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Sustainable Approaches for Developing Nations Through Education, Renewable Energy, and Foreign Direct Investment

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Abstract: *Creating impactful policies for sustainable development is crucial for countries at all levels of economic advancement. Developing economies face significant challenges in formulating a strategy that effectively integrates environmental awareness with growth. This comprehensive analysis explores the influence of renewable energy on CO2 exhaustions, considering the contributions of education, GDP, natural resources, and foreign direct investment (FDI) in E-7 nations from 1990 to 2022. The results indicate that renewable energy and education contribute to a decrease in CO2 emissions by 0.58% and 0.23%, respectively, whereas foreign direct investment and the utilization of natural resources degrade the environment by 2.5% and 2.92% respectively. The varied causality findings suggest an interconnected relationship among renewable energy, education, GDP, and emissions. The findings demonstrate the critical need for E-7 nations to prioritize investments in renewable energy and education as a systematic approach to attaining sustainable development goals.*

Keywords: Economic advancement, Natural Resources, Education, CO2, E-7, Renewable energy.

INTRODUCTION

The economies of the globe are uniting today to create sustainable industrial units and to raise living standards. In both the developing and developed worlds, addressing Climate change is a threat to other sustainable development goals (Mehmood et al. n.d.; Mehmood and Tariq 2020; Roy and Singh 2017). The problem has gotten worse after recent discoveries about the rise in carbon dioxide (CO2) emissions (Figueres et al. 2018). It was unexpected that industrialized nations had raised emissions by 2.5% because of increased energy use in tandem with their burgeoning economies. As a result, the issue of emissions has become urgent, and the governments must find an emergency solution. Numerous state-level ecological organizations were established in response to growing public awareness in the latter half of the 20th century

(Sharif et al. 2020). People's increasing awareness of environmental issues has allowed these institutions to achieve amazing things (Sarti and St. John 2019). In this regard, (Akerlof 2017) offered three crucial elements that help raise awareness of environmental issues. Firstly, affective policy instruments must address individual behavior. Second, democratic principles ought to be the foundation of any organization that makes policy. Thirdly, education and values at the social level should receive primary attention.

In any nation, environmental education plays a critical role in enhancing air quality (Sinha, Sengupta, and Alvarado 2020). Scholarly investigations have demonstrated that energy policies aimed at enhancing air quality strongly prioritize environmental consciousness (Wang et al. 2018). As per the latest data, the E-7 nations have not made enough progress towards accomplishing sustainable objectives. Thorough analyses reveal a minimal use of renewable energy in E-7 countries' making units. Not enough research and innovation may be one of the main reasons for this shortage. Low levels of education in E-7 nations may be the cause of low levels of research and development. This can have two effects on the environmental quality standards: it can impede the development of novel renewable energy sources and reduce public knowledge of environmental issues (Roy and Singh 2017). Thus, a successful education can influence the effect of renewable energy, which in turn influences the quality of the environment.

Education raises environmental awareness, which compels policymakers to create effective environmental legislation, as (Grossman and Krueger 1991) pointed out. The environmental Kuznets curve (EKC), an inverted U-shaped association, is created because of these actions. It follows that education can be a useful strategy for achieving sustainable goals and that it plays a significant role in enhancing air quality. Therefore, it is essential to consider the effects of renewable energy, economic growth, and education while developing climate policies. Furthermore, because it may draw in effective technology to produce renewable energy, foreign direct investment (FDI) plays a significant part in the economic equation of the nation. Consequently, FDI has an impact on climate quality, according to (Eastin 2018). Consumption of natural resources plays a significant role in influencing the quality of the climate (Roy and Singh 2017). The environment may be harmed using natural resources to generate economic growth (Zafar et al. 2020). Thus, bettering the climate is necessary to promote sustainable economic growth.

