DOI: 10.52131/pjhss.2024.v12i3.2510

Pakistan Journal of Humanities and Social Sciences

Volume 12, Number 03, 2024, Pages 2705-2716
Journal Homepage:
https://journals.internationalrasd.org/index.php/pjhss

PAKISTAN JOURNAL OF HUMANITIES AND SOCIAL SCIENCES (PJHSS)
INTERNATIONAL RESEARCH ASSOCIATION FOR SUSTAINABLE DEVELOPMENT

Environmental Degradation in BRI Countries: Navigating the Role of Natural Resources, Green Energy and Green Finance

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ARTICLE INFO

Article History:

Received:	June 02, 2024
Revised:	August 22, 2024
Accepted:	August 22, 2024
Available Online:	August 24, 2024

Keywords:
Natural Resources
Green Energy
Green Finance
Environmental Degradation

Funding:
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

This study examines the role of natural resources, green energy and green finance in influencing environmental degradation using the data of 105 BRI countries from 2001 to 2021. For data analysis, different panel data estimation approaches, i.e., cross-sectional dependence tests, slope homogeneity tests, panel cointegration tests, FGLS and PCSE models, and DH causality tests, are used. The outcomes of CIPS and CADF tests display that the variables ED, GDP, NR, and GF are stationary at level, whereas GE and TR are stationary at I(1). The Westerlund and Pedroni cointegration tests confirm the long-run cointegration in a model. Furthermore, the FGLS model validates the EKC framework in BRI countries. The findings also show that green energy and green finance are critical for reducing CO2 emissions in BRI countries. The study also shows that natural resources are augmenting the CO2 emissions in BRI countries. Therefore, based on the study outcomes, it is concluded that BRI countries should promote green finance and green energy to enhance environmental quality.

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1. Introduction

Environmental degradation, ecological imbalances, climate disruptions, and climate change have recently been some of the most divisive topics in developed and developing countries. Speedy economic growth and industrialization leads to intense use of traditional energy sources and natural resources (NR), which increases waste and residuals in the environment and causes harm to the ecosystem (Usman & Jahanger, 2021). CO_2 emissions are the primary factor of these degradations and reflect the widespread concern for environmental quality (EQ). Fossil fuel combustion and biomass burning are associated to human activities that produce GHGs alter the atmosphere and climate globally. Over the past few decades, human activities have extended in various ways, leading to quick urbanization and industrialization, which in consequence has augment energy consumption and caused environmental harm (Iram et al., 2024; Shah, Asghar, & Riaz, 2020; Sibt-e-Ali et al., 2023). Environmental issues such pollution, poor sanitation, and the substantial depletion of NR and forest reserves have been major issue for the countries in recent years (Danish, Baloch, & Wang, 2019). Because of their detrimental effects on the environment, especially in light of climate change, these plentiful resources have raised concerns throughout the world (Sakariyahu et al., 2023). Income and natural resources are also related. Early in their development, nations typically consume more energy with less focus for environmental quality. Although, as growth endures, concerns turns to renewables with a rise in clean energy, NR preservation, etc. (Sibt-e-Ali et al., 2023). As a result, the atmosphere begins to get better. Growth in the economy encourages industrialization, which raises the extraction of

NR (Asghar et al., 2024; Ishfaq et al., 2024). By increasing emissions, the use of NR for mining, farming, and deforestation may lower environmental quality (Danish et al., 2019).

Environmental quality and green finance (GF) are strongly correlated. Green finance promotes sustainability and environmental protection (Kemfert et al., 2019). Green finance mixes business and environmental responsibility. Green finance prioritizes environmental conservation above typical financial activity. Green finance describes achieving commercial goals while considering environmental impacts. Green finance protects the environment, unlike traditional finance (Wang & Zhi, 2016). Mukhtarov et al. (2018) demonstrated that green financial development lowers EQ and increases energy use because financial development makes financing affordable and accessible to people and businesses (Asghar et al., 2024; Sadorsky, 2011). Similarly, green financial development attracts FDI, encouraging energy-intensive growth and degrading the environment (Dhrifi, Jaziri, & Alnahdi, 2020). Similarly, green energy (GE) is used to create a sustainable environment. An environment free of emissions can be reached by concentrating on sustainable development and green energy. The adoption and use of green energy and technology offer potential means of establishing and implementing a sustainable environment. The result of sustainable energy strategies is environmental sustainability. Utilizing renewable energy sources like solar, tidal, wind, and biomass can be advantageous. Thus, investment in renewable energy replaces fossil fuels, which is more environmentally friendly and sustainable (Li et al., 2023; Midilli, Dincer, & Ay, 2006). Therefore, GE is imperative to reduce ED.

The Belt and Road Initiative (BRI) nations have seen remarkable economic expansion over the past few decades. However, this rapid expansion contributed to a significant loss of natural resources, which accelerated environmental problems. The BRI nations were selected as a sample for this paper for a number of reasons. First, BRI nations possess a substantial portion of the global NR: 58.54%, 53.82%, 74.69%, and 55.17% of the world's total oil supply (thousand barrels per day), dry natural gas production (billion cubic feet), coal production (thousand short tons), and crude oil proved reserves (billion barrels), respectively (BP, 2019). Second, 54.63% of the world's population resides in these BRI nations, which account for 38.5% of the world's land area, 23.52% of its GDP, and 24% of its household consumption. Thirdly, these nations contribute significantly to global CO_2 emissions; in 2014, BRI countries accounted for 9816.77 metric tons of global emissions (WDI, 2019). Therefore, considering the ED impacts, this study analyzes the role of NR, GE and green finance in influencing ED in BRI nations. The outcomes of the study will be helpful for the policymakers of the BRI countries in designing environmental policies by considering the role of NR, GE and GF.

