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RESEARCH ARTICLE

Impact of foreign direct investment, natural resources, renewable energy consumption, and economic growth on environmental degradation: evidence from BRICS, developing, developed and global countries

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Abstract

This research examined the impact of foreign direct investment, natural resources, renewable energy consumption, and economic growth on environmental degradation in BRICS, developing, developed, and global countries for the time period from 1991 to 2018 by using dynamic fixed effect model, GMM, and system GMM estimators. The examined results indicate that FDI causes environmental degradation in BRICS and developing countries while in developed countries, FDI helps environmental degradation reduction. The empirical results indicate that fuel resources and renewable energy consumption help to reduce the environment degradation in BRICS, developing, developed, and global countries while ore and metal resources cause environment degradation improvement in developed countries. Total natural resources (coal, oil, natural gas, and mineral rents) and economic growth are the main factors that boost the environmental degradation in BRICS, developing, developed, and global countries. Based on the examined results, policies are suggested for BRICS, developing, developed, and global countries. It is suggested that policy makers in these countries not only reply to protect environmental degradation but also support the growth of fuel resources, ore, and metal resource and total natural resources.

Keywords Foreign direct investment · CO2 emission · Natural resources · Renewable energy consumption · Economic growth

Introduction

Over the previous several years, environmental degradation has occurred as one of the main related environmental disputes. According to the statements of the Joint Research Centre of European Union, 90% combustion records of fossil fuels contribute to global environmental degradation. Olivier et al. (2012) indicated that developed countries have a huge percentage of contribution in global environmental degradation but in current time, developing countries have a higher contribution in environmental degradation. According to the Information Administration of the USA, sources of renewable energy are greatly rising in conditions of global energy and renewable energy use will enlarge global energy from 10 to 14% over 2008 to 2035. The previous studies suggested that the use of renewable energy may possibly help environmental degradation issues as well as energy safety. Krewitt et al. (2007) suggested that sources of renewable energy can offer half of the global energy desires near to 2050. There is an agreement about the utilization of advance energy to reduce the environment pollution (Álvarez et al. 2017; Lorente and Álvarez 2016).

To better recognize the association between natural resources, economic growth and environmental degradation is not merely beneficial for government representatives and policy creators to alleviate environmental degradation but also support growth in the industry of renewable energy. A huge number of works of literature have scrutinized the link of natural resources with economic growth but only a few studies

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have examined the link of natural resources with environmental degradation and given up mixed consequences (Baloch and Meng 2019; Balsalobre-Lorente et al. 2018; Bekun et al. 2019; and Dong et al. 2017). The complementary views are based on unobvious outcomes of previous studies, disclosing different impacts of economic growth and renewable energy on environmental demand an additional observed study of the link among natural resources and economic growth of environmental degradation. The recent paper aims to highlight BRICS, developing, developed, and global countries by adding large quantity of natural resources in the link among renewable energy, economic growth, and environmental degradation that might assist to reduce or in any case decrease contradiction associated with economic development.

According to the Joint Research Centre (JRC 2019), only fifteen countries are 72.2% of the causes of global environmental degradation, such as 9.84 billion tons (the uppermost level) of CO2 emission is produced by China in 2017 which is 27.2% of the global environmental degradation but the second uppermost level of CO2 emission (5.27 billion tons) is produced by the USA in 2017 which is 14.6% of the global environmental degradation, India (2.47 billion tons) which is 6.8% of the global environmental degradation, Russia (1.69 billion tons) which is 4.7% of the global environmental degradation, Japan 3.3%, Germany 2.2%, Iran 1.9%, Saudi Arabia 1.8%, South Korea 1.7%, Canada 1.6%, Mexico 1.4%, Indonesia 1.3%, Brazil 1.3%, South Africa 1.3%, Turkey 1.2%, but rest of the world is 27.7% cause of the global environmental degradation in 2017 (see Fig. 1). In current years, the slowdown in global environmental degradation growth has been determined by the unity of reduction in China and the USA, with fairly slight growth in environmental degradation in the rest of the world countries. This alters in 2017, with slight a large boost in Chinese environmental degradation and no reduction in US environmental degradation. India's environmental degradation augmented slightly in 2017 than the previous few years, although the European Union's environmental degradation has stayed fairly smooth since 2014 as well as did not obviously alter in 2017. The growth in environmental degradation also increased more than twice in the rest of the world from 2016 to 2017. Usually, human being's acts and other essential aspects have a considerable contribution to the growing level of environmental degradation in the majority of advanced countries during the interruption of the cycle of environmental degradation.

