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The role of technological innovation in environmental pollution, energy consumption and sustainable economic growth: Evidence from South Asian economies

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ABSTRACT

This study examines the causal relationship among technological innovation (TI), environment pollution (EP), energy consumption (EC) and sustainable economic growth (SEG) from selected South Asian economies. In order to identify the causal association between energy growth and nexus of CO_2 emissions, this study is employed the premises of the EKC framework. This study has used annual time series data set from world development indicator (WDI), start from 1990 to 2019. The result of a fully modified ordinary least square (FMOLS) method describes a significantly worsen the quality environment in the south Asian region. The individual country as Bangladesh shows a positively significant impact on the CO_2 emissions and destroying the level of environment regarding non-renewable and renewable energy and technological innovation index. However, negative and positive values of growth (GDP) and square of GDP respectively confirm the EKC hypothesis in this region. This study has identified the causality between GDP growth and carbon emission and found bidirectional causality between economic growth and energy use.

1. Introduction

Since 19th century, the economic activities and its impact on the environmental quality are initially discussed by the Reverend 'Thomas Malthus' and their criticism on the poor reprieve agenda. According to his view, environmental degradation issues are related to the poverty reduction programs and feed future generation and human ability can be threaten by these programs. However, the Malthus hypothesis of 'limit to grow' (association between economic growth and development and environmental quality), environment and human prosperity are associated with economic growth arguments and interrelated to each other. Jun et al. [1]; examined the world production and demand for energy, which comes from fossil fuels, specifically petroleum products, natural gas, and coal. The study explored that around 85%–93% of world energy production comes from fossil fuels. The growth of energy production over the period is split into three portions based on population and economic growth. The study also explored that the future demands and production of world energy from fossil fuels are expected to be limited due to limited energy resources.

The environmental pollution and Co2 emission is highly affected by the economic growth and development. The relationship between economic growth induced environmental pollution can be described into inverted U shaped "Environmental Kuznets curve" (EKC) hypothesis in the second category. In the early economic growth stages, to increase the production capacity of the economy, the environmental degradation issues are raised due to natural resource depletion. The environmental quality is significantly ignored by various countries to achieve highest economic growth in this stage. Chaabouni and Saidi [2] examined the

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connection among the CO2 emission, healthcare, and GDP of fifty-one selected economies f from 1995 to 2013, and these chosen countries are further segregated into three different income level slabs. GMM and dynamic simultaneous equation model employed for analysis. The outcome of the study suggested that a bidirectional association was found between CO2 emission and GDP and healthcare expenditure and GDP, while a unidirectional association was determined between CO2 emission and healthcare expenditure.

In the recent era, the most prominent approach to be employed is higher concentrations on social factors along with technological and economic factors which support the find the dimensions. Cherp et al. [3] derived different methods and approaches for the production and consumption of energy resources. Ansari and Holz [4] determined the growth rate of population, urbanization, cost of reducing side effects of energy, availability of fossil fuel, and economic integration are the key drivers by employed a STEMPLE framework. Gielen et al. [5] pointed out the future of energy, and the study suggested that by the end of 2050, technologies associated with renewable energy resources and energy efficiency will be the leading indicators.

This study supports greater environmental sustainability and these components reduce the resource usage among them. However, these components support a shift away from environmentally unsustainable energy technologies to more sustainable energy technologies. This study gives different policy implications to increase the supply of clean, efficient, and low carbon energy to recipient countries. However, improved access to clean energy is socially desirable. This study does not anticipate the program to create a socially unsustainable situation. Policy and regulatory support will highlight the importance of building inclusive growth and social sustainability into the planning and development process. The purpose of this study is to investigate the relationship among technological innovation, environment pollution, energy consumption and sustainable economic growth from selected south Asian economies. These variables are interlinked to each other, especially technological innovation plays an important role in this study through reducing the environmental pollution and increase economic development. This study is first ever attempt to investigate the causal relationship among these variables as we didn't find any comprehensive study on this topic to fully addresses whole scenario in south Asian region. From last couple of decades, the south Asian region was trying to overcome the issue of climate change and environmental pollution in order to increase their trade volume and sustainable economic growth rate.

