} + \pi_3 Techno\log y_{it-1} + \pi_4 FD_{it-1} \\ & + \pi_5 FDI_{it-1} + \pi_6 Trade_{it-1} + \lambda .\, ECM_{it-1} + \varepsilon_{it}.\end{aligned} \quad (4)$$

The above two equations include short- and long-run coefficient estimates, as "Δ" operator variables are reflected short-run estimates and long-run effects are inferred by the estimates of π_2–π_6 on π_1. Regarding meaningful estimates, Pesaran et al. (2001) recommend two economic tests for cointegration. The F-test is used for assessing the joint significance of the lagged level variables. The null hypothesis ($H0 = \pi_1 = \pi_2 = \pi_3 = \pi_4 = \pi_5 = \pi_6 = 0$) is to be verified against an alternative hypothesis ($H0 \neq \pi_1 \neq \pi_2 \neq \pi_3 \neq \pi_4 \neq \pi_5 \neq \pi_6 \neq 0$) to determine the existence of cointegration. Besides, the t-test is used to establish the significance of λ, which must be significant and negative. Indeed, under the panel ARDL method, variables could be a blend of levels and first-difference. To check whether these macroeconomic variables are stationary or not, first- and second-generation unit root tests have been applied to the panel data. Next, the panel ARDL captures the data generation process by taking a sufficient and suitable number of lags (Bahmani-Oskooee et al., 2021). This approach assumed all the variables are endogenous. Finally, the panel ARDL model is the most suitable approach in small sample size, as in our empirical case.

Data

This study explores the influence of natural disasters on the economic and environmental performance of BRICS economies for the period 1990–2019. **Table 1** displays the details about variable symbols, definitions, and descriptive statistics. Economic performance is measured through GDP per capita at constant 2015 US$. However, environmental performance is measured by CO_2 emissions. Natural disaster impact is captured through a number of deaths from disasters. This study examines the impact of natural disasters on economic and environmental performance by controlling for a patent, Internet, financial development, FDI, and trade. Patent applications are taken to capture the impact of technology. The use of Internet is captured through total numbers of Internet users as percent of population. Financial development impact is measured by domestic credit to private sector as percent of GDP. FDI is taken into net inflows as percent of GDP. Trade is

TABLE 1 | Descriptive statistics and definitions.

Variables	Definitions	Mean	Median	Maximum	Minimum	Std. dev.	Skewness	Kurtosis	Jarque–Bera	Probability
GDP	GDP per capita (constant 2015 US$)	8.356	8.710	9.226	6.427	0.807	−1.023	2.714	22.22	0.000
CO_2	CO_2 emissions (kt)	13.92	14.10	16.27	12.39	1.096	0.482	2.227	7.959	0.019
ND	Number of deaths from disasters	5.232	5.226	11.39	0.000	2.543	-0.148	2.474	1.894	0.388
Patent	Patent applications, total (residents and non-residents)	10.30	10.23	14.24	8.052	1.364	1.164	4.273	36.67	0.000
Internet	Individuals using the Internet (% of population)	23.72	12.30	82.64	0.005	24.66	0.787	2.228	16.01	0.000
FD	Domestic credit to private sector (% of GDP)	3.998	3.966	5.108	−4.037	1.033	−4.059	30.81	42.40	0.000
FDI	Foreign direct investment, net inflows (% of GDP)	2.241	2.002	5.368	0.205	1.346	0.382	2.010	8.144	0.017
Trade	Trade (% of GDP)	42.41	45.68	69.39	15.63	13.19	−0.235	2.033	6.023	0.049

TABLE 2 | Results of panel unit root tests.

	CIPS			CADF		
	I(0)	I(1)	Decision	I(0)	I(1)	Decision
GDP	−0.877	−2.929***	I(1)	1.555	−3.797***	I(1)
CO_2	−1.052	−3.978***	I(1)	1.326	−6.536***	I(1)
ND	−4.383***		I(0)	−7.588***		I(0)
Patent	−2.193**		I(0)	−1.784**		I(0)
Internet	0.118	−2.068*	I(1)	0.795	−1.704**	I(1)
FD	−3.706***		I(0)	−3.389***		I(0)
FDI	−2.672***		I(0)	−3.041***		I(0)
Trade	−1.690	−4.430***	I(1)	−0.373	−7.691***	I(1)

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

measured in terms of GDP. The required data have been scrutinized by the World Bank and Emergency Events Database (EM-DAT).