It is essential to look into the link of natural resources, economic growth, and renewable energy use with environmental degradation in developing, developed, and global countries, which is frequently fruitful not merely for struggling global environmental degradation but also for supporting growth in developing, developed, and global countries' natural resources as well as industries of renewable energy. Moreover, a few works of literature have used natural resources such as total natural resources or natural gas to look at the link among these indicators in BRICS countries as well as 5 European Union countries such as Dong et al. (2017) used natural gas rents to examine the link of renewable energy use and natural gas with CO2 emission in BRICS countries. Baloch et al. (2019) used total natural resources rents to explore the association of economic development, renewable energy use, and natural resources with carbon dioxide in BRICS countries. Balsalobre-Lorente et al. (2018) used total natural resources rents to look into the link of natural resources, renewable electricity, and economic growth with carbon dioxide in 5 European Union countries. While no comprehensive study deals with the dynamic association among environmental degradation, natural resources, economic growth, and renewable energy use in the background of the developing, developed, and global countries, as well as no comprehensive study used fuel resources as well as ore and metal resources to deal with the association among environmental degradation, natural resources, economic growth, and renewable use. To fulfill this gap, the recent paper contributes to the previous study by Baloch et al. (2019) as follows: Firstly, this is the first study to look into the association of natural resources, renewable

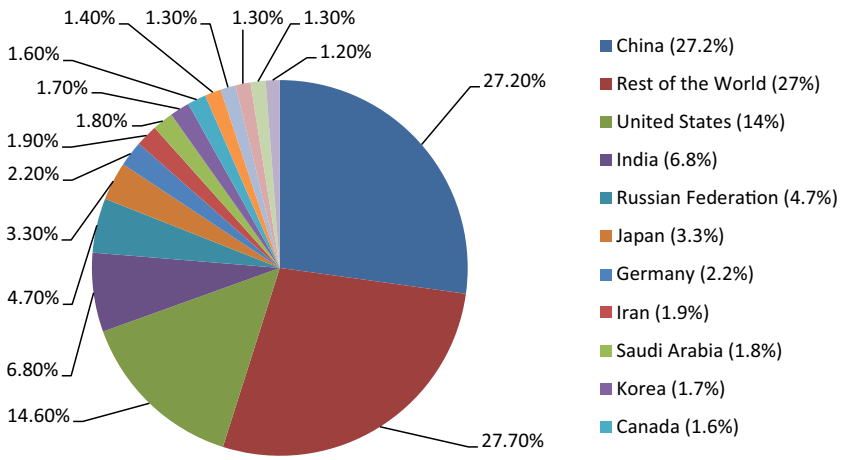

Fig. 1 Percentage of top polluted countries. Source: Based on World Economic Forum

energy use, and economic growth with environmental degradation in BRICS, developing, developed, and global countries. Secondly, we add two extra variables to natural resources such as fuel resources and ore and metal resources and take three variables as natural resources such as fuel resources, ore, and metal resources, and total natural resources (coal, oil, natural gas, and mineral rents) as probable variables to the renewable energy, economic growth, and environmental degradation association, as it was totally ignored in the previous studies and no study has used these two variables so this is the first study to use fuel resources and ore and metal resources. Finally, the study also applies dynamic models such as fixed effect, GMM, and system GMM estimators.

Literature review

Many studies have assessed the association of renewable energy consumption and economic growth with environmental degradation (Baloch, 2019; Balsalobre-Lorente et al. 2018; Bekun et al. 2019; Dong et al. 2017) but a few studies have examined the connection of natural resources such as total natural resources or natural gas with environmental degradation in a specific region such as BRICS countries and 5 European Union countries (Baloch, 2019; Balsalobre-Lorente et al. 2018; and Dong et al. 2017) while Bekun et al. (2019) examined the association among natural resources and non-renewable and renewable and environmental degradation in sixteen countries of the European Union.

The association of natural resources such as total natural resource rents, economic growth, and renewable energy use is investigated with environmental degradation in BRICS countries. Baloch et al. (2019) used cross-section dependency test, as well as panel model, and augmented mean group and found a mixed association of natural resources with environmental degradation. The said study demonstrated that a large number of natural resources mitigate environment degradation in Russia but in South Africa contributes to environmental degradation. Moreover, natural resources support environmental degradation in Russia, South Africa, Brazil, and China. A rise in renewable energy use and natural gas alleviates environmental degradation (Dong et al. 2017). Bekun et al. (2019) found that total natural resources enhance environmental degradation in sixteen countries of the European Union, whereas the overdevelopment of the accessible natural resources influence a country aptitude for the resources to reproduces (Destek and Sarkodie 2019). While such a change from ordinary equipment that exploits more resources to advanced equipment that includes innovation, recycling, value-addition, artificial resources, and using again and again that change, natural resources will get better economic growth but refuse the environment.