2. Literature review

The literature suggested that energy consumption structure can be subdivided into two sub-categories such as, renewable and non-renewable energy usage. The major contributor of environmental degradation is nonrenewable energy in terms of fossil fuels. The use of nonrenewable sources through fuels combustion are depressing the environmental quality with increases the level of Co_2 emission. Whereas, Co2 emission level increases via tremendous use of nonrenewable has been tested through EKC premises in various empirical analyses for several countries: the study for Central America is discussed by Apergis and Payne [6–8]; for Republic of China Riti et al. [9]; Nguyen et al. [10]; Jalil and Mahmud [11]; for turkey Pata [12]; Shabbir and Wisdom [13]; Yikun et al., [14]; Arslan et al., [15]; Khan et al., [16]; Liu et al. [17,18]; Yu et al. [19]; Arif et al. [20], and Halicioglu [21,22]; for Cambodia Ozturk and Al-Mulali [23]; for Pakistan Javid and Sharif [24]; the economy of Japan is discussed by Rafindadi; this three-way association examined in Malaysia and for Tunisia by Saboori and Sulaiman [25,26] and Shahbaz et al. (2014) respectively efficiently discussed the role of nonrenewable energy in worsen the quality of environment.

The environmental protection agencies also propose more significant usage of renewable energy resources to offset the rate of climate change [27,28]. The usage of renewable energy resources helped to improve the health of the general public and decreases the rate of air pollutants, supporting economic development and generating employment opportunities [17,18]. CO_2 emissions and the usage of renewable energy have become a major concern in both developed and developing countries. Alternative energy sources are employed to combat pollution in developed countries. Modern energy structures must be considered in order to meet the Millennium Development Goals. In the case of CO_2 omission and the use of renewable energy has become a critical issue in developed and underdeveloped counties. To achieve the Millennium Development Goals, modern energy structures cannot be ignored. Economic growth, employment opportunities, transportation, and commerce are positively associated with energy [29]. Ecological economics, like economic history and neoclassical economics, provides a distinct perspective on the association between non-renewable energy usage from fossil fuels and economic growth [30,31].

Furthermore, Darmstadter et al. (1979) and Rosenberg (1998) described that the living standard of the citizen can be improved by energy use and economic growth increases with the increase in the level of energy use. The analysis of Barney & Franzi (2002) explored energy as a key determinant of economic growth and playing vital role in industrial production. Furthermore, the Grossman and Helpman (1990) and Romer (1990) introduced the research and development as an important component of economic growth. But Kraft and Kraft (1978) provided the new insights of economic growth model and discussed that energy is essential for the production process.

Previous literature indicates that energy is a main ingredient in the process of production; it is the backbone of the industrial sector. The targets of economic growth cannot be achieved without the use of energy sources and rise in economic growth increases the level of energy use and both moves parallel together. Although, different economist introduced various theories of economic growth and development but energy as a key ingredient of economic growth is neglected by these growth theories. The technological advancement consider as important component of economic growth in Solow growth model. The economic growth can be increased due to increases the level of saving is discussed by the AK model. Likewise, the innovation and capital formation are considered as the most important determinants of economic growth in the growth model of the Schumpeter.

Thus the viability of the environmental-economic growth i.e. improvement in economic growth with the sustainable environment becomes a dilemma for the policy makers. Saleem et al. [32] explain that Asian economies are responsible almost half of the CO2 emission in the world. Muhammad et al. [33], examined the willingness to pay toward renewable energy sources in Turkey. Hence, it is an utmost requirement to pay heeds to environmental quality. Hence, in the light of the above discussion, we can conclude that study of the nexus between climate change, energy effects, and financial development alongside environmental-economic growth is very important to outlines the policies which can yield the sustainable environmental-economic growth in future. Li et al. [34] explored the relationship between renewable energy sources and economic growth of SAARC countries. The findings of their study show that renewable energy sources have significant positively impact on economic growth. Mujtaba and Shahzad [35] studied the relationship between economic development and Co2 emissions and its impact on the health of society of the twenty-eight OECD economies from 2010 to 2018. Vector error correction model and modified least square model employed on penal data and result suggested that there exist a long run and causal relationship between renewable energy resources and CO2 emission to healthcare expenditure.

3. Methodology

3.1. Theoretical framework and hypothesis

This study tries identifying the effects of technological innovation, environmental pollution, energy consumption and economic growth in south Asian countries and at what extend the sustainable environmental agenda influences from this causal relationship. This study uses CO_2 emissions as proxy of environmental pollution and GDP as proxy of economic growth. It is observed that due to technological advancements and modern usage, the consumption of energy increases globally. The empirical studies of [36,37]; and [27] have included various additional explanatory variables in assessments of GDP and emissions of GHG under the scheme EKC hypothesis. This study uses annual panel data set starts from 1990 to 2019 for five south Asian countries for instance, Bangladesh, Bhutan, India, Maldives and Pakistan.