RESULTS AND DISCUSSION

To detect the stationary properties of variables, this study adopted CIPS and CADF unit root tests. The stationarity results are reported in **Table 2**. It can be observed that both CIPS and CADF tests have produced the same results. The findings show that ND, patent, FD, and FDI are integrated at a level. However, GDP, CO_2, Internet, and FDI are integrated at first-difference. The pre-requisite for adopting the panel ARDL approach for analysis is that the variables of the model should be integrated of I(0) or I(1) series. Hence, the results of unit root tests support the pre-requisite for using the ARDL approach for analysis. The ARDL-PMG results of the economic growth model and CO_2 emission model are presented in **Table 3**.

The long-run and short-run estimates of CO_2 model and economic growth model have been estimated. The long-run results display that the impact of natural disasters on economic growth is proved significant and negative inferring that an increase in natural disasters tends to reduce the level of economic growth in BRICS economies. It shows that 1 percent intensification in natural disasters reduces economic growth by 0.125 percent in the long-run. This finding is also backed by Rajapaksa et al. (2017), who noted that natural disaster reduces inclusive economic growth in global economies. Several empirical and theoretical studies report a negative effect of natural disasters on growth (Skidmore and Toya, 2002; Noy, 2009; Klomp and Valckx 2014). According to Klomp and Valckx (2014), economic growth drops immediately after a natural disaster, and it has permanent effects on the level of output. The frequency of natural disasters rose dramatically in BRICS, which decreased economic performance in the short-run as well as the long-run. This finding is also supported by Keerthiratne and Tol (2018), who noted that natural disasters increase income inequality and decrease economic performance in Sri Lanka. A similar result is also found by Rosselló et al. (2020) for global level, who noted that natural disasters have negative effects on all domains of life, including tourism and economic performance. This result is reliable to Boustan et al. (2020), who inferred that economic response to natural disasters is most consistent and robust in the United States.

However, the impact of natural disasters on CO_2 emissions is proved to be statistically significant in the long-run, and hence, the relationship is robust. The findings show that natural disasters have dramatic economic and environmental consequences. Our findings infer that natural disasters increase climate change by increasing environmental pollution. This finding is also backed by Sloggy et al. (2021), who noted that natural disasters increase

TABLE 3 | ZARDL-PMG results of economic growth and CO_2 emissions.

	Economic growth				CO_2			
	(1)		(2)		(3)		(4)	
	Coefficient	**t-Stat**	**Coefficient**	**t-Stat**	**Coefficient**	**t-Stat**	**Coefficient**	**t-Stat**
Long-run								
ND	−0.125*	1.811	−0.031*	1.895	0.001	0.084	0.028*	1.892
Patent	0.931**	2.270			−0.272***	11.18		
Internet			0.003*	1.856			−0.005***	3.544
FD	2.197**	2.000	1.733***	3.403	0.325***	10.10	0.178*	1.696
FDI	0.492**	2.257	0.027	0.541	0.006	0.519	0.032	1.522
Trade	0.009	0.555	0.071***	6.796	0.016***	5.812	0.036***	5.713
Short-run								
D (ND)	−0.012**	2.090	−0.011***	2.630	0.002**	2.403	0.009**	2.546
D (ND (-1))	0.002	0.542	0.003	0.627			0.005*	1.971
D (Patent)	0.044*	1.776			0.005	0.170		
D (Patent (-1))	−0.015	0.320						
D (Internet)			0.002*	1.848			−0.002	0.410
D (Internet (-1))			−0.001	0.610			−0.007	1.089
D (FD)	0.057	0.512	0.024	0.615	0.014	0.196	0.084*	1.902
D (FD (-1))	0.155*	1.788	0.046**	2.041			−0.162	1.591
D (FDI)	−0.003	0.518	0.003	0.662	0.006	0.880	0.010**	2.097
D (FDI (-1))	0.009	1.162	0.001	0.290			0.003*	1.737
D (Trade)	0.001	0.998	0.000	0.370	−0.001	0.625	0.000	0.028
D (Trade (-1))	−0.003***	2.705	−0.001	1.147			0.000	0.008
C	0.146	1.449	0.081	0.795	2.641*	1.821	1.962*	1.768
Diagnostics								
ECM(-1)	−0.414*	1.709	−0.430*	1.847	−0.398*	1.722	-0.373*	1.730
F-test	8.325***		5.365***		6.984***		7.012***	

Note: ***p < 0.01; **p < 0.05; *p < 0.1.

climate change. The finding infers that natural disaster is closely linked to global warming. Theoretically, Israel and Briones (2012) argued that natural disaster has hurt natural resources and the environment. An important possible channel is that natural disasters cause environmental degradation by damaging agriculture, forestry, and rangelands. A similar finding is also reported by Israel and Briones (2012) in the case of Philippines. This also means that natural disasters have been increasing over time due to environmental change, which in turn increases CO_2 emissions. This finding is also backed by Botzen et al. (2019), who inferred that the direct and indirect economic effects of natural disasters are increasing. This means that natural disasters cause environmental degradation destroying man-made and natural capital. Thus, with higher levels of natural disasters, natural capital depletion increases by mitigating environmental quality.