Regarding the E-7 countries, this study intends to analyze this link between 1990 and 2022. India, Russia, China, Mexico, Brazil, Indonesia, and Turkey are the members of this group. The fact that these nations are primarily developing and dealing with the issue of climate change serves as the driving force for this study. Furthermore, the level of education in these countries is falling (Anon 2016). Therefore, the purpose of this research is to formulate SDGs 13 and 7 for E-7 countries. The relationship between CO2 and renewable energy will be considered while designing this policy framework. Here's when this study comes in handy. The study chose the E-7 nations. All E-7 countries are developing nation, and they are focused to attain sustainability at both economic and Environmental level. The technique and data specification of this article are described in Section 2. It also includes a review of related literature. The results and discussion are in Section 4, and the conclusion and policy implications are in Section 5.

LITERATURE REVIEW

The goal of the E-7 groups, which consists of 7 nations, is to lessen their debt load by strengthening relations with affluent countries. By making the most use of their natural resources, these nations hope to accelerate their economic growth. Some emerging nations are consuming a lot of energy from fossil fuels to boost economic activity, which is having a negative impact on the environment (Li et al. 2024). Environmental

pollution can be decreased by more efficient and environmentally friendly industrial methods; however, these nations have not been able to expand their energy-related research and development because of low literacy rates. Furthermore, these countries' low educational attainment hasn't raised people's understanding of environmental issues. (Javed et al. 2023; Mehmood, Aslam, and Javed 2023) assert that developing countries are more susceptible than developed countries to climate-related issues. According to earlier research, developing country policymakers must create eco-friendly policies in order to combat climate change (Mehmood 2021a, 2021b, 2021c; Mehmood et al. 2021; TARIQ 2017).

On renewable energy, the effect on public policy on renewable energy were determined (Polzin et al. 2015). They recommended creating laws governing the utilization of renewable energy sources. To boost energy that is clean in OECD countries, institutional capability must also be improved. Accordingly, the research works that investigate the relationships between natural resources, energy utilization, climatic quality, FDI, economic growth, and the use of renewable energy will be evaluated in this part.

In this regard, (Ben Jebli 2016) investigated the connections between GDP, energy use, trade, and CO2 emissions. They found that reducing CO2 emissions requires both increasing trade and renewable energy, which justified EKC. It seems sense that cutting-edge innovations to address climate issues can be brought about by international trade. In a separate study, (Shafiei and Salim 2014) used stochastic effects to examine changes in population, technology, and wealth in OECD countries between 1980 and 2011. They discovered that environmental issues are enhanced with the usage of non-renewable energy, while using renewable energy lowers energy use. Their research confirmed the EKC between quality of the climate and urbanization.(Zhu et al. 2016) apply Panel quintile regression to examine the nexus among GDP, FDI, and energy utilization and CO2 emissions in ASEAN countries. They discovered that FDI can raise the standard of air. Furthermore, distinct independent variables accurately reflect the uneven CO2 emissions. In G20 countries, FDI has little influence on CO2 emissions determined by (Lee 2013).

Furthermore, there was a negative correlation discovered among CO2 emissions and GDP. The developed G20 nations may not benefit more from FDI to enhance air quality. According to study done for the BRICS by (Pao and Tsai 2010), FDI increases air pollution. This suggests that FDI inflows should be closely examined to lessen their detrimental climate effects. Likewise, disparate research has produced conflicting findings (Behera and Dash 2017; Shahbaz et al. 2019).

Too many research has been conducted on the significance of education and environmental consciousness in many global locations (Faize and Akhtar 2020; Sánchez-Llorens et al. 2019). A study on the relationship between education and biodiversity preservation, for instance, was conducted by (Ramírez and Santana 2019). It was also discovered by (Ketlhoilwe 2019) that catastrophe risk management and climate awareness are related. Few research papers have examined the connection between CO2 and emissions education, as far as we are aware. This correlation provides a means of exploring further the relationships between environmental consciousness and sustainable development, particularly in developing countries where rising levels of pollution are correlated with lower levels of education.

