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RENEWABLE ENERGY CONSUMPTION TOWARDS ENVIRONMENTAL SUSTAINABILITY: EVIDENCE OF EKC HYPOTHESIS IN THE FRAMEWORK OF ECONOMIC GROWTH AND CO_2 EMISSIONS

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ABSTRACT

This study explores the influence of economic growth and its squared term on carbon dioxide emissions to confirm the EKC U and inverted U shape in developing countries. The study also explores which form of energy benefits environmental sustainability and deterioration. In this research, five countries are selected from South Asia, covering 1995 to 2018. The results of FMOLS and DOLS have proved the EKC inverted U-shaped hypothesis in the long run. Renewable energy consumption and squared economic growth significantly reduce carbon dioxide emissions in the long run. In contrast, fossil fuel energy consumption and economic growth positively enhanced carbon dioxide emissions in the long run. Gross capital formation negatively influences carbon dioxide emissions, while labor productivity contributes to environmental deterioration. The study suggested that South Asian developing countries should adopt renewable energy resources to sustain their environment and overcome greenhouse gases'

environmental hazards. The availability of low-cost renewables should be possible to reduce the demand for fossil fuels at the domestic level will lead to environmental sustainability.

INTRODUCTION

Economic growth and environmental sustainability are the most concerned topics in the contemporary world. Productive and stable economic growth is not just necessary for emerging economies. It is still the essence of developed societies. So, we can judge how significant economic growth is in this modern time. If we go back to the last few decades, we found that economic growth was not a concerning issue for developing and developed countries. The developed nations were into infrastructure development and other well-being related to their clean environment. On the other hand, before the industrial revolution, the developing economies were much engaged with their agriculture sector. The developing economies, especially Asian economies, have changed their growth route from agriculture to the modern or industrial sector. In this regard, they rely much on energy resources to increase their production process, enhance their industrial manufacturing, and stabilize their economic growth.

Conversely, developing Asian countries are neglecting their environmental conditions. The reliance on energy resources has enhanced economic growth, but the environmental hazards are increased. Energy resource limitations and inadequate planning have failed to synchronize with environmental hazards, and the environment has become more polluted (Saidi and Hammami, 2015; Nair *et al.*,2021; Nathaniel *et al.,* 2021). Well, energy has two measured segments: dirty energy and clean energy. The emerging Asian countries are relying on dirty energy resources like fossil fuels and crude oil. The reason is that these energy resources are less costly and readily available to third-world countries where the resources are limited. Girod *et al.* (2013) studied that fossil fuel energy is ruling in the market till 2050. However, high dependence on these dirty energy (non-renewable) resources increases greenhouse gases like carbon dioxide emissions, leading to environmental deterioration (Hanif *et al.,* 2019; Zafar *et al.,* 2019; Erdogan *et al.,* 2020; Pata, 2021).

After the considerable dependence on non-renewable energy resources, environmental threats like greenhouse gas are increased in Asian countries, which is not negligible. That's why the developing Asian countries are now concentrating on renewable energy resources to control environmental pollution without truncating their economic growth. Similarly, renewable energy resources have great significance in the modern era. Though, renewable energy is indeed costly compared to non-renewable energy consumption, especially for developing Asian economies with limited resources. But using renewable energy resources will control the deterioration of the environment, as a neat and clean environment is the demand of any progressive society to become developed society. So, it is stated that stable economic growth and a sustainable environment are in demand in Asian emerging societies. That's why this research is conducted to measure the impact of non-renewable and renewable energy resources on developing Asian countries' environmental conditions. It will be interesting to perceive the contribution of renewable energy towards environmental sustainability and how it participates in economic growth, evidencing EKC inverted U shaped in developing Asian countries. Furthermore, this research will provide policy implications for the governments and policymakers regarding the applications of renewable resources to reduce environmental hazards.