The economic growth role is opposite to both environmental degradation and climate change. Economic progress drives industrial enterprises that boost natural resources. All these activities enhance the velocity of natural resource exhaustion, with rising the quantity as well as unsafe waste produced (Sarkodie 2018). Moreover, huge quantities of natural resources used during mining, deforestation, and agriculture also affect the environment. The use of natural resources is the most important element in production; as a result, appropriate supply boosts oil to use as well as decline the prices (Balsalobre-Lorente et al. 2018). The difficulty among the environment and natural resources trails the government to provide unprofitable financial supports for fuel use which is a reason to enhance the environmental degradation of the yield. The extraction of natural resources assists in decreasing the worsening of environmental degradation due to the obligation of energy exclusion of misuse chemicals into the air and water. The observed EKC statement recommends a straight association among economic augmentation and environmental degradation, which alters behind a threshold level of growth, is achieved (Khan et al. 2019a, b; Alvarado et al. 2018; Grossman and Krueger 1991; Grossman and Krueger 1995; Panayotou 1993; Selden and Song 1994). Moreover, income and environmental degradation augment mutually until an undoubted turning point in growth is achieved, behind which the environmental pollutant reduces and after that overturns. Therefore, a reversed U-shaped association among pollutants and growth supposes a dynamic method of structural change associated with growth (Dinda 2004). This activity also designates that environmental degradation is affected due to economic growth with three major waterways: technological effects, composition, and scale (Grossman and Krueger 1991). As a result, environmental degradation is regarded as a procedure that is an outcome from technical effects, composition, and scale. At that time, as economic growth augments, society will be likely to desire clean strategies intended at defending environmental degradation.

Renewable energy use declined environmental degradation in Russia, Brazil, India, and China and indicated that renewable energy use is a very important contributor to environmental degradation reduction as equipment of renewable energy is sustainable as well as ubiquitous (Baloch et al. 2019; Nassani et al. 2017). Hu et al. (2018) suggested that rising renewable energy use contributes to a reduction in environmental degradation. Environmental degradation declines due to renewable energy use; the countries can augment the progress of renewable energy use. The growth of renewable energy use cannot merely assure the energy required of the industrialization but also alleviate environmental degradation (Cheng et al. 2019). The life series environmental degradation of renewable energy use is greatly fewer than the complement of fossil energy use (Dong et al. 2017). The fast growth of renewable energy use supports the renewable energy use reduction effect on

environmental degradation. The use of renewable energy has a very important contribution to the reduction of environmental degradation as well as numerous technological barriers, such as insufficiency of infrastructure and low energy resources, occurred with the quick growth of the renewable energy industry in BRICS countries (Sebri and Ben-Salha 2014).

Environmental degradation reduces due to foreign direct investment and the use of renewable energy in BRICS countries. Cheng et al. (2019) indicated that FDI has a vital role in environmental degradation and investment in renewable energy declines environmental degradation. FDI boosts environmental degradation in Saudi Arabia according to Omri et al. (2019) but Zhu et al. (2016) found a reduction in environmental degradation of Asian countries due to FDI. Zhang and Zhou (2016) assessed the association of FDI with environmental degradation in China and indicated that environmental degradation in China reduces due to FDI and suggested that the industrial constitution and equipment level decline environmental degradation in China.