The theoretical framework of EKC framework is used in the following the econometric model:

$$Yit = \alpha_1 + \alpha_2 CO_2it + \alpha_3(CO_2it)^2 + \alpha_4 Xit + \mu it \quad (1)$$

Where CO_{2it} show the carbon emission (per capita) level (environmental pollution), Y_{it} shows GDP (per capita) income (economic growth) and other influential macroeconomic variables are indicated by X_{it}. To make the model consistent and efficient with a meaningful interpretation, thus we use; the natural log is used for equation (1).

$$InY_{it} = \alpha_0 + \alpha_1 In\ CO_{2it} + \alpha_2\ (InCO_{2it})^2 + \alpha_3 InXit + e_{it} \quad (2)$$

The influence of technological innovation, CO_2 emissions, non-renewable and renewable energy sources, and GDP growth in the selected South Asian countries through 1990–2019 are mentioned in equation (3) and can be written as follows:

$$InY_{2it} = \alpha_1 + \alpha_2 In\ CO_{2it} + \alpha_3\ (InCO_{2it})^2 + \alpha_4 InECit + \alpha_5 InTI_{it} + e_{it} \quad (3)$$

This study used various unit root tests to control the problem of non-stationary data in the time series data. The regression results will be biased or may calculate a spurious regression if time series variables are not stationary. This study finds no evidence regarding the presence of unit root in the panel data series after applying the cross section independence test.

4. Results and discussion

4.1. Descriptive statistics

The statistical results of descriptive statistics for the explanatory variables.

The above Table 1 defines the descriptive statistics of all the variables along with different measurements and probability section. The maximum and minimum values show as 13.653 and 2.897 respectively.

The statistical findings of Cross Sectional Dependence (CSD) are reported in Table 2. To find the presence of CSD between the panel data, we have used four tests, namely Pearson LM Normal, Pearson CD Normal, Breusch-Pagan Chi-square and Friedman Chi-square. The findings of CSD shows that in a panel data analyses the cross-sectional dependency found between the data and significance of p-values are rejected the null hypotheses.

Table 3 reports the unit root result by using the tests of Pesaran and Shin (2003); Breitung [38] and Hadri [39] respectively. Thus to control the heterogeneity across panel model, this study used an alternative IPS test designed by Im et al. [40]. Table 3 reports the results of the Hadri [39]; Breitung [38] and Im et al. [40] tests, as the all variable found stationary at level in line with Hadri [39] and Im et al. [40]. Different co-integration tests, i.e., Pedroni (1999 [41], and Kao panel co-integration tests and FMOLS are used this study. The results of panel v-statistic, panel rho-statistic, panel Phillips–panel ADF-statistic and Perron (PP) (within dimension method) statistic is reported in (table) 4. These tests of cointegration are based on "Engle and Granger (1987)" where different methods, namely group ADF-test, group PP-statistic and group rho statistic are also used in this analysis. All the variables are co-integrated according to the findings, and there is a long term association among the variables as mentioned in Table 4.

Table 1
Summary of Descriptive Statistics.

Description	$LnCO_2$	LnGDP	Ln GDP2	LnEC	LnTI
Mean	9.757	6.141	12.282	3.793	3.444
Median	9.784	6.055	12.110	3.844	3.447
Maximum	11.200	6.826	13.653	4.300	3.955
Minimum	8.163	5.761	11.522	3.030	2.897
Sd. Dev.	0.891	0.299	0.598	0.392	0.331
Skew-ness	−0.096	0.796	0.796	−0.456	−0.043
Kurtosis	1.887	2.515	2.515	1.925	1.811
Jarque-Bera	2.390	5.203	5.203	3.727	2.661
Probability	0.302	0.074	0.074	0.155	0.264
Sum	439.097	276.366	552.732	170.729	155.003
Sum Sq. Dev.	34.938	3.944	15.777	6.779	4.841

Table 2
The results of residual cross-section dependence test.

Test	Statistic	Prob.	Null hypotheses	Result
Breusch-Pagan Chi- square	7.245	1	No cross section dependence (CSD) in residuals	Reject
Pearson LM Normal	1.039	1.08	No cross section dependence (CSD) in residuals	Reject
Pearson CD Normal	−0.281	0.99	No cross section dependence (CSD) in residuals	Reject
Friedman Chi-square	23.895	0.78	No cross section dependence (CSD) in residuals	Reject

This study investigated growth driven emissions for the South Asian countries under the scheme of the EKC hypothesis. The results of this study fully support the inverted EKC hypothesis, and the findings of the study show that growth activities significantly increase GHG emissions. The findings of various previous empirical studies have provided consistent results for the framework of EKC hypothesis [42–45].

