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Does Degree of Stringency Matter? Revisiting the Pollution Haven Hypothesis in BRICS Countries

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This study aims to demonstrate the validity of the Pollution Haven Hypothesis (PHH) for BRICS nations by revealing the empirical relationship between foreign direct investment (FDI), air pollution, and environmental regulations. At the same time, the study objectives are based on the BRICS′ COP26 goals focused on mobilizing climate finance annually. The SDGs agenda for 2030 seeks to implement effective climate change planning and management. However, the study uses the panel data of BRICS countries from 2000 to 2020. This study has used the PMG/PARDL model to empirically test the existence of PHH in BRICS countries. Therefore, the empirical estimates indicate that an increase in FDI increases environmental degradation. Consequently, the findings confirm the existence of PHH in BRICS. This study demonstrates that at low levels of stringency, the likelihood of pollution-intensive FDIs increases with a decrease in severity. Even though strict regulations may lead to higher pollution-intensive foreign direct investment (FDI), this is not always the case at lower levels of law. This implies that the same pollution activity may be economically and socially unsuitable for developed environments but desirable for less advanced environments. These distinctions are the foundation for the emergence of pollution havens. Therefore, environmental policy laxity must be formed to induce FDI flow into the BRICS countries, further implying SDG's accomplishment. Furthermore, additional stringent regulations might very well result in FDIs with a more significant environmental impact. This suggests that pollution havens are only possible if environmental rules are lax or inconsequential.

Keywords: foreign direct investment, pollution haven hypothesis, stringency index, BRICS, panel ARDL

INTRODUCTION

Presently, many economies are transitioning to industrialization and increasing production. The world has witnessed an influx of investments across all industries. Even underdeveloped nations produce significantly more due to increased domestic and foreign investment (Griffin, 1978; Sadiq et al., 2021). Increases in acquisitions and production have resulted in the global availability of numerous commodities. Foreign direct investment (hereinafter FDI) benefits developing economies tremendously. They attempt to increase FDI by relaxing their policies and regulations. Insufficient domestic assets, resources, and capital force underdeveloped nations to attract and utilize FDI (Bajrami, 2019). When a country receives FDI, its production and economic activities increase, increasing pollution and emissions. Thus, it is determined that FDI positively correlates with CO_2 emissions (Odugbesan and Adebayo, 2020). Therefore, increases in FDI contribute to a rise in pollution because they increase CO_2 emissions, as illustrated by the Pollution Haven Hypothesis (Pao and Tsai, 2011a; Zakarya et al., 2015).

Corporations will invest in countries with lax environmental regulations to save money on pollution abatement, the pollution haven effect claims (Copeland and Taylor 2004). One of the main reasons developing countries are reluctant to adopt environmental regulations is the pollution haven effect. Most countries in the developing world are short on capital, and FDI from developed countries is one of their primary sources of investment. Competition for foreign direct investment (FDI) would lead to a "race to the bottom" in this context. It is also possible to argue that multinational corporations that operate in advanced economies with relatively strict environmental regulations tend to relocate to developing countries with more lax environmental laws (Copeland and Taylor 2004; Taylor 2005). Because environmental improvement in developed economies could be achieved at the expense of environmental degradation in developing countries, the natural environment would be a tragedy if the hypothesis is proven. Companies that pollute a lot move from developed countries to developing ones, resulting in this problem. Politicians and environmentalists are divided on the pollution haven effect and hypotheses related to pollution havens.

Accordingly, this study demonstrates that the Pollution Haven Hypothesis (PHH) is true in developing countries such as those in the BRICS region, where FDI, pollution, and environmental regulations are closely linked. It was discovered that the new environmental policy considers FDI flows in which all agreements are subject to environmental regulations. The excessive capital-intensive production, ecological quality deteriorates as CO_2 emissions and air pollution result. Moreover, extreme production results in air pollution, but many companies also release chemical waste into rivers, resulting in water pollution (Pao and Tsai, 2011b). In addition, the loud noises caused by heavy machinery in factories contribute to noise pollution, and waste disposal on land contributes to land pollution (Al-Dulaimi et al., 2021). The emissions of harmful gases, energy, and resources have multiple adverse effects on the environment. In addition to increasing pollution, these factors also influence the climate. Daily, the global temperature rises, and the planet warms. These climatic changes also have severe effects on the environment (Mohamad et al., 2021).

