Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 3): pp. 3969-3978
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.03.409

Is Sustainable Finance And Green Technology Paring Down Environmental Pollution? An Empirical Study Of Brics Economies

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Abstract

The purpose of the study was to examine the effects of sustainable finance, green technology, economic growth, urbanization, and natural resource rent on CO2 emission, a proxy for environmental pollution, in BRICS (Brazil, Russia, India, China, and South Africa) nations. The analysis was conducted using World Development Indicators and OECD, 2022, annual data from 2005 to 2019, and a "Fixed Effect Model with least square dummy variable approach" (LSDV). According to the study's findings, Sustainable finance and green technology have a significant negative impact on environmental pollution, whereas energy development and urbanization have positive effects on environmental pollution. The natural resource rent in BRICS nations has no significant effect on environmental pollution. The study suggests that policymakers in BRICS nations should develop a strong research and development base in order to launch an increasing number of green technologies that can be used in the production process and reduce the emission rate of harmful gases and pollutants.

Keywords: Economic growth, Urbanisation, Sustainable Pollution, Green Technology, Environmental Pollution.

1. INTRODUCTION

Recent publications have paid more attention to sustainable finance, which can be attributed to the expansion of global mechanisms to combat the climate change crisis. The implementation of the "Paris Climate Agreement" and the "Sustainable Development Goals" of the United Nations represented substantial contributions to an ongoing commitment to environmental sustainability. Sustainable finance involves more than maximizing investment returns. This concept offers a double-sided scenario in finance, generating profits while simultaneously enhancing human utility. Sustainable finance is often conceived of as the financial backing for green growth, which reduces greenhouse gas emissions and air pollutants significantly. Green or sustainable financing in

agriculture, green construction, and other green projects should increase the nation's economic growth (Chowdhary et al.,2013). Due to the overwhelming scientific evidence of climate change, the world must act swiftly to avoid disastrous consequences. Therefore, green or sustainable funding is a crucial tool for mitigating the existential threats posed by climate change (Gagnon and Sack 2018). Muganyi et al. referred to sustainable finance as an environmental investment approach in 2021. Due to inadequate government funding, it permits private investors to support environmental projects. The issue of environmental deterioration can be remedied by the use of green technologies. Green technologies have benefits, according to Baloch et al. (2021), notwithstanding the cost-effective utilization of conventional and renewable energy. It increases production efficiency, hence slowing the rate of environmental degradation. Despite their abundant natural resources, Huang, Sadiq, et al. (2021) assert that certain nations have not made substantial economic growth. Due to countries' lack of progress, numerous researchers and politicians are examining the role of natural resources on economic growth. The literature demonstrates that Natural resource rent influences environmental quality (NRR) and that excessive NRR extraction resulting from economic development and modernization might impact environmental quality (Tufail et al., 2021; Wang et al., 2020). Policymakers, governments, and scholars are worried about the environmental concerns posed by urbanization. Numerous studies on green finance and variables such as energy innovation and carbon emission have been conducted. In this study, the researcher analyzed panel data from 2005 to 2019 collected in accordance with BRICS countries in order to investigate the contribution of sustainable finance and green technologies in reducing environmental pollution and assess the impact of various factors such as economic growth, urbanization, and natural resource rent on the deterioration of environmental quality.

The organization of subsequent studies is as follows: the next section presents a literature review conducted in this field; the third section explains the formulation of hypotheses; the fourth section describes the research methodology; the fifth section presents data analysis and interpretation; the sixth section discusses results, and the final section concludes the study.

2. REVIEW OF LITERATURE

Madaleno et al. (2022) analyzed the association between "environmental responsibility," "green technology," "clean energy," and "green finance" by using a novel time-varying causality test. It was found that there was a bidirectional causality between green finance, clean energy, and environmental pollution, except during the COVID period.

Ge et al. (2022) studied the impact of technological innovation in renewable energy on the industrial structure using regression analysis. The study concluded that development in renewable energy technologies leads to modification of the industrial structure. A low level of green finance prevented the industrial structure from upgradation while a high level of green finance supported in upgradation of the industrial structure.