REVIEW OF PAST STUDIES

Some shreds of evidence related to economic growth and CO_2 emissions have shown the helpful contribution of economic growth in enhancing environmental degradation (Shahbaz *et al.,* 2019; Alonso-Carrera *et al.,* 2019; Adedoyin *et al.,* 2020). The recent study by Ozcan *et al.* (2020) for 35-OECD economies and Rahman (2020) for 10 most electricity-consuming countries have evidenced the environmental pollution. In another research of developing countries, the findings have proved the rise in secretions of carbon dioxide gas with an upsurge of economic growth (Alvarado and Toledo 2017). The same conclusions are found in another panel of research on the South Asian Association for Regional Cooperation (Khan *et al.,* 2020). Despite this, it is proved that the rising growth in Pakistan's economy has diminished the secretions of carbon gas and condensed the environmental hazard (Hassan *et al.,* 2015). In another panel research of eighty-six developing economies, the doubled economic growth has reduced the CO_2 secretions in evolving nations (Hanif and Santos, 2017).

Regarding energy consumption, Mudakkar (2013) investigated that environmental pollution is increased by the overuse of energy and rising growth in Pakistan. In a panel study case of fifty-eight countries, the increased demand and consumption of energy with rising growth caused intensification in environmental pollution (Saidi and Hammami, 2015). Al-mulali *et al.* (2015) have definite evidence of energy consumption and environmental deprivation in ninety-three countries. They found that all income levels: lower, lower-middle, and high-income level economies have faced ecological degradation by high ingestion of fossil fuels energy. On the other hand, the countries with upgraded technology and reliance on renewable energy evidenced a reduction in environmental degradation. Moreover, Rahman and Rashid (2017) for SAARC countries, Gozgor *et* al. (2018) for OECD economies, Kahia *et al.* (2019) for twelve MENA countries, Zhang *et al.* (2019) for thirty-one provinces of China, Rahman *et al.,* (2021) for BRICS region, and Khan *et al.,* (2021) for 184 countries, have ascertained the reduction in environmental sustainability because of high energy feasting and enhanced growth.

In accordance with the research on GULF countries, a positive response from economic growth and energy usage help intensify GHG emissions and become a reason for environmental deterioration (Salahuddin *et al.,* 2015; Saqib, 2018). The same findings are evidenced in Pakistan. The constructive influence of energy and rising growth in Pakistan's economy have enhanced the carbon dioxide secretions and degraded Pakistan's environment (Javid and Sharif, 2015; Khan *et al.,* 2020). Moreover, environmental contamination is evidenced by Lin and Nelson (2018) in Turkey, Indonesia, Nigeria, and Mexico. Shahbaz *et al.* (2018) in ten economies and Wang *et al.* (2019) in 186 countries evidenced the environmental deterioration caused by economic growth and disbursed energy. In contrast, many countries find a negative association between disbursed energy and carbon dioxide releases. It has been found that the high ingesting of energy has lessened the secretions of carbon dioxide gas and resultantly amended environmental sustainability (Shahbaz *et al.,* 2014; Zheng, 2015; Ahmad *et al.,* 2019; Zhang *et al.,* 2019).

In accordance with evidence of renewable energy, it has a constructive share in economic growth and ecological sustainability. It has been established that renewable energy consumption has raised economic growth and lessens carbon dioxide releases (Gozgor *et al.,* 2018; Kahia *et al.,* 2019; and Ridzuan *et al.,* 2020). However, renewable energy ingesting is the most valuable economic growth tool (Rafindadi and Ozturk, 2017; Tugcu and Topcu, 2018; Carfora *et al.,* 2019; Eren *et al.,* 2019; Zafar *et al.,* 2019; Fan and Hao 2020; Saidi and Omri 2020). In the case of forty-two emerging economies, carbon dioxide discharges are condensed, and environmental sustainability is applicable just because of the adoption of renewable energy in all emerging economies (Ito, 2017). In seventeen countries, implementing renewable energy hasn't influenced the economic growth in sixteen countries except for Poland. Renewable energy has promoted the economic growth of Poland and led to sustainable production (Ozcan and Ozturk, 2019). After evidencing the significant contribution of renewable energy toward economic growth, the higher and more constructive participation of non-renewable energy in economic growth is evidenced by Adams *et al.* (2018). Furthermore, in the study of fifteen-developing countries, it is evidenced that fossil fuel energy ingestion has improved economic growth but elevated the discharges of carbon dioxide gas. In other words, the high intake of fossil fuel energy has endorsed environmental pollution in these developing economies (Hanif *et al.,* 2019).