According to PHH, when developed nations seek foreign countries to invest in, they typically select those with low production costs and lax or nonexistent environmental protection regulations. Due to increased production, this foreign investment in less stringent economies increases emissions and pollution in the host countries. Brazil, Russia, India, China, and South Africa (abbreviated as BRICS) have been chosen to test the validity of this hypothesis. This study investigates the existence of the PHH, i.e., the environmental impacts of FDI inflows, in BRICS countries. The significance of the investigation lies in the SDGs agenda 2030 and the COP26 agenda of BRICS countries to protect the environment. Additionally, the study has emphasized establishing and enforcing (non) stringent environmental protection policies.

However, the paper's structure is as follows: section one introduces the indicators that matter in discussing environmental pollution. Section two is constructed on the literature of past studies based on FDI, energy, tourism, and environmental pollution. Further, this section finds the research gap in measuring the degree of stringency and pollution heaven hypothesis in BRICS economies. The third section consists of data and methodology to examine the empirical model of the study. In the next fourth section, results are interpreted and discussed with the groundings of past shreds of evidence. In the last of the fifth section, this research is concluded and suggested by result-based policy implications.

LITERATURE REVIEW

FDI, Energy, and Environment

Widespread consensus exists regarding the effects of stringency matters and the pollution haven hypothesis. In this regard, the rule of law also matters and directly relates to environmental policy stringency. However, the indirect relationship operates with the other factors. In a piece of evidence, it is examined that the rule of law and environmental stringency policy has a direct and positive association amongst them (Chen, 2010). However, the purpose of environmental stringency policy also matters for economies. In this regard, Brunel and Levinson (2020) discussed the environmental regulatory stringency for the purpose of achieving objectives such as pollution control. Jobert et al. (2019) investigated that the probability of pollution intensive foreign direct investment (FDI) enhanced with the stringency decrease in low-level stringency. However, the increase in stringency leads to more pollution intensive foreign direct investment in high-level stringency. However, in the case of G7 and BRICS, environmental stringency policy and carbon dioxide emissions have bidirectional causality in Germany, Japan, the United Kingdom, and the United States. On the other hand, one-way causality between environmental stringency policy and carbon dioxide emissions is found in China, Canada, and France (Sezgin et al., 2021). Kim and Lin (2022) examined the environmental stringency policy in OECD economies. It is found that medium stringency fades the environmental stringency policy while emphasizing the environmental stringency policy with low and high stringency.

Kheder and Zugravu (2012) demonstrate empirically that stricter environmental regulations lead to higher FDI inflows in the majority of countries (Bu and Wagner, 2016) have discovered that firms with sound environmental technology are more likely to invest in regions with stricter regulations, while those with weak technology are less likely to invest in these regions. The current study uses new and comprehensive datasets to examine whether strict environmental rules discourage FDI inflows to developing nations. Using panel data of 120 developing countries between 2000 and 2014, the impact of environmental regulations on foreign direct investment is estimated (FDI). Sapkota and Bastola (2017) investigated environmental pollution, income, and foreign direct investment. From 1980 to 2012, data was collected from 14 Latin American countries. The researchers employed models with Panel fixed effects and random effects. Estimations supported the existence of PHH and the environmental Kuznets curve in the examined nations. Mesagan and Nwachukwu (2018) discovered ways to enhance the environmental quality in BRICS nations. The research included data from 1992 to 2014. Using FMOLS and DOLS methods, this research has found that growth and electricity consumption led to a rise in CO_2 emissions. Xie et al. (2019) examined the impact of FDI on CO_2 emissions in developing countries. The data was gathered between 2005 and 2014. The research utilized an extended panel smooth transition regression model (PSTR) and found that FDI strongly affects CO_2 and supports PHH.