Methodology

This study uses panel data from 5 BRICS, 145 developing, 31 developed, and 176 global countries over the period 1991 to 2018 to assess the association of natural resources, renewable energy use, and economic growth with environmental degradation (CO2 emission) in BRICS, developing, developed, and global countries. We use metric tons of CO2 emission per capita for environment degradation (CO2 emission) and three variables for natural resources such as fuel export percentage of merchandize export for fuel resources (FUR), ores and metal export percentage of merchandize export for ores and metal resources (OMR), and percentage of GDP total natural resource rent (coal, oil, natural gas, and mineral rents) for natural resources (TNR). We use constant 2010 USD per capita GDP for economic growth (EG), renewable energy consumption, percentage of total final energy consumption for renewable energy use (REU), current US dollar, net inflows foreign direct investment for foreign direct investment inflows (FDI), percentage of trade for trade openness (TO), and the annual percentage of urban population growth for urbanization (URB). The data for environmental degradation (CO2 emissions) are collected from the Joint Research Centre (JRC 2019) but data for fuel resources, ore and metal resources, total natural resources rents, renewable energy use, economic growth, FDI, trade openness, and urbanization are collected from the World Development Indicators (WB, WDI 2019). Figure 2 represents the total annual CO2 emission in the world and top pollutant countries which enlarged to 37.1 billion tons in global countries as well as 10.07 billion tons in China, 5.27 billion tons in the USA, 3.52 billion tons in European Union countries, and 5.42 billion tons in India, in 2018 (JRC 2019).

We select variables by following the previous literature such as Baloch et al. (2019) examined the link of total natural resource rents, economic growth, and renewable energy use with environmental degradation in BRICS countries. Khan et al. (2019) investigated the association of urbanization with CO2 emissions but Farhani et al. (2014) investigated the impact of trade on environmental degradation as well as Cheng et al. (2019) and Zhang and Zhou (2016) investigated the impact of FDI on environmental degradation. We extend the study by Baloch et al. (2019) to developing, developed, and global countries and also include two natural resource variables such as fuel resources and ore and metal resources that are ignored by the previous literature.

Based on the above studies, we investigate the association of natural resources, renewable energy use, and economic growth with environmental degradation in BRICS, developing, developed, and global countries over the period 1990 to 2018 and get the following model:

$$\begin{aligned} CO2_{i,t} = {} & B_1 CO2_{i,t-1} + B_2 FUR_{i,t} + B_3 OMR_{i,t} \\ & + B_4 TNR_{i,t} + B_5 REU_{i,t} + B6EG_{i,t} + B_7 FDI_{i,t} \\ & + B_8 TO_{i,t} + B_9 URB_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

The above equation is the dynamic equation, where i represents the country, t represents time, and $\varepsilon_{i,t}$ is the error term. We take the lag of dependent variable $CO2_{i,t-1}$ by using dynamic fixed effect, GMM estimator recommended by Arellano and Bond (1991), and system GMM estimator recommended by Arellano and Bover (1995), and Blundell and Bond (1998). The enormous dissimilarity among time periods and number of sample of panel data and the distress of endogeneity in our estimators suggest that the wonderful procedure to take up in scrutinized testing is the generalized method of moment (GMM) estimator and system GMM estimator. The GMM estimator is in the universal operational process to calculate the factors with endogenous regresses and ignore individual precise heterogeneity. In such type of situation, LSE, simple fixed effect, and OLS estimator are not reliable so we ignore the least square, OLS, and simple fixed effects in our study. We exercise system GMM since this model calculates the factors with endogenous to fixed effects estimator with a lagged of dependent variable and compacts with unobserved heterogeneity. The system GMM exercises ahead of the difference GMM via adding more suppositions that no association is scrutinized between first differences of appliances. The added suppositions in system GMM are superior in the accuracy and minor in the limited bias of the model.

Table 1 reports the summary of different variables by country group. We find the bad quality of CO2 emission in BRICS

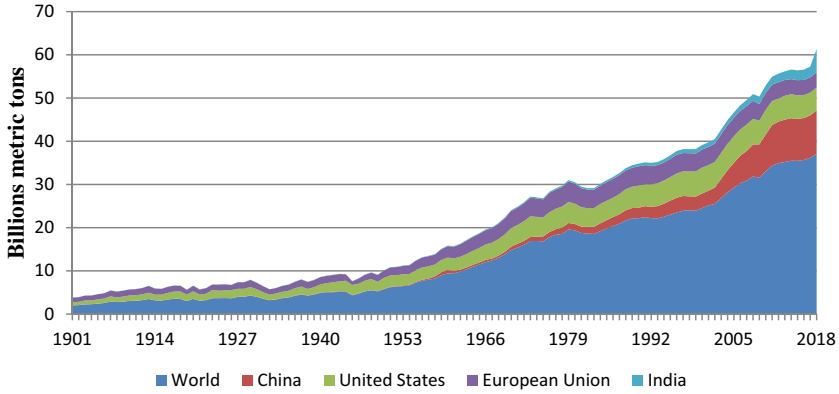

Fig. 2 Sum of annual CO2 emission by global and top pollutant countries. Source: based on the Joint Research Centre and World Bank

and developed countries than developing countries as well as worse renewable energy in developed countries than BRICS and developing countries but the per capita GDP is higher in developed countries than BRICS and developing countries given that the developed countries' economic growth highly affects environmental degradation.