2. Literature Review

The effect of NR, green energy and GF on environmental degradation (ED) was analyzed by different scholars. In this section, the literature of some of these studies is presented.

2.1. Relationship between Natural Resources and ED

Several researchers examines the association between NR and ED such as from 1990 to 2021, Sibt-e-Ali et al. (2023) examined how ED in East and South Asia was impacted by technological innovation (TI), NR, globalization, and the use of renewable energy (REC). The results displayed that REC, TI and globalization lower emission levels while growth of the economy dramatically deteriorates ecological quality. Using data from 1990 to 2018, Majeed et al. (2022) investigated the non-linear impact of globalization, technological advancement, and NR on the ecological footprint in BRI countries. The results demonstrated that technical advancements aid in halting ED while NR substantially damages the EQ. Aladejare (2022) examined how ED in the five wealthiest African countries occurred between 1990 and 2019 as a result of globalization and NR. The outcomes demonstrated that ED was largely caused by NR. In contrary, urbanization improved environmental sustainability while globalization decreased environmental deterioration. The dynamic relationships between ASEAN's NR, HC, growth of the economy (EG), and ecological footprint from 1990 to 2016 were examined by Nathaniel (2021). The outcomes validated the adverse influence of NR, HC and EG on EQ. Using data from 1990 to 2018, Luo et al. (2023) evaluated the effect of EG and NR on ED in Asian nations. The outcomes exhibited that carbon emissions and NR were strongly positively correlated, especially among low-income nations. The study also showed that, for middle- and low-income countries, EG and

ED was positively correlated, whereas for high-income countries, the link was negatively correlated. Therefore, considering the previous studies, the following hypothesis is developed:

H_1: Natural resources are positively associated with the ED in BRI countries

2.2. Relationship between Green Energy and ED

Iram et al. (2024) determined the different factors of ED in OIC economies by exercising the data from 2003 to 2021. The study revealed that FDI and ICT use positively enhanced environmental degradation (ED) while financial development and REC negatively related to ED in OIC countries. Similarly, Kartal et al. (2022) examined the link between energy use and ED in the United States from 1989 to 2021. The outcomes reveled that energy use significantly affects ED. The results also demonstrated the significance of REC to reduce ED. According to the findings, US policymakers should focus on lowering their reliance on fossil fuels and increasing the REC by changing their energy structure to emit less CO_2 emissions. Khan et al. (2021) examined the influence of trade, FDI, REC, and tourism on ED for the years 1985 to 2018. The results demonstrated that REC negatively affects ED while FDI has a positive influence in rich countries whereas it has an adverse effect on ED in underdeveloped countries. Belaïd and Zrelli (2019) investigated the relationship between ED, GDP, NREC and REC in the context of Mediterranean nations between 1980 and 2014. The outcomes demonstrated that there was a reciprocal relationship between NREC and ED. REC and ED, GDP and ED, and NREC and ED were revealed to have unidirectional causal relationships. Therefore, following the previous studies, the following hypothesis is developed:

H_2: Green energy is negatively associated with the ED in BRI countries

2.3. Relationship between Green Finance and ED

Liu et al. (2022) investigated the influence of FD and institutional quality (IQ) on the ecological footprints of developing nations using data spanning 1990 to 2018. The findings showed that FD degrades ecological quality by increasing ecological footprints. Their research also showed that HC and IQ decline the ecological footprints. Furthermore, financial development (FD) promotes EQ via the use of HC. Inamullah and Rehman (2022) evaluated the impact financial expansion from 1974 to 2018 on ED in Pakistan. The study discovered that financial development has an adverse effect on ED. Population growth, ED, and FDI all had positive and statistically significant effects over time. Trade has an adverse and significant influence on ED. Wang, Cai and Elahi (2021) explored the impacts of various GF mechanisms under various environmental regulatory intensities. From 2005 to 2017, the study examined panel data from 126 Chinese cities. The findings demonstrated that GF instruments significantly reduced the intensity of CO_2 emissions and that GF was flexible enough to accommodate environmental requirements with varying degrees of strictness. The study concluded that a managerial change was needed in green financing and environmental laws to reduce CO_2 emissions and enhance sustainable development. From 2004 to 2017, Zaidi, Hussain and Uz Zaman (2021) explored the connections among ED, EC, and financial inclusion in OECD economies. The study found a direct link between financial inclusion, ED, and energy use. Therefore, considering the previous studies, the following hypothesis is developed:

H_3: Green finance is negatively associated with the ED in BRI countries

3. Data and Methodology

To examine the role of NR, green energy, and green finance on ED, this study used the panel dataset of 105 Belt and Road Initiative (BRI) countries from 2001 to 2021. We collected the data for all the variables from the World Development Indicators. The study model is based on the EKC framework, which states that at the initial phases of development, an increase in GDP contributes to the ED in a country, but after a certain point, it tends to reduce it. Furthermore, we have added green energy, green finance, and natural resources as core variables in a model. In addition, trade openness is used as a control variable. The model's econometric form is given as under:

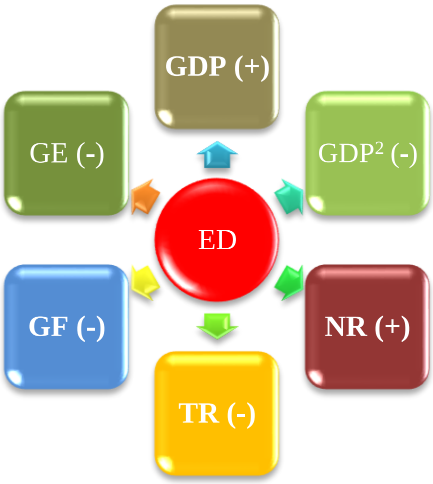
$$ED_{it} = \beta_o + \beta_1 GDP_{it} + \beta_2 GDP^2_{it} + \beta_3 NR_{it} + \beta_4 GE_{it} + \beta_5 GF_{it} + \beta_6 TR_{it} + u_{it} \quad (1)$$

Where ED indicates environmental degradation, GDP is the gross domestic product, NR indicates natural resources, GE represents green energy, GF indicates green finance, TR refers to the trade openness and u_{it} is the error term.

Table 1: Variable's Descriptions

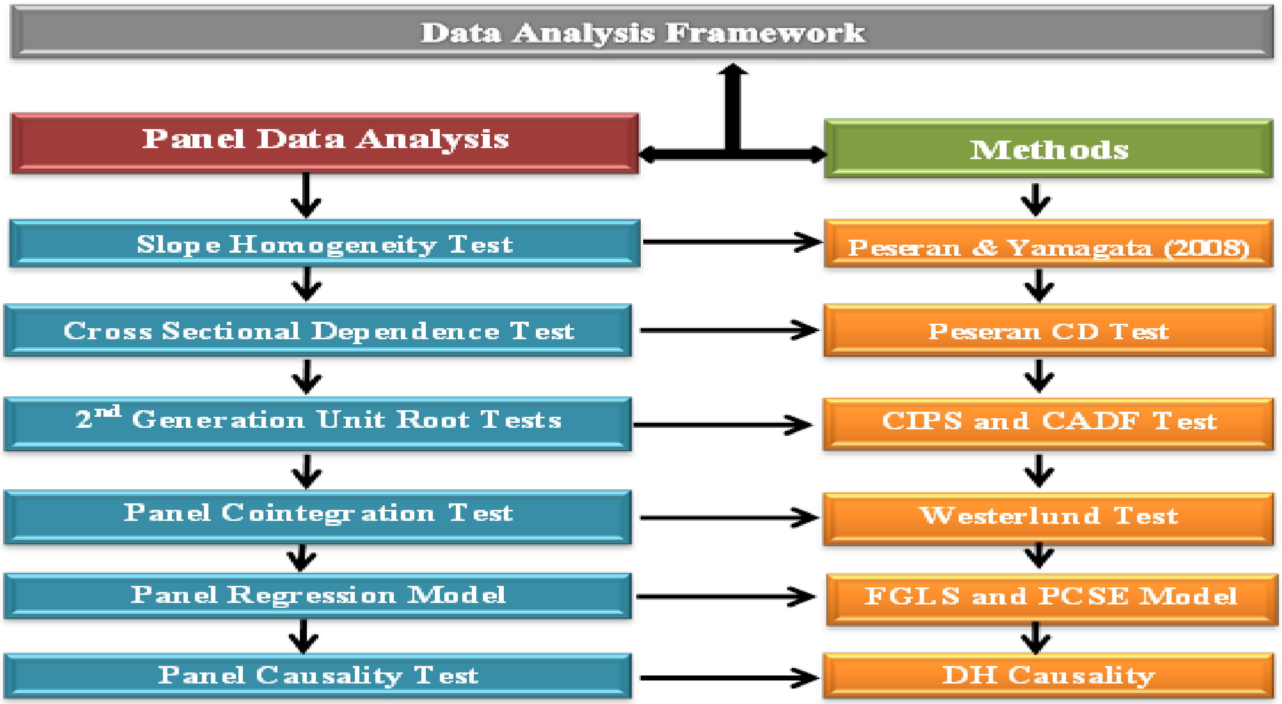
Variables	Descriptions
ED	Environmental Degradation (CO_2 emissions kt)
GDP	Gross domestic product (Current US dollars)
NR	Natural resource rents (Percent of GDP)
GE	Renewable energy consumption (Percent of total energy consumption)
GF	Financial development (Credit to private sector as a percent of GDP)
TR	Trade openness (as a percent of GDP)

Figure 1: Conceptual Model



For data analysis, different panel data estimation techniques are used. First, the descriptive and correlation coefficient is used. Second, cross-sectional dependency (CD) and slope homogeneity (SH) tests are exercised. Third, panel cointegration tests are used. Fourth, FGLS model is used for the long-run estimation and PCSE model for robustness estimation. Lastly, DH causality test is used to check the casual relationship between the variables.