Balsalobre-Lorente et al. (2019) examined the PHH in MINT economies. They used DOLS/FMOLS methods to find the relationship between ecological footprints and FDI for MINT countries where it supports the PHH (Bildirici and Gokmenoglu, 2020). Liu et al. (2019) examined China's economic development and the evidence for PHH. From 1996 to 2016 data, this study found no evidence for PHH. Baglitas and Yaprak. (2019) selected a panel of countries, including Brazil, India, Turkey, South Africa, and Indonesia, and found no existence of PHH. Guzel and Okumus (2020) examined PHH in the ASEAN-5 nations, and the findings confirmed the validity of PHH in these nations. Nathaniel et al. (2020) investigated whether PHH holds for Mediterranean coastal countries. In the context of Pakistan, Rehman et al. (2019) investigated the pollution haven hypothesis. From 1975 to 2016, annual data was collected. CO_2 was the dependent variable, while FDI, GDP, GDP square, financial development, population growth, and trade openness were independent variables. The NARDL method was utilized. Long-term and short-term results indicated that an increase in FDI decreased environmental quality, whereas a decrease in FDI improved environmental quality. The results confirm the pollution haven hypothesis for Pakistan. In the case of Turkey, FDI contributes to environmental sustainability while energy consumption helps in environmental deterioration (Agboola et al., 2022). Moreover, it is estimated that urbanization and industrialization are the causes of environmental deterioration in Bahrain (Qader et al., 2022). Furthermore, urbanization and energy consumption significantly reduce environmental quality, while technological innovation has improved the environmental quality in Bangladesh (Islam et al., 2022). However, green investment and technological innovation are effective measures to reduce environmental deterioration (Li et al., 2022). In discussing the COP26 pledge, technological innovation offsets environmental deterioration in Mexico, and the outcomes upkeep the pollution haven hypothesis (Hossain et al., 2022).

Bandoyopadhyay and Rej. (2021) found the relationship between GD, FDI, nuclear energy consumption, trade openness, and CO_2 for India from the years 1978–2019. The study also examined the Environmental Kuznets curve hypothesis and confirmed the existence of inverted N-shaped. The study also showed the existence of J shaped relationship between FDI and CO_2, which shows the transition of the Indian economy from a pollution halo to pollution heaven with an increase in FDI. The results also identified that nuclear energy consumption has a good effect on air quality. The study suggests environmentally friendly energy use for sustainable growth. Hanif et al. (2019) examined that fossil fuel energy consumption is an encouraging factor in carbon emissions, while FDI contributes to environmental degradation in developing Asian countries. However, FDI and fossil fuel energy consumption are also significant contributors to the economic growth of developing Asian countries (Huang et al., 2020). Moreover, a non-renewable form of energy taken as fossil fuels significantly increases carbon emissions in European and Central Asian developing economies (Chunyu et al., 2021). In South Asian economies, non-renewable energy contributes to the ecological footprint (Xue et al., 2021). However, renewable energy refers to a clean form of energy that contributes to environmental cleanliness in East and South Asia economies (Batool et al., 2022). In South Asian economies, renewable energy consumption mitigates carbon secretions (Murshed et al., 2021). In other evidence, renewable energy consumption attempts to reduce carbon emissions in E-7 countries (Huang et al., 2022). In some evidence, renewable energy is a significant indicator of mitigating carbon emissions and ecological footprint (Usman et al., 2022a; Usman et al., 2022b; Usman and Balsalobre-Lorente, 2022; Wan et al., 2022).

Tourism and Environment

Mikayilov et al. (2019) analyzed the long-term effects of tourism and its development on ecological footprint using a time-varying coefficient cointegration approach, revealing a positive correlation between tourism and environmental footprint. Consequently, environmental issues such as pollution, waste, and depletion of natural resources contribute to economic crises (Sezgin et al., 2021). Carbon emissions have been found to have a long-term positive effect on tourist arrivals. Khan et al. (2020) examine CO_2 emissions about tourism growth in the most visited countries. According to the findings, there may be a long-term co-movement and causal relationship between travel and CO_2 emissions. According to a study by Sakadevan and Nguyen. (2017), tourist arrivals have an immediate and long-term positive impact on carbon emissions in Asia-Pacific nations. Tourism is now the world's most significant and most vital industry, but its rapid expansion has harmed the environment and natural resources (Gjorgievski et al., 2016; Hanif et al., 2019). Hanif et al. (2019) have studied tourism activities to determine their impact on the carrying capacity of the environment and to find ways to protect the natural environment while expanding tourism (Hanif et al., 2019). According to a study by Zou (2019), environmental taxes are now an effective economic regulation tool due to their demonstrated ability to reduce the negative ecological impacts of tourism (Surugiu and Surugiu, 2017). Tourism has been found to increase pollution in Egypt, decrease pollution in Tunisia, and have no effect on pollution in Morocco (Sghaier et al., 2019). Tourism had a positive impact on the environment in Malaysia but a negative impact on Thailand and Singapore.