Results and discussions

Table 2 describes the results of the fixed-effect model. The observed results indicate that fuel resources have a significant and negative association with environmental degradation in BRICS, developing, developed, and global countries. The results show that fuel resources mitigate environmental degradation 1.4% in BRICS countries, 0.4% in developing countries, 0.6% in developed countries, and 0.8% in global countries. Ore and metal resources have an insignificant and negative association with environmental degradation in developing and global countries but insignificantly and positively affect environmental degradation in BRICS countries while in developed countries, ore and metal resources have a significant and negative association with environmental degradation. The results indicate that ore and metal resources are 0.3% cause of environmental degradation reduction in developed countries. Total natural resources have a significant and direct link with environmental degradation in BRICS, developing, developed, and global countries and describe that total natural resources are 6.3% cause of environmental degradation in BRICS countries, 1.7% in developing countries, 1.4% in developed countries, and 2.1% in global countries. Renewable energy use has a significant and indirect association with environmental degradation in BRICS, developing, developed, and global countries. The results demonstrate that environmental degradation alleviates 2.7% in BRICS countries, 0.7% in developing countries, 5.7% in developed countries, and 1.8% in global countries due to renewable energy use. Economic growth has significant and direct affiliation with environmental degradation in BRICS, developing, developed, and global countries and indicates that economic growth is 79% cause of environmental degradation in BRICS countries, 25% in developing countries, 52% in developed countries, and 42% cause of environmental degradation in global countries. FDI inflows have a direct and significant

Table 1 Description of variables by country group

Variables	BRICS		Developing		Developed	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
CO2	5.44	4.12	3.69	6.75	9.06	4.26
FUR	15.39	19.93	19.72	29.84	7.41	11.04
OMR	9.03	7.88	8.73	15.55	4.74	6.01
TNR	5.70	4.75	9.08	12.20	1.06	1.98
REU	27.35	17.76	38.16	32.30	15.42	15.99
EG	5947.19	3648.08	6257.86	10,227.73	35,274.42	20,755.83
FDI	4.02	6.12	2.74	1.40	2.61	6.09
TO	42.23	15.84	82.08	40.93	93.95	69.21
URB	2.08	1.29	2.47	2.14	0.97	0.91

Sources: World development indicators (WB; 2019) and European Union (JRC, 2019)

Table 2 Results of Fixed effect model. Dependent variable: CO2 emission

	BRICS	Developing	Developed	Global
$CO2E_{it-1}$	0.539*** (0.078)	0.672*** (0.016)	0.712*** (0.026)	0.721*** (0.014)
FUR	− 0.014** (0.006)	− 0.004** (0.002)	− 0.006*** (0.008)	− 0.008*** (0.002)
OMR	0.008 (0.007)	− 0.003 (0.002)	− 0.003*** (0.011)	− 0.003 (0.003)
TNR	0.063*** (0.012)	0.017*** (0.005)	0.014** (0.029)	0.021*** (0.005)
REU	− 0.027* (0.014)	− 0.007*** (0.003)	− 0.057*** (0.010)	− 0.018*** (0.003)
EG	0.793*** (0.234)	0.250*** (0.076)	0.522** (0.256)	0.423** (0.094)
FDI	0.063** (0.029)	0.023* (0.013)	− 0.030*** (0.026)	0.007 (0.014)
TO	− 0.022*** (0.006)	− 0.00 (0.001)	− 0.005** (0.002)	− 0.003*** (0.001)
URB	0.082 (0.091)	− 0.026* (0.014)	0.110** (0.050)	− 0.006 (0.016)
Constant	− 3.801 (2.301)	− 1.072** (0.519)	− 1.874 (2.208)	0.085 (0.716)
R-squared	0.946	0.698	0.664	0.681
No. of countries	5	145	31	176

***Point out significance results at 0.01 level

**Point out significance results at 0.05 level

*Point out significance results at 0.1 level

association with environmental degradation in BRICS and developing countries while in developed countries, FDI inflows have a significant and indirect association with environmental degradation but in global countries, FDI inflows have insignificant and positive linkage with environmental degradation. The results indicate that FDI is a 6.3% cause of environmental degradation in BRICS countries and 2.3% in developing countries but 3% in developed countries. Trade openness has a significant and negative connection with environmental degradation in BRICS, developed, and global countries but in developing countries shows an insignificant and negative association with environmental degradation. The results demonstrate that trade openness is 2.2% cause of environmental degradation reduction in BRICS countries, 0.5% in developed countries, and 0.3% in global countries. Urbanization has significant and indirect relation with environmental degradation in developing countries while the significant and direct association with environmental degradation in developed countries but in global countries shows an insignificant and negative relationship with environmental degradation while in BRICS countries reveals an insignificant and direct link with environmental degradation. The urbanization results indicate that urbanization is an 11% cause of environmental degradation in developed countries but in developing countries 2.6% cause environmental degradation reduction.