In the next phase of literature, some confirmations originated related to reducing carbon dioxide secretions by sustainable energy and doubled economic growth. The appropriate energy intake and the double effect of economic growth have condensed carbon dioxide releases and enhanced environmental sustainability. The negative influence of squared economic growth on CO_2 secretions has confirmed the EKC hypothesis, which is inverted U-shaped (Jammazi and Aloui, 2015; Nasreen *et al.,* 2017; Khan *et al.,* 2019; and Khan *et al.,* 2020). In developing Asian economies, fossil fuel intake strongly enhances carbon dioxide discharges, which are later condensed by doubled economic growth. The mitigation of environmental pollution is triggered by the squared of economic growth and upholds the inverted U-shaped (Hanif *et al.,* 2019), also evident in the study of Sharif *et al.* (2019).

The overall confirmations from past research related to energy consumption (renewable and non-renewable), economic growth, and environmental quality have proved mixed confirmations. In this regard, some studies have shown the positive, and some have found the inverse relationships among the above-discussed indicators. However, this study has provided the research gap in combining a sole combination of variables and emerging countries of the South Asian region compared to previous research. Renewable and fossil-fuel energy consumption with economic growth, squared term growth, gross capital formation, and labor productivity will influence carbon dioxide emissions. Moreover, the EKC inverted U shape in the South Asian region will be evident.

DATA, EMPIRICAL MODAL, AND METHODOLOGY

This section consists of the data description with their sources and period. Moreover, this section consists of the model's specification and econometric techniques to apply to the empirical model.

Data and Selection of Countries

To inspect the EKC inverted U shape in five developing economies from the South Asian region, the panel data is collected from WDI over the period of 1995 to 2018. The selection of the countries consists of their income levels. Simultaneously, these developing economies are highly dependent on fossil fuels, using their renewable resources and fronting environmental worsening.
The detail of these developing economies is given below:

South Asian low income country: Nepal.
South Asian lower middle income countries: Bangladesh, India, Pakistan, and Srilanka.

Description of Variables

This section is based on the explanation of the determinants regarding their sources, measuring units, and projected association sign, which is presented in Table 3.1.

Table 3.1

Variables and Unit of Measuring	**Sources of the data**
Carbon-dioxide emissions (CO_2) metric ton per capita	WDI
Economic Growth (ECG) GDP per capita growth (annual percent)	WDI
Squared Economic Growth (ECG^2) Square of GDP per capita growth (annual percent)	WDI
Renewable Energy Consumption (RNC) percentage of total final energy consumption	WDI
Fossil Fuel Energy Consumption (FFC) percentage of total	WDI
Gross Capital Formation (GCF) annual percent growth	WDI
Labor Productivity (LPR) labor force, total	WDI

Model Specification and Methodology

This research establishes the EKC hypothesis, developed by Kuznets (1955) and evidenced and implemented by Grossman and Krueger (1991). According to the theoretical framework, the theory said that economic growth is indeed associated with CO_2 emissions. However, the squared growth per capita has an inverse influence on CO_2 secretions and resultantly condenses environmental pollution, which has proved the EKC inverted U-shaped hypothesis (Hanif *et al.*, 2019; Sharif *et al.*, 2019).

The function equation is given below:

$$CO_2 = f\,(ECG, ECG^2, RNC, FFC, GCF, LPR) \quad (1)$$

The next step is forming a linear equation for further empirical analysis.

$$CO_{2it} = \alpha_0 + \alpha_1 ECG_{it} + \alpha_2 ECG^2_{it} + \alpha_3 RNC_{it} + \alpha_4 FFC_{it} + \alpha_5 GCF_{it} + \alpha_6 LPR_{it} + \mu_i \quad (2)$$

The above equation (2) is based on coefficients in the form of $\alpha's, \beta's,$ and γ with the error term *ui*. At the same time, *it* shows the panel equation concerning time. The above equation is for long-run analysis. But first, we must examine the stationarity level of variables which indicates the cointegration analysis. After this, the necessary initial step is cross section dependence, described below.

CD Test

CD test applies to indicate the cross sectional dependency in the empirical model. It consists of null (not indicate cross section dependence) and alternative hypothesis (indicates cross section dependence) in the observed model (Pesaran, 2004). The CD test equates as below:

$$CD = \left(\frac{TN(N-1)}{2}\right)^{1/2} \acute{P} \quad (3)$$

Equation (3) indicates cross sections by N, while time dimensions by T. Nonetheless, pairwise correlation coefficients are indicated by $\acute{P}$.