Research Gap

In this research, the literature of past studies examined the influences of FDI, energy, and tourism on environmental degradation. Most studies have significantly found that FDI, tourism and non-renewable energy contribute to environmental deterioration. However, renewable energy is a significant source of environmental sustainability. Regarding this, we have noticed that the literature mainly covers the developing and developed economies of different regions to measure these relationships. On the other hand, it has not enough evidence to prove it in the case of BRICS in the presence of COP26 goals. Furthermore, this research focuses on the degree of stringency that the literature also lacks to prove. However, this research has found the research gap by exploring the degree of stringency and pollution heaven hypothesis in BRICS economies under the COP26 goals.

DATA AND METHODOLOGY

Data

This study gathered information on pertinent variables to determine the validity of PHH in BRICS. In this study, CO_2 emissions are used as a proxy for environmental degradation as the dependent variable, and FDI is the primary independent variable; other independent variables include energy use (ENG), ecological policy stringency index (EPS), and an international tourist arrival (TOUR). In addition, the study collects data from BRICS nations. BRICS nations attract substantial FDI, have a high pollution level, are popular tourist destinations, and have less stringent environmental policies. These nations provide an ideal test case for the pollution haven or pollution halo effect. The panel data is collected from the year 2000–2020. Therefore, this panel data of the past 2 decades is used. The data on CO_2 emissions (kt), foreign direct investment net inflows (current US$), energy use (kg of oil equivalent per capita), and international tourism (number of arrivals) is collected from the data files of the world development indicators (WDI). Moreover, the environmental policy stringency index data is compiled from OECD. All the variable descriptions along with data sources are described in **Table 1**.

Model Specification

With previously explored background, this paper presents the existence of the pollution haven hypothesis (PHH) in BRICS countries. In this regard, it is necessary to measure whether the degree of stringency matters for BRICS economies. However, environmental stringency can be measured at low, medium, and high stringency levels to achieve objectives such as pollution control. It is mainly examined that the increase in the probability of pollution intensive factors will increase or decrease environmental stringency at the low, medium, and high stringency levels. This research will examine the effect of pollution intensive FDI on environmental stringency (taken in the form of carbon dioxide emissions). In this regard, this study used the aggregate data for a panel of five countries. However, this study employed the Panel autoregressive distributed lag (PARDL) model to illustrate the existence of PHH in BRICS. This model allows us to analyze the cross-country dispersions in the FDI-CO_2 nexus while considering, at the same time, the pollution. Before starting the analysis, the initial step is unit root testing, for which we have applied Levin, Lin, and Chu and Im, Pesaran, and Shin tests (Levin et al., 2002; Im et al., 2003). After this, we have employed a cross-section dependence test on the model following Pesaran et al. (2001). Further, Pedroni and Kao cointegration techniques are applied to measure the cointegration amongst variables (Kao, 1999; Pedroni, 1999).

In the starting step of P-ARDL, we first developed the linear equation model to establish the link between the variables in the econometric form.

$$LCO_2 = f\,(LFDI, \text{LENG}, \text{LEPS}, \text{LTOUR})$$

The equation of the relationship estimates the long-run relationship among the variables. Therefore, the model can be expressed as:

$$LCO_2 = \alpha_0 + \alpha_1 LFDI_{it} + \alpha_2 LENG_{it} + \alpha_3 LEPS_{it} + \alpha_4 LTOUR_{it} + \mu_{it}$$

α_0 = intercept, α_1, α_2, α_3, α_4 are the coefficients and μ is the error term, "i" is the identification of cross-sections, and "t" is the identification of time series in a panel of BRICS countries.