The nexus between CO_2 emissions and its three essential components: energy use, technological innovation and economic growth are used in this study. The full FMOLS findings indicate that these variables significantly increase environmental degradation in South Asian regions. Table 5a and Table 5b have reported the results of full FMOLS and country specific, respectively. The full panel of FMOLS findings in Table 5b indicates that these variables significantly increase environmental degradation in South Asian regions. Furthermore, the empirical results for these economies suggest that fossil fuel are substantially increasing the CO_2 emissions in this region. Thus results of full FMOLS show that if there is a unit change in non-renewable, it will lead to 0.84 unit change in CO_2 emissions holding all other variables are being constant. The findings of Liu and Dietz [46]; Tao et al. [47]; Saboori and Sulaiman [25,26]; Ahmed et al. [48,49] and Nasreen et al. [50] are supported the results of this study.

Table 6 reported the statistical results of the Dumitrescu-Hurlin test (Granger causality test). The bidirectional causality is moving from energy use to GDP. The uni-directional causality is running from CO_2 to GDP, GDP^2 to CO_2, GDP to TI, GDP^2 to TI, non-renewable and renewable energy sources to TI and non-renewable and renewable energy sources to GDP^2.

The findings of VDM are reported in Table 7 in the context of selected South Asian countries. The change in a variable due to its contribution through various exogenous variables and innovative shock can be accounted for by this method. Furthermore, regarding CO_2 emission the foremost endogenous contribution of CO_2 is 49.73% due to innovative shock. These results reveal that in the Asian region, the (GDP_{it}) sources of energy, as well globalization, were dominant elements for CO_2 emission. The findings of VDM are consistent with the regression analysis findings, and for the next ten years all these variables are included in the proposed framework.

5. Conclusion

This analysis utilizes these theoretical aspects and assesses economic

Table 3
Panel unit root test analysis.

			Im-Pesaran-Shin (IPS) test		Hadri test	
Variables	t-values	p-values	t-values	p-values	t-values	p-values
lnCO2 it	−1.078	0.4130	−1.875	0.006***	−2.606	0.004***
lnGDPit	−19.949	0.012***	−2.889	0.005***	−3.037	0.000***
ln(GDPit)2	−35.587	0.000***	−2.909	0.003***	−3.406	0.003***
lnECit	16.742	0.001***	−4.293	0.002***	−2.979	0.001***
lnTIit	−0.868	2.801	−4.038	0.002***	−4.62	0.000***

Note: Where ***, ** signifies 1 and 5% level of significance.

Table 4
The statistical results of the Pedroni and Kao co-integration.

Pedroni (1999 [41], residual co-integration test		
within-dimension		
	Statistic	Prob.
Panel v-Statistic	−0.5301	0.7020
Panel rho-Statistic	−2.8286	0.0023***
Panel PP-Statistic	−4.2235	0***
Panel ADF-Statistic	0.0413	0.5165
Between the dimension		
	Statistic	Prob.
Group rho-Statistic	−1.0664	0.1431
Group PP-Statistic	−5.5722	0.000***
Group ADF-Statistic	−2.1206	0.017***
Kao (1999) panel cointegration test		
ADF	t-statistics	p-value
	22.07927	0.0000

Note: SIC is used to select the lag length criteria. Where *** and ** signify 1 and 5% levels of significance, respectively.

Table 5a
The statistical findings of FMOLS technique (country-specific long-run elasticities).

Country name	Variables	Coefficient	t-statistics	Prob
Bangladesh				
	lnGDPit	4.63	2.01	0.05
	ln(GDPit)2	−0.30	−1.73	0.09
	lnECit	0.89	7.03	0.00
	lnTIit	0.88	4.52	0.00
Bhutan				
	lnGDPit	1.62	13.01	0.00
	ln(GDPit)2	−0.06	−18.38	0.00
	lnECit	1.53	15.80	0.00
	lnTIit	0.87	5.13	0.00
India				
	lnGDPit	15.81	237.88	0.00
	ln(GDPit)2	−1.08	−19.58	0.00
	lnECit	0.63	4.43	0.00
	lnTIit	0.39	2.38	0.02
Maldives				
	lnGDPit	13.56	5.39	0.00
	ln(GDPit)2	−0.92	−4.83	0.00
	lnECit	0.47	2.37	0.02
	lnTIit	1.11	7.27	0.00
Pakistan				
	lnGDPit	2.50	2.10	0.04
	ln(GDPit)2	−0.12	−1.54	0.13
	lnECit	1.08	11.23	0.00
	lnTIit	0.08	0.33	0.75