Li et al. (2022) analyzed the role of green finance and energy innovation in enhancing environmental quality in MINT economies using the Cross-sectional dependency test, Robustness Test, and Granger Causality test. It was found that "natural resource rent," "urbanization," and "economic growth" has a positive relationship with environmental degradation while "green finance" and "energy innovation" have a significant negative relationship with environmental degradation.

Sun et el. (2022) examined the impact of green finance on renewable energy development for reducing carbon emissions in China using Difference-in-Difference analysis. They found a significant impact of green finance on renewable energy development and concluded that major pollutants such as “sulphur dioxide,” “nitrogen dioxide,” and “PM2.5” in China were reduced by increasing green finance in the renewable energy sector.

Nawaz et al. (2020) analyzed the relationship between green finance and climate change mitigation in N-11 and BRICS countries by using DID analysis and Probit regression analysis. It was found that "renewable energy source consumption," “Population,” “FDI,” “CO_2 emission,” “inflation,” "technical corporation grants," "domestic credit to the private sector," and "research and development" played a significant positive role in promoting green finance and climate change mitigation.

3. HYPOTHESES DEVELOPMENT

3.1 Sustainable Finance and Environmental Pollution

Multiple research has discovered a correlation between green finance, sustainable finance, and energy finance and environmental pollution. Green finance mitigates environmental deterioration by encouraging investment in renewable energy (Wang et al., 2021). In their analysis of the top ten economies, Meo and Karim (2021) discovered that green financing had an inverse association with environmental damage. Based on these studies, the following hypothesis has been formulated:

H_{01} : There is no significant impact of sustainable finance on environmental pollution.

H_{A1} : There is a significant impact of sustainable finance on environmental pollution.

3.2 Green Technology and Environmental Pollution

Environmental degradation can be reduced by promoting environmental technologies (Baloch et al., 2021). It indicates a negative relationship between green technology and environmental pollution (Shahbaz et al., 2018). Mensah et al. (2019) investigated the effects of environmental technologies on environmental pollution in OECD nations and discovered that it aids in the decrease of environmental degradation. The following hypothesis was formulated by a researcher on the basis of a survey of a variety of relevant publications.

H_{02} : There is no significant impact of green technology on environmental pollution.

H_{A2} : There is a significant impact of green technology on environmental pollution.

3.3 Economic Growth and Environmental Pollution

The 21st century is a technological period, and practically all nations are rising swiftly. It entails the expansion of companies and other economic activities that result in the rapid depletion of natural resources and the emission of hazardous chemicals. During the development phase of most nations, environmental contamination increases (Grossman and Kruger, 1995; Musah et al., 2020; Usman et al., 2020). Based on these studies, the following hypothesis has been formulated:

H_{03} : There is no significant impact of economic growth on environmental pollution.

H_{A3} : There is a significant impact of economic growth on environmental pollution.

3.4 Urbanisation and Environmental Pollution

Urbanization increases industrial and household energy consumption, resulting in production structures that are increasingly technologically oriented. According to this viewpoint, economic development and progress, together with the effects of urbanization, have led to a rise in energy consumption and CO2 emissions, the fundamental cause of environmental degradation. It has an immediate and favorable effect on environmental pollutants (Odugbesan and Rjoub, 2020; Musah et al., 2020). Based on these studies, the following hypothesis has been formulated:

H_{04} : There is no significant impact of urbanization on environmental pollution.

H_{A4} : There is a significant impact of urbanization on environmental pollution.

3.5 Natural Resource Rent and Environmental Pollution

The majority of nations, particularly developing nations, rely on natural resource extraction for economic growth and development (Xue et al., 2021). It may lead to environmental damage in the lack of suitable mechanisms. It contributed to environmental contamination in BRICS nations (Ibrahim and Ajide, 2021). Based on these studies, the following hypothesis has been formulated:

H_{05} : There is no significant impact of Natural Resource Rent on environmental pollution.

H_{A5} : There is a significant impact of Natural Resource Rent on environmental pollution.