Table 3 explains the results of GMM estimator and system GMM. The estimated results indicate in GMM as well as system GMM estimators that fuel resources have significant and negative association with environmental degradation in BRICS, developing, developed, and global countries. The results show that fuel resources alleviate environmental degradation 0.8 to 1.4% in BRICS countries, 0.2 to 1.5% in developing countries, 1.2 to 1.6% in developed countries, and 0.2 to 1.8% in global countries. Large quantities of natural resources decline imports of fossil reserves and, as a result, assist to control environmental degradation. Ore and metal resources have insignificant and negative association with environmental degradation in global countries in GMM and system GMM, but it insignificantly and positively affect environmental degradation in BRICS countries in GMM and system GMM. In developing countries, ore and metal resources have an insignificant and negative association with environmental degradation in GMM estimator but in system GMM shows the significant and negative association with environmental degradation. It is only in developed countries that ore and metal resources have significant and negative association with environmental degradation in both GMM and system GMM estimators. The results indicate that ore and metal resources are 1.0 to 3.9% cause of environmental degradation reduction in developed countries. Total natural resources (coal, oil, natural gas, and mineral rents) have a significant and direct link with environmental degradation in BRICS, developing, developed, and global countries. It is described that total natural resources are 4.4 to 6.3% cause of environmental degradation in BRICS countries, 1.6 to 2% in developing countries, 1.2 to 1.5% in developed countries, and 1.4 to 2.7% in global countries. The results confirm that total natural resources boost environmental degradation in BRICS, developing, developed, and global countries. The overdevelopment of the accessible natural resources influences a country aptitude for the resources to reproduce, but such a change from ordinary equipment

Table 3 Results of GMM estimator and System GMM estimator. Dependent variable: CO2 emission

	BRICS GMM estimator	Developing	Developed	Global	BRICS System GMM estimator	Developing	Developed	Global
$CO2E_{it-1}$	0.539*** (0.070)	0.188*** (0.035)	0.527*** (0.036)	0.388*** (0.027)	0.918*** (0.029)	0.929*** (0.007)	0.939*** (0.015)	0.910*** (0.008)
FUR	− 0.014** (0.008)	− 0.015*** (0.002)	− 0.016** (0.014)	− 0.018*** (0.003)	− 0.008** (0.003)	− 0.002** (0.001)	− 0.012** (0.003)	− 0.002* (0.001)
OMR	0.008 (0.006)	− 0.003 (0.003)	− 0.039** (0.019)	− 0.005 (0.004)	0.001 (0.007)	− 0.003*** (0.001)	− 0.010* (0.005)	− 0.002 (0.001)
TNR	0.063*** (0.011)	0.020*** (0.005)	0.012*** (0.041)	0.027*** (0.008)	0.044*** (0.012)	0.016*** (0.003)	0.015** (0.024)	0.014*** (0.003)
REU	− 0.027** (0.012)	− 0.029*** (0.005)	− 0.087*** (0.018)	− 0.052*** (0.007)	− 0.014** (0.007)	− 0.002** (0.001)	− 0.007*** (0.003)	− 0.003*** (0.001)
EG	0.793*** (0.210)	0.872*** (0.103)	0.993*** (0.334)	0.885*** (0.176)	0.023*** (0.046)	0.076*** (0.019)	0.149** (0.064)	0.359*** (0.023)
FDI	0.063** (0.026)	0.041** (0.017)	− 0.042*** (0.034)	− 0.004 (0.019)	0.023*** (0.024)	0.020*** (0.007)	− 0.072*** (0.022)	0.007 (0.008)
TO	− 0.022*** (0.006)	− 0.003** (0.00)	− 0.009*** (0.003)	− 0.008*** (0.002)	− 0.002 (0.004)	0.001* (0.001)	− 0.014 (0.003)	− 0.001*** (0.001)
URB	0.082 (0.082)	− 0.132*** (0.032)	0.133** (0.064)	− 0.001 (0.034)	− 0.096 (0.090)	− 0.013* (0.007)	0.044*** (0.033)	− 0.003 (0.009)
AR(2)	− 0.54 (0.590)	− 1.22 (0.223)	− 1.66 (0.196)	− 1.64 (0.102)	− 0.40 (0.686)	0.60 (0.551)	− 1.61 (0.107)	− 1.51 (0.132)
Sargan test	121.27 (0.086)	1397.06 (0.059)	411.39 (0.037)	1494.77 (0.024)	110.32 (0.120)	1472.19 (0.011)	469.83 (0.027)	1459.47 (0.007)
Constant					2.112 (1.333)	− 0.799*** (0.183)	0.536 (0.548)	− 1.073*** (0.216)
Countries	5	145	31	176	5	145	31	176