After this we have to develop the short run and error correction term equation in the model which is given below:

$$\begin{aligned}\Delta(LCO_{2it}) = {} & \alpha 0 + \sum{}^{k} i = 1\ \alpha 1 \Delta(LCO_{2it-1}) \\ & + \sum{}^{k} i = 0\ \alpha 2 \Delta(LFDI_{it-1}) \\ & + \sum{}^{k} i = 0\ \alpha 3 \Delta(LENG_{it-1}) \\ & + \sum{}^{k} i = 1\ \alpha 4 \Delta(LEPS_{it-1}) \\ & + \sum{}^{k} i = 0\ \alpha 5 \Delta(LTOUR_{it-1}) \\ & + \beta_1(LCO_{2it-1}) + \beta_2(LFDI_{it-1}) \\ & + \beta_3(LENG_{it-1}) + \beta_4(\text{LEPS}_{\text{it}-1}) \\ & + \beta_5(\text{LTOUER}_{\text{it}-1}) + \beta_6(\text{EC}(-1)_{\text{it}-1}) + \mu_{\text{it}}\end{aligned}$$

In the above equation, $\acute{\alpha}'s$ are the short run intercept, and slops and $\sum_{i=1}^{k}$ and Δ are short run dynamics. However, $\beta's$ indicate the intercept and slops of long run variables that have been stabilized with the term of error correction (EC) in the model.

TABLE 1 | Description of variables.

Variables	Proxies (if Used) and unit of measurement	Abbreviation	Source of data
Environmental Degradation	CO_2 Emissions (kt)	CO_2	World Development Indicator (WDI)
Foreign direct investment	FDI net inflows (current US$)	FDI	World Development Indicator (WDI)
Energy use	Energy Use (kg of oil equivalent per capita)	ENG	World Development Indicator (WDI)
Strictness level of environmental policies	Environmental policy stringency index	EPS	OECD.Stat
Tourism	International Tourism (number of arrivals)	TOUR	World Development Indicator (WDI)

TABLE 2 | Results of unit root tests.

Variables		At level		At 1st difference		Conclusion
		Individual intercept	Individual intercept and trend	Individual intercept	Individual intercept and trend	
LCO_2	LL & C	-3.576 0.000	_	_	_	I (0)
	IPS	-2.673 0.003	_	_	_	
LFDI	LL & C	-2.456 0.007	_	_	_	I (0)
	IPS	-1.776 0.037	_	_	_	
LENG	LL & C	-4.256 0.000	_	_	_	I (0)
	IPS	-1.589 0.056	_	_	_	
LEPS	LL & C	-0.789 0.215	-1.471 0.070	-7.494 0.000	_	I (1)
	IPS	0.074 0.529	0.134 0.553	-6.761 0.000	_	
LTOUR	LL & C	-1.041 0.148	-1.161 0.122	-8.594 0.000	_	I (1)
	IPS	0.452 0.674	-1.080 0.140	-6.807 0.000	_	

Source: Author's Estimations using E-Views 9.

TABLE 3 | Results of CD tests.

Test	CO_2	FDI	ENG	EPS	TOUR
Breusch-Pagan LM	91.750***	88.631***	135.050***	62.609***	116.247***
Pesaran scaled LM	17.161***	16.464***	26.844***	10.645***	22.639***
Bias-Corrected scale LM	17.036***	16.339***	26.719***	10.520***	22.514***
Pesaran CD	8.731***	9.082***	11.108***	4.666***	10.494***

Source: Author's Estimations using E-Views 9.

RESULTS AND DISCUSSION

The study applied P-ARDL/PMG methodology to get results. Next are the stationarity tests, CD tests, panel cointegration tests, and the long-run and short-run estimates of Panel ARDL.

Unit Root Tests

LL&C and IPS unit root tests to check if the panel data are stationer.

It is clear from **Table 2** that three variables are stationer at the level, and the other two are stationer at first difference. There is a mixture of integration in the results, which means that the Panel ARDL technique will be applied in this study.

Cross-Sectional Dependence Test

It is essential to check cross-sectional dependence when using panel data. Cross-sectional dependency refers to a situation when the effects of an action in one region or country of the cross-section can be felt in the other countries; therefore, if a policy is implemented in one section affects different sections.