Figure 2: Methodological Framework



3.1. Cross-Sectional Dependence Test

CD test that was established by Pesaran (2004) is exercised in a study to check the CD. When economies are interconnected on a regional or international level, CD is recognized to exist. CD is evaluated to avert the issues of biasedness, and inconsistency in panel data. The CD test is estimated by using the subsequent equation:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \sqrt{T_{ij} h_{ij}^{2}} \right) \tag{2}$$

Where h refers to the correlation coefficient, x^2 is asymptotic circulation for fixed, N indicates the size of the cross-section, and T is the time period. The null hypothesis for CD test is no CD against alternative hypothesis presence of CD.

3.2. Slope Homogeneity Test

When using panel data in econometrics, slope homogeneity is essential to test. Cross-sectional units and SH between nations are related (Pesaran, 2004). The slope homogeneity is tested using the following hypotheses:

H_o: "Slope coefficients are homogeneous"
H_1: "Slope coefficients are heterogeneous"

3.3. Panel Unit Root Test

Second-generation panel unit root tests are being utilized instead of traditional ones because of their ability to address the CD problem in recording the variables' integration order. For stationary test, we employed Pesaran (2007) framework, which is also known as CIPS and CADF. The outcomes of the 2nd generation unit tests are dependable in the presence of heterogeneity and CD among the economies under investigation.

$$\Delta x_{it} = \alpha_{it} + \beta_i x_{it-1} + \partial_i T + \sum_{j=1}^{N} \theta_{it} \Delta x_{i,t-j} + \nu_{it} \tag{4}$$

Where Δ indicates a differenced function, x_{it} refers to the variables with time series and cross sections, $x_{i,t-j}$ is the 1st lag difference handling serial correlation among the errors, ɑ is the divergent intercept, T is time and v_{it} is the error term.

3.4. Approaches for Long-Run Parameters of Model

For the long-run estimation of parameters, the study used a feasible generalized least square approach (FGLS). FGLS model can produce reliable outcomes when the panel data have more time series (T) than size of the cross sections (N) (Alharthi & Hanif, 2020; Iram et al., 2024). In addition, this approach also address the issues of SH and CD. Furthermore, for the robustness of FGLS model, the study employs panel corrected standard errors (PCSEs) model that was developed by Beck and Katz (1995). This approach is also useful and address the issues of SH and CD.

4. Results and Discussions

4.1. Descriptive Analysis

Table 2 reveals the descriptive estimates of variables. The results shows that the mean values of ED, GDP, NR, GE, GF and TR in BRI countries are 9.4937, 24.0975, 0.9517, 3.2456, 3.2198 and 4.3085, respectively. The maximum values of ED, GDP, NR, GE, GF and TR are 16.2908, 30.5114, 4.5952, 4.5884, 5.5400 and 5.9613, respectively. In contrast, the minimum values of ED, GDP, NR, GE, GF and TR are 4.6977, 19.7518, -6.8424, -2.5996, -6.4292 and 1.4176, respectively. The skewness values of ED and GDP indicate the distribution is positively skewed while the distribution of NR, GE and GF are negatively skewed. Lastly, kurtosis values of all the variables are greater than 3 signifying that the distribution of ED, GDP, NR, GE, GF and TR are leptokurtic.

Table 2: Descriptive Estimates

Variables	Mean	Maximum	Minimum	S.D.	Skewness	Kurtosis
ED	9.4937	16.2908	4.6977	1.9439	0.2819	3.4007
GDP	24.0975	30.5114	19.7518	1.7632	0.3182	3.1707
NR	0.9517	4.5952	-6.8424	1.9219	-1.0391	4.6252
GE	3.2456	4.5884	-2.5996	1.1234	-1.0963	4.0095
GF	3.2198	5.5400	-6.4292	1.2951	-2.9429	19.5809
TR	4.3085	5.9613	1.4176	0.4785	-0.1371	3.6752

4.2. Correlation Analysis

Correlation matrix examines the extent of association between any pair of variables. The estimates of correlation coefficient are given in Table 3. The outcomes show that environmental degradation is positively correlated to the GDP (0.816), and NR (0.182) while ED is negatively correlated to the GE (-0.515), GF (-0.453) and TR (-0.020).

Table 3: Correlation Matrix

Correlation	ED	GDP	NR	GE	GF	TR
ED	1.000					
GDP	0.816	1.000				
NR	0.182	-0.225	1.000			
GE	-0.515	-0.348	0.210	1.000		
GF	-0.453	0.427	-0.476	-0.285	1.000	
TR	-0.020	-0.100	-0.266	-0.286	0.286	1.000

4.3. CD and Slope Homogeneity Analysis

To evaluate the CD among BRI countries, we have used Pesaran CD test. CD test statistic value of all the variables is statistically significant as shown in Table 4, demonstrating that CD holds in BRI countries. It suggests that any shock in any of the BRI country can influence the economies of other BRI countries. In contrast, slope homogeneity test shows that Δ Test and Δ Adj Test values are statistically significant, indicating that the H_o is rejected and it is proposed that the issue of slope heterogeneity prevails in the model.