***Point out significance results at 0.01 level

**Point out significance results at 0.05 level

*Point out significance results at 0.1 level

that exploits more resources to advanced equipment that includes innovation, recycling, value-addition, artificial resources, and using again and again that change, natural resources will get better economic growth but refuse environment. Economic progress drives industrial enterprises that boost natural resources. All these activities enhance the velocity of natural resource exhaustion, with rising the quantity as well as unsafe waste produced (Sarkodie (2018)). Moreover, huge quantities of natural resources are misused during mining, deforestation, and agriculture which negatively affect the environment. Renewable energy use has a significant and indirect association with environmental degradation in BRICS, developing, developed, and global countries. The results demonstrate that environmental degradation reduces 2.7% in BRICS countries, 2.9% in developing countries, 8.7% in developed countries, and 5.2% in global countries due to renewable energy use in system GMM estimator. Renewable energy use augmentation is a very important contributor to environmental degradation reduction as equipment of renewable energy is sustainable as well as ubiquitous. Environmental degradation declines due to renewable energy use, and the countries can augment the progress of renewable energy use. The growth of renewable energy use cannot merely assure the energy requirements of industrialization; however, it also alleviates environmental degradation. Our results follow the studies by Baloch et al. (2019), Hu et al. (2018) and Khan et al. (2020a, b, c). Economic growth has significant and direct affiliation with environmental degradation in BRICS, developing, developed, and global countries and indicates that economic growth is 79% cause of environmental degradation in BRICS countries, 87% in developing countries, 99% in developed countries, and 88% in global countries in GMM estimator. Most countries are trying to increase their growth and achieve high-level growth but societies start to give less concentration to environmental safety which badly affects citizen's health. Economic growth and environmental degradation augment mutually until an undoubted turning point in growth is achieved, behind which the environmental degradation reduces and after that overturns. Therefore, a reversed U-shaped association among pollutant and growth supposes a dynamic method of structural change associated with growth. Environmental degradation is affected due to economic growth with three major waterways: technological effects, composition, and scale. As a result, environmental degradation is regarded as a procedure that is an outcome from technical effects, composition, and scale. At that time, as economic growth augments, society will be likely to desire clean strategies intended at defending environmental degradation. Climax consequent to the environmental change is probable to move ultimately because of

technological transformation and augmented issues due to pollutant environment (Lorente and Álvarez 2016; Goklany 2012; Song et al. 2013). FDI inflows have a significant and direct association with environmental degradation in BRICS and developing countries while in developed countries, FDI inflows have a significant and indirect association with environmental degradation, but in global countries, FDI inflows have insignificant and positive linkage with environmental degradation. The results indicate that FDI is 2.3 to 6.3% cause of environmental degradation in BRICS countries and 2 to 4.1% in developing countries, but in developed countries, FDI is 4.2 to 7.2% cause of environmental degradation reduction. The FDI results suggest that industrial constitution, investment in clean energy, and equipment level augment environmental degradation in BRICS as well as developing countries but mitigates environmental degradation in developed countries. The firms invest in manufacturing, electric power, and mining in BRICS and developing countries; as a result, it enhances environmental degradation in BRICS and developing countries. Our results consist of the studies by Khan et al. (2020a, b, c), Teng et al. (2020) Bakhsh et al. (2017), Behera and Dash (2017), Kastratović (2019), Sun et al. (2017) and Zakarya and Mostefa (2015), and Khan et al. (2020a, b, c). Trade openness has a significant and negative connection with environmental degradation in BRICS, developing, developed, and global countries in GMM estimator but in system GMM shows a significant and positive association with environmental degradation in developing countries. In global countries, it indicates the significant and negative association with environmental degradation but in BRICS and developed countries, it demonstrates insignificant and negative association with environmental degradation. The results indicate that trade openness is 2.2% cause of environmental degradation reduction in BRICS countries, 0.3% in developing countries, 0.9% in developed countries, and 0.8% in global countries in the GMM estimator. The equipment transforms from developed and high-income countries to low-income developing countries in recent time which alleviate environment degradation in high-income countries as well as developed countries but enhance environment degradation in low-income developing countries. Urbanization has significant and indirect relation with environmental degradation in developing countries while significant and direct association with environmental degradation in developed countries. In global countries, it shows an insignificant and negative relationship with environmental degradation in both GMM and system GMM estimators while in BRICS countries, it reveals an insignificant and direct link with environmental degradation in GMM estimator but in system GMM shows insignificant and indirect association with environmental degradation. The urbanization results indicate that urbanization is 4.4 to 13.3% cause of environmental degradation in developed countries but in developing countries 1.3 to 13.2% cause of environmental degradation reduction. Environmental degradation increases due to urbanization in upper-middle economies as well as high-level economies (Adusah 2016; Huang and Wang 2016; Wang et al. 2016a, b; Zhang and Lin 2012).