In the above **Table 3**, *** shows that the variable is significant 1% level of significance. All four statistics clearly show that all the

TABLE 4 | Results of pedroni cointegration tests.

Test type: Pedroni cointegration test		
Test	**Individual intercept and individual trend**	**No intercept or trend**
Panel v-Statistic	0.55 (0.28)	1.82** (0.03)
Panel rho-Statistic	-0.78 (0.21)	-2.32** (0.01)
Panel PP-Statistic	-8.44*** (0.00)	-9.11*** (0.00)
Panel ADF-Statistic	-11.38*** (0.00)	-13.82*** (0.00)
Group rho-Statistic	0.34 (0.63)	-0.03 (0.48)
Group PP-Statistic	-6.42*** (0.00)	-4.67*** (0.00)
Group ADF-Statistic	-7.04*** (0.00)	-5.93*** (0.00)

Source: Author's Estimations using E-Views 9.

TABLE 5 | Results of the Kao cointegration test.

Test type: Kao cointegration test		
Test	***t*-Statistic**	**Probability**
ADF	-25.176	0.000

Source: Author's Estimations using E-Views 9.

variables are important at 1%. The results depict that the cross-sections are interlinked, and cross-section dependency is very much present in the variables.

Panel Cointegration Tests

Before moving on to P-ARDL estimates, it is necessary to know whether variables have a long-run relation or not. This is tested by Pedroni Cointegration tests and Kao Cointegration tests.

According to the findings of **Table 4**, six out of seven statistics are significant at 5 and 1% significance levels. The Pedroni Cointegration test results show long-run cointegration in all the variables.

In **Table 5**, Kao's cointegration test, extending the Pedroni cointegration test, indicates that ADF -25.176 is significant at 1%. Thus, there exists a long-run cointegration in all of the variables.

P-ARDL Model Results

Following are the long-run and short-run estimates of PMG/P-ARDL model estimates.

The long-run results in **Table 6** show that the coefficient value of the core independent variable FDI is 0.076; the probability value indicates that the coefficient is significant. When FDI increases by 1%, the CO_2 emissions increase by 0.076%. There is a direct positive relation between FDI and CO_2 emissions. Results of the analysis reveal that in the long-run increase in FDI increases CO_2 emissions, thus increasing environmental degradation. This proves the validity of the pollution haven hypothesis existing in BRICS. Many other studies have also found such results (Liu et al., 2020; Rahman et al., 2020). ENG has a coefficient value of 0.934. The coefficient sign is positive, indicating a direct positive link of ENG with CO_2 emissions. The probability of the ENG coefficient is significant. CO_2 increases by 0.934% with every 1% rise in ENG. The environment deteriorates more and more with the increasing use of energy. Other studies have also found similar results (Bertucci et al., 2020; Halliru et al., 2020) found that increased energy use increases pollution.

TABLE 6 | Estimates of P-ARDL.

Dependent variable: LCO_2				
Long run equation				
Variable	**Coefficient**	**Std. error**	***t*-Statistic**	**Probability**
LFDI	0.076***	0.010	7.166	0.000
LENG	0.934***	0.028	32.545	0.000
LEPS	0.055***	0.009	5.749	0.000
LTOUR	0.092***	0.019	4.811	0.000
Short Run Equation				
EC (-1)	-0.577*	0.330	-1.750	0.084
LCO_2 (-1)	-0.032	0.112	-0.291	0.771
LFDI	-0.031**	0.014	-2.117	0.038
LENG	0.646*	0.381	1.695	0.094
LEPS	-0.004	0.022	-0.189	0.850
LTOUR	-0.008	0.047	-0.174	0.862
C	2.800	1.743	1.606	0.113

Source: Author's Estimations using E-Views 9.

EPS coefficient is 0.055. The probability value reveals that EPS has a significant and positive impact on CO_2. The EPS has shallow values in the BRICS economies. When the EPS value is low, more foreign polluting industries will invest and set up their branches in the countries with low EPS. Low EPS refers to the attraction to avoid pollution taxes and increasing production levels of even polluting commodities due to easy unenforced environmental protection strategies. Thus, as the BRICS have low levels of EPS, they have high levels of CO_2 because of this. Their low EPS is attractive to foreign investors and polluting industries. Thus, their low EPS causes CO_2 to rise by attracting more investment and increasing the production of polluting commodities. This type of result is also supported by the results (Yilanci and Pata, 2020) that revealed that less stringent economies attract more polluting FDI.