Table 4: CD and SH Test Estimates

Variables	Pesaran CD	P-Value
ED	90.31***	0.0000
GDP	303.51***	0.0000
NR	82.25***	0.0000
GE	14.12***	0.0000
GF	88.93***	0.0000
TR	30.7452***	0.0000
Slope Homogeneity Test		
Δ Test	32.389***	0.0000
Δ Adj Test	41.166***	0.0000

*Note: ***, **, * are p<0.01, <0.05 and <0.10, respectively*

4.4. Panel Unit Root Analysis

Following the issues of CD and slope heterogeneity, we have applied 2nd generation unit root tests as 1st generation unit root tests does not deals with the issues of CD and slope heterogeneity. For this purpose, CIPS and CADF tests are employed and their estimates are shown in Table 5. The outcomes CIPS and CADF tests confirms that the variables ED, GDP, NR and GF are stationary at I(0) whereas GE and TR are stationary at I(1), suggesting the mixed order of integration.

Table 5: Unit Root Test Estimates

Variables	CIPS		CADF		Outcomes
	I(0)	I(1)	I(0)	I(1)	
ED	-2.254***	-3.587***	-2.395***	-4.302***	I(0)
GDP	-2.683***	-4.826***	-2.775***	-3.992**	I(0)
NR	-2.515*	-3.731***	-2.529***	-5.324***	I(0)
GE	-1.762	-4.179***	-1.192	-2.826***	I(1)
GF	-2.196**	-2.976***	-2.241***	-4.730***	I(0)
TR	-1.722	-3.848***	-0.992	-2.077**	I(1)

Note: ****, **, * are p<0.01, <0.05 and <0.10, respectively*

4.5. Panel Cointegration Analysis

For the model's long-run cointegration among variables, we have utilized Westerlund and Pedroni cointegration tests. Table 6 demonstrates the outcomes of the cointegration tests. The variance ratio of the Westerlund test is designates to be statistically significant at the 5% level. Similarly, Modified PP t, PP t and ADF t tests found statistically significant values. Therefore, Westerlund and Pedroni test suggest that the long-run cointegration exists between the variables in a model.

Table 6: Panel Cointegration Test

Westerlund Cointegration		
Test	**Statistic**	**Prob.**
Variance Ratio	-2.8875**	0.0190
Pedroni Residual Cointegration Test		
Modified PP t	-2.0121**	0.0221
PP t	-2.3473**	0.0105
ADF t	-11.6428***	0.0000

*Note: ***, **, * are p<0.01, <0.05 and <0.10, respectively*

4.6. FGLS Analysis

Considering the issues of CD and SH, we have applied FGLS approach for the long-run estimation of parameters. Firstly, the findings display that GDP is positively and considerably linked with the ED in BRI countries. The GDP's coefficient directs that the ED increases by 3.49 percent for every percent increase in GDP. Furthermore, the square of GDP is turn out to be negatively linked to the ED in BRI countries. These outcomes confirms the EKC framework in BRI countries suggesting that at the initial stages of development, an increase in GDP enhances the ED, but after a time, it leads to improve the EQ. Similar outcomes was also established by (Li et al., 2023; Weimin et al., 2022). In contrast, NR is positively and substantially linked with the ED in BRI economies. The NR's coefficient directs that the ED increases by 8.91 percent for every percent increase in NR. These outcomes support the resource curse theory signifying that overreliance on NR contribute to the increasing CO_2 emissions in BRI countries. Similar findings were also established by Sibt-e-Ali et al. (2023) and Zhu et al. (2024). Furthermore, the outcomes also show that GE is negatively and substantially linked with the ED in BRI countries. The GE's coefficient directs that the ED decreases by -38.78 percent for every percent increase in GE. It implies that green energy sources, such as wind, solar, and biomass, are projected to be both economical and environmentally benign since they reduce pollution, enhance energy security, lessen the hostile effect of climate change and provide affordable electricity to remote locations and therefore lead to improve the EQ. The negative relationship between GE and ED was also confirmed by Iram et al. (2024); Ji et al. (2023); Zhu et al. (2024). Besides, GF is imperative to decline the CO_2 emissions. The results also found that GF is adversely and substantially connected with the ED in BRI countries. The GF's coefficient directs that the ED decreases by -11.98 percent for every percent increase in GF. It suggests that GF makes green energy investments more realistic by facilitating easier access to important and competitive financial schemes for businesses and individuals. On the other hand, investment in GF promotes environmentally friendly technologies to create eco-friendly goods that improve the climate (Salahuddin, Alam, & Ozturk, 2016). The negative relationship between GF and ED was also validated by Qadri et al. (2023); Zhao et al. (2023). Lastly, the association between TR and ED is turn out to direct but statistically insignificant in BRI countries. The positive yet insignificant association between TR and ED in BRI countries could reflect minimal influence from trade policies on EQ due to weak regulations or enforcement practices.