Conclusion and policy recommendation

This study intends to assess the association of natural resources, renewable energy use, and economic growth with environmental degradation in BRICS, developing, developed, and global countries. No comprehensive study has used fuel resources and ore and metal resources to deal with the association among environmental degradation, natural resources, economic growth, and renewable energy use. To fulfill this gap, the recent study uses three measures as natural resources such as fuel resources, ore and metal resources, and total natural resources (coal, oil, natural gas, and mineral rents) to assess the association of natural resources, renewable energy use, and economic growth with environmental degradation in BRICS, developing, developed, and global countries by using dynamic fixed effect, GMM, and system GMM estimators.

The estimated results indicate that fuel resources and renewable energy use are causes of environment degradation reduction in BRICS, developing, developed, and global countries but ore and metal resources are the only cause of environmental degradation reduction in developed countries. Total natural resources (coal, oil, natural gas, and mineral rents) as well as economic growth are the main causes of environmental degradation in BRICS, developing, developed, and global countries. FDI is the cause of environmental degradation in BRICS and developing countries while in developed countries, FDI is the cause of environmental degradation reduction. The equipment transforms from developed countries in recent time which alleviate environment degradation in BRICS and developed countries but enhance environment degradation in low-income developing countries. The urbanization results indicate that urbanization is a cause of environmental degradation in developed countries but in developing countries, it is a cause of environmental degradation reduction.

Most global countries have large quantities of fuel resources which get better the quality of environmental degradation and reduce imports of fossil sources and as a result reduce environmental degradation, but huge quantities of natural resources misused during mining, deforestation, and agriculture which negatively affect the

environment of global countries as well as the fast-rising of renewable energy use have an important role in environmental degradation reduction. Economic growth and total natural resource rents are the main cause of environmental degradation because every country is struggling to achieve high-level growth and as a result of rising environmental pollution which badly affects citizen's health. Industrial constitution, investment in clean energy, and equipment level are the causes of environmental degradation in BRICS as well as developing countries but mitigate environmental degradation in developed countries. The exclusion of natural resources and the extensive use of energy-intensive equipment and misuse during mining, deforestation, and agriculture directly affect environmental degradation.

The results of the study suggest the subsequent implications in order to decrease environmental degradation and increase their economy. Policy creators should create such strategies in BRICS and developing countries that foreigner investors invest in energy development to protect their environment as well as increase economic growth. The total natural resource results recommend in BRICS, developing, and developed countries that total natural resources are the causes of environmental degradation so the government should provide advanced equipment to exploit natural resources as well as make proper use during mining, deforestation, and agriculture so that better quality of the environment will be achieved. The life series environmental degradation of renewable energy use is greatly fewer than the complement of fossil energy use so BRICS, developing, and developed countries should make proper policies to increase the use of renewable energy which will increase their economy and protect their environment. The government should make proper policies for chemical use in BRICS, developing, and developed countries because of the misuse of the chemical into the air and water not only affects the environment but also badly affects the citizen's health, so the government should give more concentration to the environment during a struggle for economic growth in BRICS, developing, and developed countries. We also advise that developed economies should move sophisticated equipment to BRICS as well as developing countries to reduce environmental degradation.

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