Though there is conflicting research that highlights the significance of non-sustainable energy sources for economic rise, the literature in this study shows that renewable energy plays a favorable effect in fostering economic progress. Furthermore, the idea that education plays a beneficial role in establishing sustainable energy sources in both established and non-established nations is currently under controversy (Apergis, Ben Jebli, and Ben Youssef 2018; Mahalik, Mallick, and Padhan 2021; Wang et al. 2021). Determining how

education level affects the reduction of environmental pollution is crucial, when it comes to developing nations. This study completely defines, the role of education, renewable energy and foreign direct investment in fostering the country's economy growth to move towards sustainable economy and environment, with proven effect of reduction of Co2 emission in these developing nations. To accomplish sustainable development, this study provides its effort to offers innovative policy instruments by combining education and awareness.

Theoretical background

The theoretical background offers substantial support for empirical analysis; thus, it is essential to reference existing literature for theoretical justification. The E-7 economies primarily consist of developing nations that are increasing their energy consumption to attain greater economic growth. Over time, these nations are trying to integrate green energy sources utilization into their energy use. Hence, putting all efforts to use green energies, these economies still have a risk of environmental pollution. However, the E-7 countries have plenty of natural resources but, these are not sustainable due to poor management of these resources. Natural resources with hydro carbonized structures may emit more CO2 during usage. Consequently, an overuse of natural resources can lead to a reduction in the quality of environmental standards. Furthermore, most of these nations are dependent on conventional technologies for their energy consumption. To enhance the appeal for foreign direct investment, these countries might prioritize economic incentives over environmental balance.

At this point, it is important to discuss the impact of education to improve the air quality and spread its awareness through education to the public. Due to environmental awareness, there is improvement in the air quality, after a certain level of economic growth. This is due to better education and people become aware to their surrounding issues and become more concerned about the environmental quality. In this way, people urge to policymaker to make policies that create cleaner environment. This whole process is only created by education. In this regard, both private and public sectors should set up, to enhance environmental issues awareness among the public. Thus, the education system must be updated to promote environmental sustainability. Furthermore, it is necessary to add a lesson of environmental issues in the high school and secondary school courses, so that the people can obtain a basic concept of protection of environmental issues. Hence, environmental challenges may be understood via education.

Renewable energy can be affected by foreign direct investment, natural resources, and education's technical impacts on the quality of the environment. Thus, renewable energy and education might lower CO2 emissions, but natural resources, foreign direct investment, and economic expansion may increase them. We also equate the Co2 emissions to air quality standard to control environmental pollution in the emerging economies. However, previously studies work on these variables linkage for a limited time, but in this study, we deeply analyzed the long-term association between the parameters and their effect and linkage on the nations with addressing proper several policy implications for achieving the sustainable development goal for future implementations.

Model specification and data

GDP is used as a controlled factor to study how education (ED), natural resources (NA), foreign direct investment (FDI), and renewable energy (RE) use impact CO2 emissions. Econometric equation is given below:

The F (ED, GDP, FDI, NA, RE) EnFDIc equation looks like this: rowth might be an outspoken role model. It should also be covered in high and secondary schools' curriculum. (1)
We converted the parameters into logarithmic form to guarantee normal distribution. Heteroskdasticity and autocorrelation issues are removed in logarithmic form. Furthermore, logarithmic data yields reliable findings (Shahbaz et al. 2016). Consequently, the logarithmic equation that is produced is as follows.

$$\ln CO_{2it} = \beta_{i0} + \beta_1 \ln EDU_{it} + \beta_2 \ln G_{it} + \beta_3 \ln FDD_{it} + \beta_4 \ln NA_{it} + \beta_5 \ln RE_{it} + \epsilon_{it} \quad (2)$$

where t is the time period from 1990 to 2022, and i stands for the cross sections of NA, EDU, FID, G, and RE values are displayed in β_{i0}, whereas error term is indicated by ϵ_t.