Table 7: FGLS Estimates

DV: Environmental Degradation (CO_2 Emissions)				
Variables	**Coefficient**	**S.E.**	**Z-Stat.**	**Prob.**
GDP	0.0349***	0.01530	8.82	0.0000
GDP^2	-0.5354***	0.1850	-2.89	0.004
NR	0.0891***	0.0082	10.86	0.000
GE	-0.3878***	0.0138	-27.99	0.000
GF	-0.1198***	0.0134	-8.90	0.000
TR	0.0085	0.0332	0.26	0.798
C	11.7722	8.0629	1.46	0.144
Wald Chi^2 (6)	18003.94***			
Log likelihood	-2181.338			

Note: ***, **, * *are p<0.01, <0.05 and <0.10, respectively*

4.7. Robustness Estimation

For robustness estimation, we have applied PCSE model as it also deals with the issues of CD and SH. The estimates of PCSE model also confirming the estimates of the FGLS model signifying that GDP, NR and TR are positively associated to the ED in BRI countries while GDP^2, GE and GF are negatively associated to the ED in BRI countries.

Table 8: Panel Corrected Standard Error (PCSE) Estimates

DV: ED (CO_2 Emissions)				
Variables	**Coefficient**	**S.E.**	**Z-Stat.**	**Prob.**
GDP	0.1349***	0.0123	10.93	0.000
GDP^2	-0.5354***	0.1543	-3.47	0.001
NR	0.0891***	0.0107	8.27	0.000
GE	-0.3878***	0.0148	-26.18	0.000
GF	-0.1198***	0.0077	-15.56	0.000
TR	0.0085	0.0285	0.30	0.765
C	11.7722*	6.9396	1.70	0.090

*Note: ***, **, * are p<0.01, <0.05 and <0.10, respectively*

Figure 2: Summary of FGLS and PCSE Outcomes in BRI Countries

4.8. Causality Analysis

Lastly, for the panel causal relationship between the variables, we have used Dumitrescu Hurlin Panel Causality Test. The outcomes show that there is bidirectional causality between GDP and ED, NR and ED, GE and ED, GF and ED and TR and ED.

Table 8: DH Causality Estimates

H_o:	**W-Stat.**	**Zbar-Stat.**	**Prob.**
GDP ≠ ED	4.7994***	9.1963	0.0000
ED ≠ GDP	2.8414*	1.8949	0.0581
NR ≠ ED	3.0341***	2.6134	0.0090
ED ≠ NR	4.6666***	8.7013	0.0000
GE ≠ ED	3.9100***	5.8799	0.0000
ED ≠ GE	4.7195***	8.8984	0.0000
GF ≠ ED	4.3320***	7.4534	0.0000
ED ≠ GF	5.1959***	10.6752	0.0000
TR ≠ ED	4.1801***	6.8871	0.0000
ED ≠ TR	5.0387***	10.0888	0.0000

*Note: ***, **, * are p<0.01, <0.05 and <0.10, respectively*

5. Conclusions and Recommendations

This study analyzes the role of NR, GE and green finance in influencing the ED in BRI countries. The study employed data of 105 BRI economies from 2001 to 2021 and the data was collected from WDI indicators. For data analysis, different panel data estimation approaches i.e., CD test, SH test, panel cointegration tests, FGLS and PCSE model and DH causality tests are performed. Correlation estimates found that environmental degradation is directly correlated to the GDP and NR whereas ED is negatively correlated to the GE, GF and TR. To assess the CD among BRI countries, we have used Pesaran CD test. The CD analysis found that cross-sectional dependence holds in BRI countries suggesting that any shock in any of the BRI country can influence the economies of other BRI countries. Similarly, SH test found the issue of slope heterogeneity in the model. The outcomes CIPS and CADF tests confirms that the variables ED, GDP, NR and GF are stationarity at I(0) whereas GE and TR are stationary at I(1). The Westerlund and Pedroni cointegration tests confirm the long-run cointegration in a model. Furthermore, the FGLS model shows that EKC framework is validated in BRI countries. The study also found that green energy and green finance are critical to reduce the CO_2 emissions in BRI countries. The study also shows that natural resources are augmenting the level of CO_2 emissions in BRI countries. Therefore, considering the study outcomes, it is concluded that green finance and green energy must be encouraged in BRI countries to improve the EQ.

The study has also several policy implications. First, to lessen the effects on the environment, natural resources must be managed effectively. The economies of BRI should create and enforce stringent regulations as well as ecologically sound, sustainable practices to lessen pollution, habitat devastation, and deforestation caused by resource extraction. Second, encouraging green energy sources through financial and regulatory support is essential. In a similar vein, expanding global cooperation for green technology transfer and knowledge exchange can hasten the adoption of GE. Third, governments of BRI countries must offer green credit to the people so they can replace high energy consuming appliances with energy-savings appliances. Lastly, to improve environmental quality, it is important to support R & D in green technologies as well as public education regarding the use of GE sources. Despite the significant contribution in the literature, this study also has some limitations. First, the study used 105 countries' data for empirical work. Future studies can make country-wise analyses to better estimate the effects of NR, GE and GF on ED. Second, the study used FGLS and PCSE models for data estimation. However, future studies can use the CS-ARDL technique to capture both the long- and short-run effects of NR, GE, and GF. In addition, to see the heterogeneous effects of NR, GE and GF, the MMQR approach can also be used. Lastly, in addition to NR, GE and GF, studies can also analyze the effects of the digital economy, environmental taxes and financial technology on ED in BRI countries.