The turning point of EKC 6455.579 per capita US$
Where =α2 is naturallogGDPit and α3 natural log(GDPit)2

growth, energy use, and technological innovation and influence within the framework of the environmental Kuznets curve analysis. The long-run association found between CO_2 emissions, real GDP growth, the square of GDP growth, energy sources, and technological innovation in selected South Asian economies.

Table 5b
The statistical findings of FMOLS technique: Full Panel.

Variables	Coefficient	t-statistics	Prob
lnGDPit	3.86	4.28	0.00
ln(GDPit)2	−0.22	−3.61	0.00
lnECit	0.84	8.07	0.00
lnTIit	0.55	0.01	0.01

Table 6
Panel causality Dumitrescu-Hurlin test (full panel).

S·NO	Hypothesis	W-stat	Z. Stat	Prob	Result	Conclusion
1	LCO_2 ↛ LGDP	2.560	1.560	0.249	NO	
	LGDP ↛ LCO_2	4.576	3.576	0.040	YES	Unidirectional causality
2	LCO_2 ↛ LGDP2	1.906	0.907	0.497	NO	
	LGDP2 ↛ LCO_2	4.650	3.650	0.030	YES	Unidirectional causality
3	LCO2 ↛ LNEC	1.098	0.098	0.359	NO	
	LNEC ↛ CO_2	6.143	5.143	0.000	YES	Unidirectional causality
4	LCO_2 ↛ LTI	1.574	0.574	0.380	NO	
	LTI ↛ LCO_2	2.816	1.816	0.080	YES	Unidirectional causality
5	LGDP ↛ GDP^2	0.208	−0.739	0.477	NO	
	$LGDP^2$ ↛ LGDP	0.262	−0.613	0.466	NO	Neutrality
6	LGDP ↛ LEC	4.951	3.951	0.041	YES	
	LEC ↛ LGDP	11.823	10.824	0.000	YES	Bidirectional causality
7	LGDP ↛ LTI	3.753	2.753	0.005	YES	
	LGLB ↛ GDP	1.689	0.689	0.560	NO	Unidirectional causality
8	$LGDP^2$ ↛ LEC	2.199	1.199	0.230	NO	
	LEC ↛ $LGDP^2$	11.767	10.767	0.000	YES	Unidirectional causality
9	$LGDP^2$ ↛ LTI	0.775	−0.224	0.822	NO	
	LTI ↛ $LGDP^2$	12.697	10.697	0.000	YES	Unidirectional causality
10	LEC ↛ LTI	1.912	0.912	0.456	NO	
	LTI ↛ LEC	6.383	5.383	0.000	YES	Unidirectional causality

The full panel of FMOLS findings shows that these variables significantly increase environmental degradation in South Asian regions. Furthermore, the empirical results for these economies indicate that fossil fuel and use of energy are substantially increasing the CO_2 emissions and resulting in GHG issues in this region.

The conflict between technological innovation and environment degradation can revisit by sustainable development policies. Additionally huge dependence on fossil fuel energy consumption is not environmentally friendly to the sustainable development of this South Asian region. However, these countries under the "South Asian Association of

Table 7
The results of Variance Error Decomposition forecast model.