To ascertain the magnitude, we calculated an Environmental Kuznets Curve equation for the compositional and technical impacts of education, GDP, foreign direct investment, natural resources, and renewable energy. We used the quadratic form of EKC, as (T. 1993) had done, to examine the effects of independent parameters. All variables, apart from renewable energy, are predicted to worsen environmental quality under the EKC framework; but, after a certain threshold, to improve air quality these parameters are predicted. Countries don't care about the environment in the early phases of economic progress, but as time goes on, individuals begin to express concern about the state of the environment. Environmental policies are developed by governments, currently by luring FDI and making use of natural resources, which expands employment prospects. The scale effects of FDI on environmental balance could be explained by this phenomenon. A rise in professional activity raises educational attainment even further. Environmental protection may be subordinated to higher priorities for educational advancement. As a result, sequestration education policies cause the standards of the environment to decline. Therefore, in this case, the environment is further deteriorated by the careless use of natural resources in industrial facilities. This process also shows how education and natural resources affect the state of the environment at scale. Once GDP reaches a certain level, education raises awareness. Education's dimension impact and technique influence on environmental quality can be used to describe how education changed from vocational activities to environmental awareness.

The square term of schooling provides an explanation for this phenomenon. As a result, increasing educational attainment currently also enhances environmental quality. The square term of FDI explains this phenomenon, which is the point at which additional economic expansion and FDI precisely slow down the impact on climate quality. Additionally, public awareness has led to a shift in focus toward the preservation of natural resources through efficient manufacturing methods. Natural resources begin to grow, which reduces environmental deterioration. The natural resources square term provides a mathematical explanation for this mechanism. In the context of the E-7 nations, where economic activity is rising and environmental degradation is happening quickly, this phenomenon is significant. The EKC nonlinear equation is provided below:

$$\ln C_{2it} = \beta_{i0} + \beta_1 \ln EDU_{it} + \beta_2 \ln EDU_{it}^2 + \beta_3 \ln G_{it} + \beta_4 \ln G_{it}^2 + \beta_5 \ln FDI_{it} + \beta_6 \ln FDI_{it}^2 + \beta_7 \ln NA_{it} + \beta_8 \ln NA_{it}^2 + \beta_9 \ln RE_{it} + \epsilon_{it} \quad (3)$$

Using annual data from 1990 to 2022, the study demonstrates the relationships among education, GDP, FDI, natural resources, renewable energy, and CO2 emissions in E-7 member nations. The following E-7 nations were included: Mexico, China, Russia, Brazil, India, Indonesia, Turkey. CO2 emissions are expressed in terms of GDP per capita (G), natural resources (NA), foreign direct investment (FDI), and RE as a proportion of total energy output. As a measure of education (ED), we included percentage of total expenditure in public institutions. It takes all institute of education to comprehend climate pollution and take necessary action. All information is derived from global data indicators. (Anon 2016).

Cross sectional dependence test

Cross-sectional dependence (CD) in panel data might lead to unreliable results (Phillips and Sul 2003). Economic, social, and cultural connections can make nations reliant on one another. This interdependence between nations produces CD. Therefore, we used the LM test by (Breusch and Pagan 1980) and the CD test by (Pesaran 2004) to check CD. The following formula is used to check CD in this regard.

$$LM = T\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}\partial_{ij}^{t} \tag{4}$$

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{n-1}\sum_{j=i+1}^{n}\partial_{ij}^{t}\right) \tag{5}$$

Where T is time and N is cross sections. The erroneous pairwise correlation between i and j is denoted by ∂_{ij}^{t}. After looking at the cross-sectional dependence, we checked the slope phenomena using the slope homogeneity test. The presence of equality in the panel data of nations may yield conclusions that are not trustworthy (Le and Ozturk 2020). The following are the formulas for the $\Delta^{\sim}$ and $\Delta^{\sim}_{adj}$ regions' slope homogeneity tests:

$$\Delta^{\sim} = \sqrt{N}\left(\frac{N^{-1}S^{\sim} - K}{\sqrt{2K}}\right) \tag{6}$$

$$\Delta^{\sim}_{\text{adj}} = \sqrt{N}\left(\frac{N^{-1}S^{\sim}_{\sim} - E(Z^{\sim}_{iT})}{\sqrt{\text{var}(Z_{iT}{}^{\sim})}}\right) \tag{7}$$

Where $E(Z^{\sim}_{iT})$= var$(Z^{\sim}_{iT}) = ¼2K(T-K-1)/(T+1)$.The modified test of S can be applied by using the equation as follows:

$$S^{\sim} = \sum_{i=1}^{n}(\gamma_i - \gamma_{\widetilde{W}FE})\frac{Y_i' M_T X_i}{\emptyset_i^{\sim 2}}(\gamma_i - \gamma_{\widetilde{W}FE}) \tag{8}$$

γ_i represents the individual unit's pooled OLS test value $\gamma_{\widetilde{W}FE}$displays the weighted pool estimator, while MT denotes the identity matrix.