4. RESEARCH METHODOLOGY

This study is empirical and analytical in nature. The researchers have chosen BRICS countries for this impact analysis, and the study period is 2005-2019. The study is based on secondary data that is collected from the websites of World Development Indicators and OECD. This study is based on the model proposed by Li et al. (2022) that was based on the EKC theory proposed by Grossman and Kruger (1995). This study has used fixed effect with least square dummy variable approach to analyze the impact of sustainable finance, green technology, urbanization, and economic growth on environmental

pollution in BRICS countries. The intention of using fixed effect model is to get reliable and validated outcomes. Since every country (BRICS) has a different economic condition, availability of resources, government policies, etc., it is advisable to choose this method for panel data analysis.

4.1 Variables of the Study-

Dependent Variable- Environmental Pollution-**ENP** (CO_2 emission is taken as a proxy for environmental pollution)

Independent Variables- Sustainable Finance-**SF** (Proportion of renewable consumption in final consumption), Green Technology-**GT** (No. of patents in environmental-related technologies), Economic Growth-**EG** (per capital GDP constant 2015 US$), Natural Resource Rent-**NRR** (natural gas rent as a percent of GDP), Urbanisation-**URBN** (urban population as percent of the total population).

5. DATA ANALYSIS AND INTERPRETATION

The following table 1 shows the descriptive statistics of the BRICS countries for the panel dataset from 2005 to 2019.

Table 1. Descriptive Statistics

		ENP	EG	GT	SF	NRR	URBN
Total	N	75	75	75	75	75	75
	Mean	2,630,133.0549	6,341.6289	1011.88	21.872	.7511	61.0741
	Median	1,592,560.0600	6,591.6500	446.00	13.100	.1000	63.2700
	Minimum	331,690.00	953.57	5	3.2	.02	29.24
	Maximum	10,707,219.73	10,155.49	5211	48.9	4.83	86.82
	Std. Deviation	3,260,353.42019	2,906.09286	1363.763	16.4505	1.40915	18.70567
	Kurtosis	.833	-.828	2.710	-1.516	1.562	-1.087
	Skewness	1.545	-.694	1.847	.418	1.773	-.365

a. Limited to the first 100 cases.

Source: Author's calculation

5.1 Fixed Effect Model with Least Square Dummy Variable Approach

The researcher used fixed effect model with LSDV approach to testing the research hypotheses. This approach drops a dummy variable of Brazil to avoid the dummy variable trap. The functional form of LSDV is,

$$CE_i = \beta_0 + \beta_1 EG_i + \beta_2 GT_i + \beta_3 SF_i + \beta_4 NRR_i + \beta_5 URBN_i + u_1 DR + u_2 DI + u_3 DC + u_4 DS + \varepsilon_i$$

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.996[a]	.993	.992	292,104.44951	.993	1017.113	9	65	.000

a. Predictors: (Constant), dummy variable for South Africa, GDP per capita (constant 2015 US$), dummy variable for China, renewable consumption (% of total final consumption), No. Of patent on environmental-related technologies, NRR (% of GDP), dummy variable for India, dummy variable for Russia, urban population (% of total pop.)

The above table displays the model glimpse in which R represents the coefficient of multiple correlations. The value of R- 0.996 shows the significant relationship between environmental pollution and explanatory variables jointly. R^2 is a multiple "coefficient of determination" that measures the goodness of fit of the model. The value of R^2 is 0.993, which is close to 1, which means 99.3 % variation in environmental pollution is explained by the explanatory variables. The difference between R-square and adjusted R-square should be minimum in an effective model, and in this case, the difference is only 0.001. it means the model is very effective and reliable. The p-value of F is less than 0.05 (0.000), which means all slope coefficients are not zero simultaneously, and the high value of the F-ratio shows the effectiveness of model.