The impact of patent on economic growth is significant and positive revealing that 1 percent rise in patent increases economic growth by 0.931 percent in the long-run. However, the impact of patent on CO_2 emissions is significant and negative revealing that 1 percent rise in patent decreases CO_2 emissions by 0.272 percent in the long-run. The impact of Internet on economic growth is found to be significant and positive displaying that 1 percent upsurge in the use of Internet improves economic growth by 0.003 percent in the long-run. However, the impact of Internet on CO_2 emissions is found to be significant and negative displaying that 1 percent escalation in the use of Internet mitigates CO_2 emissions by 0.005 percent in the long-run. The findings further reveal that the effect of financial development on economic growth is significant and positive displaying that 1 percent rise in financial development increases economic growth by 2.197 percent in the long-run. However, the effect of financial development on CO_2 emissions is significant and positive revealing that 1 percent rise in financial development escalates CO_2 emissions by 0.325 percent in the long-run. Furthermore, the impact of FDI on economic growth is proved significant and positive inferring that the increase in the inflows of FDI tends to increase the level of economic growth in BRICS economies. It shows that 1 percent increase in inflow of FDI enhances economic growth by 0.492 percent in the long-run. However, the impact of FDI on CO_2 emissions is proved to be statistically insignificant in the long-run, and hence, the association is rejected. Similarly, the impact of trade on economic growth is proved to be statistically insignificant in the long-run. However, the impact of trade on economic growth is proved significant and positive inferring that the increase in trade tends to intensify CO_2 emissions in BRICS economies. It shows that 1 percent increase in trade enhances CO_2 emissions by 0.016 percent in the long-run. Hence, ND, patent, Internet, FD, FDI, and trade are found to be long-term determinants of economic and environmental performance.

In the short-run, the findings display that natural disaster has a statistically significant impact on economic growth. It shows that natural disasters have also a short-term effect on economic growth. However, natural disasters show a significant and positive impact on CO_2 emissions in the short-run. The findings further reveal that patent and Internet are significantly and positively associated with economic growth in the short-run. In contrast, patent and Internet

TABLE 4 | Panel quantile regression of economic growth.

	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
ND	−0.132	−0.140	−0.173	−0.246***	−0.274***	−0.270***	−0.273***	−0.178***	−0.105*	−0.020	0.034
	1.510	1.134	1.284	4.461	6.228	6.098	4.398	2.435	1.690	0.298	0.475
Patent	0.256*	0.293*	0.324	0.573***	0.669***	0.776***	0.850***	0.819***	0.799***	0.798***	0.856***
	1.863	1.802	1.545	3.714	4.783	6.050	9.502	9.474	11.18	14.02	15.58
FD	1.170***	1.066**	0.965	0.581	0.651*	0.587*	0.356**	0.396***	0.401***	0.367***	0.190***
	3.087	2.120	1.577	1.570	1.852	1.690	2.454	3.215	3.789	4.119	4.028
FDI	0.109	0.085	0.074	0.042	0.056	0.091	0.130	0.075	0.005	0.039	0.101
	1.237	0.690	0.495	0.333	0.530	0.858	1.099	0.651	0.052	0.470	1.285
Trade	0.015	0.018	0.026	0.020	0.001	0.009	0.007	0.003	0.001	0.001	0.007
	0.891	0.870	0.978	0.665	0.048	0.515	0.675	0.323	0.074	0.146	1.109

*Note: ***p < 0.01; **p < 0.05; *p < 0.1.*

TABLE 5 | Panel quantile regression of CO_2 emissions.