After verifying slope homogeneity, the sequence of interaction among components is explored since time series with unit roots might yield fascinating results. Two types of unit root tests assessed variable stationarity. Thus, first-generation unit root tests (Levin, Lin, and James Chu 2002; Pesaran, Shin, and Smith 2001) and data is tested with second-generation unit root tests. It is necessary to investigate variable co-integration If the parameters are co-integrated at first difference yet the tests for unit root suggest integrational level I(0), simple regression of ordinary least square (OLS) can be applied. Eliminate co-integration methods like (Johansen et al. 1990; Kao 1999; Pedroni 1999), we used the Westerlund Edgerton [50] test in this case, which considers CSD between the time series.
We estimate long-run coefficients after verifying co-integration between estimated variables. This was done using FMOLS and DOLS. These tests' formulae are provided as follows:

$$\gamma_{FMOLS} = \left[N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{t} \mathrm{U}_{it} - \tilde{u_i} \right)^2 \right]^{-1} \tag{9}$$

$$\widehat{\gamma_{DOLS}} = \left[N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \mathrm{C}_{it} \mathrm{C}'_{it} \right)^{-1} \left(\sum_{t=1}^{T} \mathrm{C}_{it} \mathrm{C}'_{it} \right) \right] \tag{10}$$

The long-run coefficients were found in this study using (DOLS) and (FMOLS) approaches. These tests are frequently used in literature because they eliminate endogeneity and autocorrelation issues. We used testing to determine the variables' causal relationship. Because this test eliminates the CS issue in the data, it is effective.

RESULTS AND DISCUSSION

Examining panel data for cross-sectional dependence is the initial step in the empirical estimating process, and Table 1 and 2 display the CD test results. To verify the values, We report three coefficients. All three tests reveal cross-sectional dependency at 1%. This dependence may be due to E7 economic and cultural dependence. CD also allows second-generation unit root tests to check variable integration order. Therefore, we employed CADF and CIPS unit root testing. Tables 3 exhibit first- and second-generation unit root test results. Unit root test findings indicated some variables are stationary at first difference and some are integrated at level. Furthermore, we used (Westerlund and Edgerton 2007) to determine whether cointegration existed among the calculated equations after determining the integration order. In the long run, Table 4 demonstrates that GDP, FDI, CO2 emissions, education attainment, renewable energy and natural resources all move collectively at a 1% level in E-7 countries between 1990 and 2022.

Table 1
Cross sectional Dependence test

Variables	Cd-Test	P-value
CO2	10.51***	0.000
GDP	6.019***	0.000
GDP^2	1.631	0.103
RE	16.608***	0.000
RE^2	17.189***	0.000
FDI	-1.574	0.116
FDI^2	9.45***	0.000
ED	23.022***	0.000
ED^2	21.414***	0.000
NA	12.169***	0.000
NA^2	11.049***	0.000

1%*, 5%**, 10%*, Significant value differences.**

Table 2
Cross section dependence test

Test	Statistic	Prob.
Breusch-Pagan LM	68.33763	0.0000
Pesaran scaled LM	7.304355	0.0000
Pesaran CD	-0.398656	0.0180

Table 3
Unit Root Test CADF and CIPS

Variables	Value At level	Value 1st difference	CIPS At level	CIPS At 1st difference
CO2	-2.69**	-3.35***	-2.52***	-5.82***
GDP	-3.52***	-2.30***	-4.09***	-4.12***
GDP^2	-3.33**	-4.60***	-3.47***	-4.63***
ED	-1.03*	-1.82***	-1.98***	-3.14***
ED^2	-2.94***	-1.37***	-1.78***	-3.78***
FDI	-1.69***	-1.87***	-2.23***	-6.78***