The coefficient of TOUR is 0.092, and its probability is significant. The coefficient value has a positive sign of a direct positive relation between TOUR and CO_2. The outcomes indicate that a 1% increase in TOUR causes a 0.092% increase in CO_2 emissions. Thus pollution increases with excessive international tourism level. Many studies have also found the same results and found that increased tourism is linked with increased pollution and intense climatic changes, overutilization of resources, increased waste, etc. (Balsalobre-Lorente et al., 2020; Qader et al., 2022).

In **Table 6**, the coefficient of the cointegration equation in the short-run results reveals how much adjustment is present in the model. This means it states how the model will be adjusted towards equilibrium. The negative sign of the coefficient shows that this model is deviating away from the disequilibrium, which means it is adjusting towards the equilibrium. The value of -0.577 indicates that there is a 57% adjustment towards stability. As the probability is also significant thus, the coefficient of cointegration is also substantial. According to the short-run results, 1 year lagged value of CO_2 is negatively and insignificantly related to the current value of CO_2. However, foreign direct investment (FDI) is negatively and significantly related to CO_2 in the short run. On the other hand, ENG is positively and significantly associated with CO_2. In contrast with ENG, EPS and TOUR are negatively and insignificantly related to CO_2. Most of the time, the short-run and long-run results are different because some variables have not wholly matured effects in a short period. That is why the behavior of variables, in the long run, is studied to capture the full effects impact of variables.

CONCLUSION AND POLICY IMPLICATIONS

This study is carried out to examine the validity of the pollution haven hypothesis in five countries called BRICS. The main intention is to find out how foreign direct investment affects the environmental quality in the following mentioned five countries: Brazil, Russia, India, China, and South Africa. The panel ARDL methodology reveals that the BRICS are pollution havens because FDI has a significant positive effect on CO_2 emissions. Foreign direct investment is a driving force in the growth of a country. FDI helps a country generate more money to invest in various sectors and initiatives to improve the economy's total output and production level. Even though FDI helps significantly with the increase in industrialization, it also has some surprises in its usage. The increased economic activity is not always good for the environment if it involves harmful activities.

The irresponsible utilization of FDI has led to an increase in pollutants emissions. This increases the dangers and threats to the environment we live in. The results show that increased energy use causes pollution to increase in BRICS. Also, the low EPS in BRICS contributes to increased CO_2 emissions. The results also show that the high level of tourism and increases in tourism also increase pollution in BRICS. All the independent variables of our model positively and significantly affect the dependent variable. The pollution level is closely related to its environmental protection policies. If environmental protection policies are lax, there will be many pollutions. To attract an increasing amount of FDI from developed countries, developing nations relax their environmental regulations. Therefore, they do not have to pay higher taxes on polluting commodities. Developed nations eagerly anticipate investing in developing nations that lack strict rules and regulations regarding environmental sustainability. The ecological policy stringency index measures the level of stringency of environmental policies. This index describes the degree of severity of environmental protection policies in various nations. The BRICS countries must introduce laws, fines, and taxes to utilize FDI in pollution-intensive industries. FDI must be spent on cleaner and greener production and renewable energy. The host countries need to increase their environmental policy stringency to have a high level of strictness and enforcement in BRICS. This will help in the reduction of pollution and reduction in attraction pollution, increasing FDI. BRICS should strictly impose fines and taxes on foreign investors who invest in polluting industries to attract clean FDI.

This study can be expanded by applying different modern techniques and then comparing their results. Due to the unavailability of data for GHG emissions could not be incorporated as the dependent variable; it can be used as a dependent variable if complete data is available. BRICS have low values of EPS, so this study can be extended by examining PHH for countries with high values of EPS to compare results and get a clearer picture. Some other influential independent variables can also be included in the study. The study can be extended by using different kinds of other harmful gasses as dependent variables in separate models. Their results could be compared for a deeper understanding.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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