Period	SE	CO_{2it}	EC_{it}	GDP_{it}	$2^{(GDP_{it})}$	TIit
Variance Decomposition of CO_{2it}						
1	0.053463	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.064543	79.09123	0.004104	0.015498	1.688469	19.20070
3	0.072142	66.04123	0.851420	0.246249	1.614706	31.24639
4	0.078430	62.30278	1.326685	0.703257	1.411935	34.25534
5	0.084180	59.37292	2.441953	0.824865	1.289188	36.07107
6	0.089467	56.56463	2.752867	0.941740	1.208907	38.53185
7	0.094385	54.16059	3.052759	0.971155	1.113945	40.70155
8	0.098988	52.41041	3.346803	0.992818	1.015428	42.23455
9	0.103322	50.97510	3.654140	0.995887	0.933091	43.44178
10	0.107395	49.73146	3.894635	0.986339	0.878239	44.509
Variance Decomposition of EC_{it}						
1	0.034535	31.87078	68.12922	0.000000	0.000000	0.000000
2	0.041244	36.66831	49.58632	0.969486	3.605675	9.170207
3	0.044430	33.72261	43.59082	0.907179	5.520787	16.25861
4	0.047971	34.41351	37.40430	2.211239	7.149582	18.82138
5	0.051180	33.83550	33.57368	2.392792	9.461705	20.73632
6	0.054482	33.04709	29.77826	2.822463	11.99424	22.35796
7	0.057849	31.94314	26.72074	3.050981	14.83178	23.45336
8	0.061297	30.88558	24.02483	3.319412	17.92518	23.84499
9	0.064986	29.65769	21.59964	3.583062	21.49490	23.66470
10	0.069006	28.19449	19.32307	3.846801	25.62172	23.01391
Variance Decomposition of GDP_{it}						
1	0.014070	10.00017	0.920363	99.07946	0.000000	0.000000
2	0.016145	20.07378	13.61939	75.39856	0.289688	3.618581
3	0.017505	20.76224	11.80742	65.29934	5.685593	10.44540
4	0.019871	30.90184	12.16973	51.21608	15.60387	15.10846
5	0.022793	30.72339	9.811252	39.18111	29.04921	16.23504
6	0.026456	40.20847	8.355201	29.65772	40.90296	15.87564
7	0.030838	40.48563	6.739829	22.57663	51.41638	14.78153
8	0.036092	30.75645	5.417601	17.34617	60.18060	13.29917
9	0.042379	30.04408	4.351367	13.57158	67.37784	11.65513
10	0.049879	30.41008	3.494791	10.85631	73.19366	10.04516
Variance Decomposition of $(GDP)^2$						
1	0.164948	0.007600	0.983546	98.95070	0.058150	0.000000
2	0.190252	7.389810	13.64122	74.52314	0.768169	3.677658
3	0.208039	6.820125	11.58595	63.30471	7.825880	10.46333
4	0.239443	5.732097	11.69370	48.42815	19.37892	14.76713
5	0.278498	5.342239	9.214914	36.13943	33.80341	15.50001
6	0.327042	4.713989	7.710922	26.87897	45.83009	14.86603
7	0.384881	3.961818	6.136183	20.24527	56.02468	13.63205
8	0.453880	3.253186	4.887105	15.50049	64.22880	12.13042
9	0.536104	2.594748	3.904165	12.16592	70.78248	10.55268
10	0.633860	2.027605	3.129035	9.816157	75.97134	9.055861
Variance Decomposition of TI_{it}						
1	0.033245	2.431226	5.949910	3.884664	5.465288	82.26891
2	0.038717	4.797875	4.388962	7.918514	4.715521	78.17913
3	0.042687	16.83483	5.322983	6.853499	4.650501	66.33819
4	0.044803	18.97840	7.591718	6.221787	4.221725	62.98638
5	0.046351	19.91540	7.133334	5.941443	3.995294	63.01453
6	0.047843	20.66431	7.016624	5.615584	3.802581	62.90090
7	0.049216	21.64652	6.943423	5.377727	3.620832	62.41149
8	0.050529	22.43852	6.956506	5.174904	3.467411	61.96266
9	0.051752	23.02819	6.923553	4.997245	3.332943	61.71807
10	0.052921	23.55079	6.892059	4.838889	3.204856	61.51341

Regional Cooperation" (SAARC) block can overcome the issue of environmental degradation through global cooperation. Policies for environment friendly energy use can significantly control the emissions and increase GDP growth. In contrast, the expansion of technological innovation increases energy use.

Some of the limitations which we face during the course of analysis, for instance, the first factors are about the validity of collected data, because sources of data are limited so collecting data for a longer period of time is a bit difficult task. In light of the findings of this study, researchers and policymakers should be careful that non-renewable energy investments should be reduced for a reduction in health expenditure. For this purpose, renewable energy generation would help to reduce the health expenditure in these south Asian countries.

Credit author statement

Dr Nafeesa has completed the data analysis part, Miss Asma completed the Introduction section, Mr. Vipin completed the Literature review section, Mr Supat wrote Methodology section, Mr Malik Shahzad interpreted the data analysis section, Mr Carlos wrote conclusion and Mr. Rinat Zhanbayev wrote abstract parts and format the paper as per journal requirements.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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