FDI^2	-2.17***	-3.66***	-2.43***	-6.04***
NA	-2.58***	-2.53***	-1.88***	-4.18***
NA^2	-3.22 ***	-2.83***	-2.37***	-3.18***
RE	-2.28**	-2.42***	-2.24***	-3.57***
RE^2	-2.76***	-2.18***	-2.13***	-6.13***

1%*, 5%**, 10%*, Significant value differences.**

Table 4
Westerlund co integrations

Stat.	Value	Z-value	P-value
Gt	-5.156	-6.968	0.000
Ga	-15.150	-0.056	0.478
Pt	-13.687	-6.854	0.000
Pa	-15.627	-1.369	0.086

Table 5
Linear long run results

Variables	FMOLS	Prob	DOLS	Prob	PMG	Prob
ED	-0.23***	0.00	-1.37***	0.00	-0.76***	0.00
GDP	0.38***	0.00	1.09***	0.00	0.56***	0.00
FDI	-0.05***	0.00	-0.39***	0.00	-0.29	0.19
NA	0.07***	0.02	0.13**	0.09	0.82	0.13
RE	-0.58***	0.00	-4.93***	0.00	-0.11***	0.00

1%*, 5%**, 10%*, Significant value differences.**

Table 6
Non-Linear long run results

Variables	FMOLS	Prob	DOLS	Prob	PMG	Prob
ED	-0.72***	0.00	-3.43***	0.00	-0.43***	0.00
ED^2	3.23***	0.00	3.09***	0.00	0.06***	0.01
GDP	-3.00***	0.00	-3.03***	0.00	-0.31***	0.00
GDP^2	1.53***	0.04	0.18***	0.03	2.09***	0.00
FDI	-2.5***	0.00	-0.76***	0.00	-0.11***	0.01
FDI^2	0.81***	0.00	1.73***	0.09	0.76***	0.00
NA	-2.92***	0.00	-2.71***	0.00	-0.49***	0.00
NA^2	2.97***	0.01	0.93***	0.00	0.37***	0.00
RE	-0.22***	0.00	-0.03***	0.07	-0.29***	0.03
RE^2	0.01***	0.03	0.02***	0.00	0.04***	0.00

1%*, 5%**, 10%*, Significant value differences.**

Table 7
Dumetrescu and Hurlin test.

Null Hypothesis	W-Stat.	Z-bar-Stat.	Prob.
LNEDU--LNCO	4.34	4.01***	0.00
LNCO--LNEDU	4.94	2.87***	0.00
LNEDU2--LNCO	5.12	3.04***	0.00
LNCO--LNEDU2	3.18	3.93***	0.00
LNFD--LNCO	5.65	2.03***	0.00
LNCO--LNFDI	3.76	1.21**	0.03
LNFDI2--LNCO	2.16	-0.78	0.35
LNCO--LNFDI2	4.02	3.09***	0.00
LNGDP--LNCO	9..87	10.98***	0.00
LNCO--LNGDP	3.98	3.91***	0.00
LNGDP2--LNCO	10.65	11.01***	0.00
LNCO--LNGDP2	5.12	4.78**	0.07
LNNAT--LNCO	3.87	1.99***	0.00
LNCO--LNNAT	6.54	5.84***	0.00
LNNAT2--LNCO	3.23	2.41**	0.06
LNCO--LNNAT2	6.09	5.94***	0.00
LNREN--LNCO	5.09	4.32***	0.00

1%*, 5%**, 10%*, Significant value differences.**

Table 8
Descriptive statistics Test

	CO2	ED	FDI	GDP	NA	RE
Mean	4.055604	4.26E+10	1.52E+10	3.124847	4.802013	25.55388
Median	2.774762	2.47E+10	-6.12E+08	3.732852	3.280885	21.90000
Maximum	14.62149	3.15E+11	3.44E+11	13.63582	21.50270	59.18000
Minimum	0.647451	1.909091	-5.32E+10	-14.61392	0.143922	3.180000
Std. Dev.	3.427734	5.36E+10	6.30E+10	4.567471	4.406124	16.70614
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000029