	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
ND	0.025	0.012	0.042	0.007	0.030	0.034*	0.043*	0.080**	0.134***	0.220***	0.230***
	0.280	0.003	0.958	0.293	1.089	1.704	1.677	2.223	3.172	5.645	6.702
Patent	−0.854***	−0.879***	−1.066***	−1.108***	−1.107***	−1.129***	−1.139***	−1.164***	−1.251***	−1.157***	−1.159***
	11.86	9.116	15.76	20.58	19.04	16.97	19.42	18.30	20.00	17.56	19.85
FD	0.320**	0.308*	0.246**	0.288***	0.309***	0.247**	0.286***	0.272**	0.132***	0.222***	0.243***
	2.162	1.684	2.425	3.493	3.372	2.397	3.127	2.345	3.701	5.574	6.695
FDI	0.140	0.105	0.054	0.081	0.101	0.086	0.077	0.106	0.208**	0.149***	0.154***
	1.013	0.605	0.055	1.101	1.224	1.028	1.081	1.442	2.555	2.585	3.033
Trade	0.066***	0.064***	0.040***	0.031***	0.029***	0.030***	0.025***	0.023***	0.022***	0.033***	0.033***
	9.237	8.190	4.841	5.965	5.177	5.321	4.325	3.090	2.733	3.077	3.471

*Note: ***p < 0.01; **p < 0.05; *p < 0.1.*

have a statistically insignificant impact on CO_2 emission, which shows that improvement in technology and increase in the use of Internet are not linked with CO_2 emissions in the short-run. The findings also confirm that financial development, FDI, and trade report no significant impact on economic growth and CO_2 emissions. It shows that financial development, FDI, and trade are not associated with economic performance and environmental performance in the short-run.

The results of ECM term and F-stat prove that there exists a long-term relationship among the variables of the models. The results of robust models shown in columns (2) and (4) are consistent in terms of sign and significance level in most cases. The results of panel quantile regression report that natural disasters produce significant and negative impacts on economic growth from the 4th quantile to the 9th quantile. The results of panel quantile regression report that natural disasters produce a significant and negative impact on economic growth from the 4th quantile to the 9th quantile, as shown in **Table 4**. However, natural disasters produce a significant and positive impact on CO_2 emissions from the 6th quantile to the 11th quantile, as shown in **Table 5**.

CONCLUSION AND IMPLICATIONS

During the last three decades, the severity and frequency of natural disasters have increased dramatically. A bulk of empirical literature has made effort to explore the effect of this rising trend on various variables. However, the obtained results are still inconclusive. There are several studies discussing the impact of natural disasters on economic development, but ignoring environmental degradation. However, the current study investigates the consequences of natural disasters simultaneously on environmental and economic performance. This study explores the said nexus for BRICS economies by employing the ARDL-PMG approach. By using this approach, this study reported short-run and long-run coefficient estimates of the models. The findings of this study report the significant and negative impact of natural disasters on economic growth in the long-run, showing that happenings of natural calamities discourage economic growth in BRICS economies. However, natural disasters produce no effect on CO_2 emissions in the long-run. In the short-run, the findings of the study report that natural disasters produce no impact on economic growth. However, natural disasters tend to produce an increasing impact on CO_2 emissions in the short-run. The findings also show that technology, Internet use, financial development, FDI, and trade reports significantly increase impact on economic growth and CO_2 emissions in the long-run. Hence, the overall findings of this study confirm that natural disasters, technology, Internet, financial development, FDI, and trade are significant determinants of environmental performance and economic growth.

The findings of our study deliver various policy implications for researchers, policymakers, and governments of BRICS economies. It is suggested that the governments of BRICS economies should develop such research institutes that provide prior information regarding the occurrence of natural disasters. These governments should improve their technological setup that supports providing such kind of information. Moreover, the government should increase investment in research and development. The governments should take immediate initiatives to increase their capacity to tackle the consequences of natural disasters and disaster-related reconstructions, mitigation, and prevention. It is also suggested that governments of BRICS economies should emphasize the significance of suitable planning for the management of natural disasters. Most specifically, pre-disaster and post-disaster appropriate planning and management are required for controlling the frequency of consequences of disasters. The economies can control maximum consequences of disasters by improving their preparation to confront any disaster significantly and timely. Policymakers and governments of concerned economies should deliver enough attention to natural disasters in formulating and instigating policies to promote economic development and poverty reduction. Insurance, financial post-disaster compensation measures, government spending, and social safety arrangements could be used to control the economic and environmental impacts of natural disasters.

This study contains several limitations. The current study is mainly considering BRICS economies, while in future research a large sample can be used for analysis by considering a mixture of developing and developed economies to make a comparison. Meanwhile, this study was done by employing the NARDL approach which provides an asymmetric impact of natural disasters on economic and environmental performance. In future research, the energy consumption role can be added to the analysis along with some other macro variables.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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