References

Aladejare, S. A. (2022). Natural resource rents, globalisation and environmental degradation: New insight from 5 richest African economies. *Resources Policy*, *78*, 102909. https://doi.org/10.1016/j.resourpol.2022.102909

Alharthi, M., & Hanif, I. (2020). Impact of blue economy factors on economic growth in the SAARC countries. *Maritime Business Review*, *5*(3), 253-269. https://doi.org/10.1108/MABR-01-2020-0006

Asghar, M. M., Safdar, R., Zubair, M., & Hanif, M. (2024). Exploring the Influence of Financial Development, Institutional Quality and Trade Openness on Inclusive Growth in SAARC Countries. *Pakistan Journal of Humanities and Social Sciences*, *12*(2). https://doi.org/10.52131/pjhss.2024.v12i2.2221

Beck, N., & Katz, J. N. (1995). What To Do (and Not to Do) with Time-Series Cross-Section Data. *American Political Science Review*, *89*(3), 634-647. https://doi.org/10.2307/2082979

Belaïd, F., & Zrelli, M. H. (2019). Renewable and non-renewable electricity consumption, environmental degradation and economic development: Evidence from Mediterranean countries. *Energy Policy*, *133*, 110929. https://doi.org/10.1016/j.enpol.2019.110929

Danish, Baloch, M. A., Mahmood, N., & Zhang, J. W. (2019). Effect of natural resources, renewable energy and economic development on CO2 emissions in BRICS countries. *Science of The Total Environment*, *678*, 632-638. https://doi.org/10.1016/j.scitotenv.2019.05.028

Danish, Baloch, M. A., & Wang, B. (2019). Analyzing the role of governance in CO2 emissions mitigation: The BRICS experience. *Structural Change and Economic Dynamics*, *51*, 119-125. https://doi.org/10.1016/j.strueco.2019.08.007

Dhrifi, A., Jaziri, R., & Alnahdi, S. (2020). Does foreign direct investment and environmental degradation matter for poverty? Evidence from developing countries. *Structural Change and Economic Dynamics*, *52*, 13-21. https://doi.org/10.1016/j.strueco.2019.09.008
Inamullah, M., & Rehman, A. (2022). The Impact of Financial Sector Development on Environmental Degradation (Carbon Dioxide Emission) in Pakistan. *Journal of Economic Impact*, *4*(3), 244-251. https://doi.org/10.52223/jei4032211
Iram, M., Zameer, S., Asghar, M. M., & Kalsoom, U.-e.-. (2024). Financial Development, ICT Use, Renewable Energy Consumption and Foreign Direct Investment Impacts on Environmental Degradation in OIC Countries. *Pakistan Journal of Humanities and Social Sciences*, *12*(2). https://doi.org/10.52131/pjhss.2024.v12i2.2167
Ishfaq, M., Rasool, A., Muzammil Asghar, M., Karim, S., & Ahmad, R. (2024). Impact of Natural, Physical and Human Capital Formation on Economic Growth in Pakistan: An ARDL Analysis. *Journal of Asian Development Studies*, *13*(3), 222-233. https://doi.org/10.62345/jads.2024.13.3.19
Ji, D., Sibt-e-Ali, M., Amin, A., & Ayub, B. (2023). The determinants of carbon emissions in Belt and Road Initiative countries: analyzing the interactive role of information and communication technologies. *Environmental Science and Pollution Research*, *30*(46), 103198-103211. https://doi.org/10.1007/s11356-023-29719-8
Kartal, M. T., Kılıç Depren, S., Ayhan, F., & Depren, Ö. (2022). Impact of renewable and fossil fuel energy consumption on environmental degradation: evidence from USA by nonlinear approaches. *International Journal of Sustainable Development & World Ecology*, *29*(8), 738-755. https://doi.org/10.1080/13504509.2022.2087115
Kemfert, C., Schäfer, D., Semmler, W., & Zaklan, A. (2019). Green Finance: The Macro Perspective. *Vierteljahrshefte zur Wirtschaftsforschung*, *88*(2), 5-9. https://doi.org/10.3790/vjh.88.2.5
Khan, H., Weili, L., Khan, I., & Khamphengxay, S. (2021). Renewable Energy Consumption, Trade Openness, and Environmental Degradation: A Panel Data Analysis of Developing and Developed Countries. *Mathematical Problems in Engineering*, *2021*, 1-13. https://doi.org/10.1155/2021/6691046
Li, H., Ali, M. S. E., Ayub, B., & Ullah, I. (2023). Analysing the impact of geopolitical risk and economic policy uncertainty on the environmental sustainability: evidence from BRICS countries. *Environmental Science and Pollution Research*, *31*(34), 46148-46162. https://doi.org/10.1007/s11356-023-26553-w
Liu, G., Khan, M. A., Haider, A., & Uddin, M. (2022). Financial Development and Environmental Degradation: Promoting Low-Carbon Competitiveness in E7 Economies' Industries. *International Journal of Environmental Research and Public Health*, *19*(23), 16336. https://doi.org/10.3390/ijerph192316336
Luo, J., Ali, S. A., Aziz, B., Aljarba, A., Akeel, H., & Hanif, I. (2023). Impact of natural resource rents and economic growth on environmental degradation in the context of COP-26: Evidence from low-income, middle-income, and high-income Asian countries. *Resources Policy*, *80*, 103269. https://doi.org/10.1016/j.resourpol.2022.103269
Majeed, A., Ye, C., Chenyun, Y., Wei, X., & Muniba. (2022). Roles of natural resources, globalization, and technological innovations in mitigation of environmental degradation in BRI economies. *PLOS ONE*, *17*(6), e0265755. https://doi.org/10.1371/journal.pone.0265755
Midilli, A., Dincer, I., & Ay, M. (2006). Green energy strategies for sustainable development. *Energy Policy*, *34*(18), 3623-3633. https://doi.org/10.1016/j.enpol.2005.08.003
Mukhtarov, S., Mikayilov, J. I., Mammadov, J., & Mammadov, E. (2018). The Impact of Financial Development on Energy Consumption: Evidence from an Oil-Rich Economy. *Energies*, *11*(6), 1536. https://doi.org/10.3390/en11061536
Nathaniel, S. P. (2021). Environmental degradation in ASEAN: assessing the criticality of natural resources abundance, economic growth and human capital. *Environmental Science and Pollution Research*, *28*(17), 21766-21778. https://doi.org/10.1007/s11356-020-12034-x
Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.572504
Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2), 265-312. https://doi.org/10.1002/jae.951
Qadri, S. U., Shi, X., Rahman, S. U., Anees, A., Ali, M. S. E., Brancu, L., & Nayel, A. N. (2023). Green finance and foreign direct investment–environmental sustainability nexuses in