Three estimate techniques were used to ascertain the long-term coefficients of the independent variables: Pooled Mean Group (PMG) ARDL, (DOLS), and (FMOLS). Tables 5 and 6 display the long-run linear and non-linear coefficients. First, we look at the linear connection among the parameters and indicate education effectively lowers CO2 emissions by 0.23%. This implies that people become more environmentally conscious as their level of education rises, which prompts them to call on the government to enact more robust climate laws. Therefore, better environmental quality is the product of successful policy implementation. Similar conclusions were reached by Puukka(Puukka n.d.), who observed that in OECD nations, education encouraged sustainable growth. The findings of (Bano et al. 2018a), who discovered that greater education levels lead to less environmental contamination, are similarly consistent with our findings. Our results concur with those of Danish et al. (Danish et al. 2017) in Pakistan and (Sinha and Shahbaz 2018).

in India.

To reduce CO2 emissions, authorities should start to enhance the use of renewable energy owing to sustainability efforts and public pressure. For sustainable growth, these nations must consider their environmental regulations. A profusion of natural resources also gives governments the chance to use them to boost GDP. When natural resources are used carelessly, the ecosystem will deteriorate. Other natural resources that release greenhouse gases include fossil fuels (Ben Jebli, Ben Youssef, and Ozturk 2016) findings are comparable to ours for the OECD. Higher economic growth caused these nations to concentrate on industrial output, which was aided by foreign direct investment. FDI is enhancing the quality of the air in E-7 nations in this regard. These findings align with (Sapkota and Bastola 2017; Solarin et al. 2017). E-7 nations must take these issues into account considering empirical findings to meet the SDGs.

The analysis results of the quadratic equation are given in Table no 6. Education's positive coefficients and negative square term confirm the EKC hypothesis that education and CO2 emissions are connected. As education levels grow, occupational activities are increasingly stimulated. Professional endeavors increase energy demands and cause environmental issues. Nevertheless, as economic progress increases, people's

educational attainment rises, and they begin to take greater care of their surroundings. As a result of increased public awareness, cleaner energy use is demanded, improving air quality. This result is consistent with (Balaguer and Cantavella 2018) findings for Australia, but it contrasts with (Jiang 2015) findings, which did not discover an inverted U-type connection among CO2 and education in China. FDI and its square term have positive and negative correlations. The EKC between FDI and CO2 in E-7 nations was validated by this finding. The results indicate that (FDI) is causing environmental degradation in these emerging countries through the consumption of fossil fuels for large industrial outputs. However, FDI will eventually begin to improve air quality by importing efficient technology in China as demonstrated by (Bano et al. 2018a).

Both positive and negative relationships exist between GDP and its square term, which validates EKC in E-7 countries. Early economic expansion that relies on fossil fuels degrades the quality of the air. Air quality begins to improve if GDP reaches a certain threshold level. As a result of climate awareness and education, the public is calling for cleaner technologies that lower CO2 emissions. These results show the sustainable course for E-7 countries. According to Latin America and India, respectively, these findings are consistent with (Sapkota and Bastola 2017; Sinha and Shahbaz 2018). Then we analyzed how natural resources affect CO2 emissions. Natural resources and their square term were positively and negatively correlated, validating EKC. For economic progress, governments must employ rich natural resources.CO2 emissions are rising rapidly. The use of natural resources slows down because of GDP and education awareness. At this phase, air quality begins to improve due to the increase in natural resources. Last, but not least, renewable energy is thought to greatly boost air quality standards. This conclusion is in conflict with (Farhani and Shahbaz 2014) in African countries but in agreement with (Sinha and Shahbaz 2018) in India. Our final results from the causality analysis are shown in Table 7. Because of the significant policy ramifications, this test is required bi-directional(Lu et al. 2014). The causality test therefore has significant ramifications for successful policy tools. We used (Dumitrescu and Hurlin 2012), which considers parameters heterogeneity. The outcomes are shown in Table 7. Education and CO2 emissions are causally related in both directions. Bano et al. (Bano et al. 2018b) also discovered a causal feedback relationship between CO2 emissions and human capital. FDI and CO2 emissions are found to be causally related in both directions. (Seker, Ertugrul, and Cetin 2015) also found a one-way impact of CO2 emissions on FDI. Similar to (Salahuddin et al. 2018), also found a one-way impact of CO2 emissions on GDP, bidirectional causation exists between CO2 and GDP. Additionally, a feedback causal relationship between CO2 emissions, renewable energy, and natural resources is discovered.