Table 3. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9891069.006	2219045.578		-4.457	.000
	Economic Growth	358.131	74.809	.319	4.787	.000
	Green Technology	-190.354	67.237	-.080	-2.831	.006
	Sustainable Finance	-45354.929	17930.826	-.229	-2.529	.014
	NRR	157388.784	94283.531	.068	1.669	.100
	Urbanization	110291.816	27505.161	.633	4.010	.000
	DR	-47286.377	987603.060	-.006	-.048	.962

DI	9445223.589	1125446.834	1.167	8.392	.000
DC	11878222.502	1173864.231	1.467	10.119	.000
DS	1626331.617	887144.271	.201	1.833	.071

a. Dependent Variable: Environmental Pollution
Source: Author's calculation

In the above table, p-value of economic growth, green technology, sustainable finance, and urbanization is less than the significance level of 0.05. It means all these variables have a significant impact on environmental pollution in BRICS countries. The regression coefficient of economic growth and urbanization are 0.319 and 0.633, respectively, which means for every 1 unit increase in economic growth and urban population, environmental pollution will increase by 31.9 % and 63.3 %, respectively. The regression coefficient of green technology and sustainable finance are -0.080 and -0.229, which means that if green technology and sustainable finance increase by one unit, environmental pollution will reduce by 8 % and 22.9 %, respectively. While p-value of NRR is more than 0.05, that means it does not have a significant influence on environmental pollution. The result shows that the intercept of Brazil is -9891069.006, and variations in the intercept of India, China, and South Africa from that of Brazil are 9445223.589, 11878222.502, and 1626331.617, respectively. There is no significant difference in environmental pollution between Brazil and Russia, as p-value is more than 0.05.

6. RESULTS AND DISCUSSION

The following table presents the result of the hypotheses after applying fixed effect model.

Table 4. Hypotheses-Result

Independent Variables	Sig. value	Result of hypotheses testing
Economic Growth (EG)	.000***	The null hypothesis is rejected
Green Technology (GT)	.006***	The null hypothesis is rejected
Sustainable Finance (SF)	.014***	The null hypothesis is rejected

NRR	.100	The null hypothesis is accepted
Urbanization (URBN)	.000***	The null hypothesis is rejected

Source: Author's calculation, ***significant ($p<0.05$)

Table 1. describes the descriptive statistics of all the factors and the dependent variable. The results indicate mean, median, standard deviation, etc. the variables show a high standard deviation level. As per result, CO_2 emissions of BRICS countries are here taken as a proxy for environmental pollution positively influenced by the economic growth of the country and rate of urbanization. It depicts that as the rate of economic growth and urbanization of BRICS countries increases, environmental pollution in those countries also increases. While it is negatively influenced by green technology and sustainable finance. It means the promotion of green or environmental-related technologies and sustainable or green or climate finance leads to the reduction of environmental pollution in BRICS countries.

7. CONCLUSION

This study analyzed the impact of sustainable finance, green technology, economic growth, urbanization, and natural resource rent (NRR) on environmental pollution in BRICS nations from 2005 to 2019, using CO2 emissions as a proxy for environmental pollution. Using a "fixed effect model with least square dummy variable approach" to analyze the data, it was shown that NRR had not had a substantial impact on the amount of environmental pollution. Growth in the economy and urbanization have a positive impact on environmental pollution, whereas sustainable finance and green technology have a negative impact, and promoting them helps reduce environmental pollution. BRICS nations should collaborate with affected parties to fully comprehend their impact. They should prioritize research and development in order to launch green technologies for the generation of renewable energies, the efficient use of "natural resources," the reduction of "greenhouse gas emissions," and the creation of "non-renewable resource" alternatives. They should advocate policies that can aid in securing and restoring natural habitats such as wetlands, thereby facilitating the adaptation of landscapes, ecosystems, and species to climate change. These nations should prioritize the adaptation of green production technology, including cleaner processes, cleaner production, and green investment.

Finally, this study includes limitations that open the door to future research. First, the available data for this investigation spanned only 15 years (from 2005 to 2019). It would be recommended to solve this restriction in future studies if longer datasets become available. Second, the impact of chosen variables, including economic growth, green technology, sustainable finance, urbanization, and natural resource rent, has been analyzed in this study. However, there may be more factors that influence environmental pollution in BRICS nations. Future research may investigate the impact of additional variables. Third, only CO2 emissions are used as a proxy for environmental pollution in

this study. As an indicator of environmental degradation, future research may examine greenhouse gas emissions, NO2, etc. In the future, other advanced econometric approaches can be utilized to analyze the factors driving environmental pollution.

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