emerging countries: new insights from the environmental Kuznets curve. *Frontiers in Environmental Science*, *11*, 1074713. https://doi.org/10.3389/fenvs.2023.1074713

Sadorsky, P. (2011). Financial development and energy consumption in Central and Eastern European frontier economies. *Energy Policy*, *39*(2), 999-1006. https://doi.org/10.1016/j.enpol.2010.11.034

Sakariyahu, R., Lawal, R., Etudaiye-Muhtar, O. F., & Ajide, F. M. (2023). Reflections on COP27: How do technological innovations and economic freedom affect environmental quality in Africa? *Technological Forecasting and Social Change*, *195*, 122782. https://doi.org/10.1016/j.techfore.2023.122782

Salahuddin, M., Alam, K., & Ozturk, I. (2016). Is rapid growth in Internet usage environmentally sustainable for Australia? An empirical investigation. *Environmental Science and Pollution Research*, *23*(5), 4700-4713. https://doi.org/10.1007/s11356-015-5689-7

Shah, S. Z. A., Asghar, M. M., & Riaz, U. (2020). Exploring the Factors Affecting Economic Growth in Pakistan. *Global Social Sciences Review*, *V*(III), 400-409. https://doi.org/10.31703/gssr.2020(V-III).43

Sibt-e-Ali, M., Weimin, Z., Javaid, M. Q., & Khan, M. K. (2023). How natural resources depletion, technological innovation, and globalization impact the environmental degradation in East and South Asian regions. *Environmental Science and Pollution Research*, *30*(37), 87768-87782. https://doi.org/10.1007/s11356-023-28677-5

Usman, M., & Jahanger, A. (2021). Heterogeneous effects of remittances and institutional quality in reducing environmental deficit in the presence of EKC hypothesis: A global study with the application of panel quantile regression. *Environmental Science and Pollution Research*, *28*(28), 37292-37310. https://doi.org/10.1007/s11356-021-13216-x

Wang, F., Cai, W., & Elahi, E. (2021). Do Green Finance and Environmental Regulation Play a Crucial Role in the Reduction of CO2 Emissions? An Empirical Analysis of 126 Chinese Cities. *Sustainability*, *13*(23), 13014. https://doi.org/10.3390/su132313014

Wang, Y., & Zhi, Q. (2016). The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies. *Energy Procedia*, *104*, 311-316. https://doi.org/10.1016/j.egypro.2016.12.053

Weimin, Z., Sibt-e-Ali, M., Tariq, M., Dagar, V., & Khan, M. K. (2022). RETRACTED ARTICLE: Globalization toward environmental sustainability and electricity consumption to environmental degradation: does EKC inverted U-shaped hypothesis exist between squared economic growth and CO2 emissions in top globalized economies. *Environmental Science and Pollution Research*, *29*(40), 59974-59984. https://doi.org/10.1007/s11356-022-20192-3

Zaidi, S. A. H., Hussain, M., & Uz Zaman, Q. (2021). Dynamic linkages between financial inclusion and carbon emissions: Evidence from selected OECD countries. *Resources, Environment and Sustainability*, *4*, 100022. https://doi.org/10.1016/j.resenv.2021.100022

Zhao, J., Rahman, S. U., Afshan, S., Ali, M. S. E., Ashfaq, H., & Idrees, S. (2023). Green investment, institutional quality, and environmental performance: evidence from G-7 countries using panel NARDL approach. *Environmental Science and Pollution Research*, *30*(45), 100845-100860. https://doi.org/10.1007/s11356-023-29332-9

Zhu, R., Xu, Q., Xiqiang, X., Sibt-e-Ali, M., Waqas, M., Ullah, I., & Anwar, A. (2024). Role of resources rent, research and development, and information and communication technologies on CO2 emissions in BRICS economies. *Resources Policy*, *93*, 105072. https://doi.org/10.1016/j.resourpol.2024.105072