suggestion for sustainable development

This study presents long-term and causal effects among many factors to offer recommendations for sustainability goals in E-7 member countries. It is found that education have a feedback causal effect on CO2 and to enhance air quality. Policy implications for E-7 countries' sustainable development are provided by this finding. Education helps the country understand environmental issues and respond appropriately. Furthermore, creative methods for cleaner manufacturing are made possible by increased awareness and education. Jobs and a cleaner environment are provided by these cutting-edge technology (Sinha, Shahbaz, and Sengupta 2018). The SDGs for high-quality education, environmentally friendly work practices, industrial advancements, and climate action may therefore be achieved. The nexus among education, renewable energy, and CO2 emissions offer important tools in the context of E-7 countries' effective energy strategies. As educational attainment rises, so does the use of renewable energy, indicating a trend toward sustainable energy solutions in nations. Fossil fuels impair the quality of the air, while renewable energy offers sustainable alternatives. This is why GDP contributes to renewable energy. Thus, it is essential that

policymakers transition from fossil fuels to sustainable energy sources gradually. Additionally, throughout this shift from sustainable energy over fossil fuels, educational channels can prevent future loss of natural resources. Following this course of action, achieving the SDGs for education, climate action, renewable energy, and clean energy use, requires a high level of education.

However, E-7 countries should not rely on foreign technology through FDI in their attempts to innovate efficient technologies and deliver high-quality education, since local technologies will endure through research and development. Furthermore, governments will have more control over the natural resources that are accessible if there is less reliance on foreign direct investment. Along with cleaner technologies in domestic channels, policymakers should prioritize the effective preservation of public buildings.

E-7 nations vary greatly in economic and environmental variables, as seen in the table 8. CO2 emissions (mean 4.06) and renewable energy consumption (mean 25.55) have moderate averages but substantial variability, notably CO2. Outliers include nations that spend more on education and attract more FDI. GDP growth averages 3.12, while several nations saw negative growth. Natural resource availability is reasonable yet skewed toward a few resource-rich nations. Other factors are less uniformly distributed than renewable energy usage.

CONCLUSION AND FUTURE SUGGESTIONS

Over the last few decades, economies throughout the world have struggled to create cleaner environments without compromising economic development. Several economic and social aspects might be useful in this context. This empirical study examines the relationships between CO2 releasing in E-7 countries between 1990 to 2022 and education, FDI, NA, GDP, and the usage of renewable energy. To provide policy tools for sustainable development, this study used unit root tests of the first and second generations. This research advocated strategies to promote renewable energy and boost public awareness to minimize CO2 emissions. This path will lead to the achievement of SDGs 7, 13, and 4. Consequently, our effort has added to the present wave of knowledge by offering several avenues for achieving long-term objectives. Listed below are the provisional policy tools. Since education has a minimal effect on CO2 exhaustion, E-7 countries may enhance air quality by raising awareness of the issue in the education sector. Governments may foster environmental awareness and encourage societal energy conservation for sustainability by including environmental advantages and energy efficiency into curricula. Accordingly, curricula should be created such that people's educational awareness comes before their professional endeavors.

This strengthens public-private partnerships and decreases air quality impacts from foreign direct investment. The E-7 countries must only offer incentives to foreign direct investment (FDI) that brings greener energy production and consumption technology. Additionally, companies should get financial incentives for using sustainable technology. Since using fossil fuels can hinder economic growth, policymakers must transition to sustainable energy sources gradually. In this case, environmental measures will be effectively supported by the role of education awareness. As a result, E-7 countries ought to be required to raise their educational budgets.

There are several limitations in addition to the contribution of this study, which can be addressed by further research. This study used panel estimations, and structural fractures can be taken into account in future research on specific nations. Additionally, quintile analysis can be used in future research to give deeper policy implications.

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