Panel Cointegration Test

Pedroni and Kao panel cointegration tests are followed by Pedroni (1999 and 2004) and Kao (1999). Pedroni cointegration is practiced in response to validating the model's cointegration and its long run existence. However, it consists of two cointegration sets, including common AR coefficients to approve the long run existence among variables. Further, Kao (1999) cointegration test applies to validate the outcome of the Pedroni co-integration test and robustness (Adedoyin *et al.*, 2020).

The Pedroni cointegration equation following Chen *et al.* (2019) is given below:

$$CO_{2it} = \beta_i + \rho_i t + \beta_1 ECG_{it} + \beta_2 ECG^2_{it} + \beta_3 RNC_{it} + \beta_4 FFC_{it} + \beta_5 GCF_{it} + \beta_6 LPR_{it} + \varepsilon_{it} \quad (4)$$

In Equation (4), countries are denoted by i and time with t, while β_i is intercept and ρ_i are deterministic trends. However, $\rho_i = 1$ for the null hypothesis and $\rho_i = \rho_i < 1$ for the alternative hypothesis specify the cointegration and variables’ long run existence.

FMOLS and DOLS

FMOLS and DOLS are used for long run estimation and to validate the inverted U shape of EKC in South Asian economies. Pedroni (2000 and 2001) proposed Fully Modified Ordinary Least Square (FMOLS), dealing with serial correlation and endogeneity bias. FMOLS allows precise and efficient long-term estimators, which are biased and unpredictable in OLS estimation. The equation of FMOLS followed by Chen *et al.* (2019) is given below:

$$\hat{\beta}_{FMOLS} = \left[\sum_{i-1}^{N} \sum_{t-1}^{T} (X_{it} - \bar{X}_{\iota})(X_{it} - \bar{X}_{\iota})'\right]^{-1} \left[\sum_{i-1}^{N} \left(\sum_{t-1}^{T} (X_{it} - \bar{X}_{\iota})\, \hat{y}_{it}^{+} - T\hat{\Delta}_{\varepsilon u}^{+} \right)\right] \quad (5)$$

Above equation (5) of FMOLS indicates the dimension of the cross section by N, time by T, and individual specific mean by $\bar{X}_{\iota}$. However, $\hat{y}_{it}^{+}$ and $\hat{\Delta}_{\varepsilon u}^{+}$ indicating endogeneity series corrected and correction term.

Further, Kao and Chiang (2000) established the Dynamic Ordinary Least Square technique. DOLS applies the augmented cointegrating equation and includes cross section lags to terminate the serial correlation and attain endogeneity corrected estimates of variables. The equation of panel DOLS is written as follows:

$$\hat{\beta}_{DOLS}\, \hat{y}_{DOLS} = \left(\sum_{i-1}^{N} \sum_{t-1}^{T} \widetilde{W_{\iota t}} \widetilde{W}_{\iota t'}\right)^{-1} \left(\sum_{i-1}^{N} \sum_{t-1}^{T} \widetilde{W_{\iota t}} \widetilde{W} \widetilde{y_{\iota t'}}\right) \quad (6)$$

In equation (6) of DOLS, $\widetilde{W}_{it'}$ refers to the regressors' vector. Further, these long run estimators will ensure the inverted U form of the EKC hypothesis in evolving South Asia.

RESULTS AND DISCUSSION

This section starts with statistical indicators to evaluate the statistical worth of the empirical model. However, table 4.1 shows that the model is statistically suitable and acceptable for further investigation. In the next step of statistical analysis, variables have gone through a correlation process to measure the strength of their relationship and to indicate that there is no subject of multicollinearity. However, table 4.2 indicate that selected indicators have a weak and moderate association with the dependent variable, which indicates no multicollinearity.

Table 4.1: Descriptive Summary

	CO_2	**ECG**	**ECG^2**	**RNC**	**FFC**	**GCF**	**LPR**
Mean	0.574	3.553	17.129	59.874	47.757	6.249	1.07E+08
Median	0.587	3.383	11.450	55.798	56.070	6.530	40120937
Maximum	1.799	9.002	81.052	95.119	74.378	23.082	4.73E+08
Minimum	0.049	-2.243	0.003	30.706	5.051	-17.470	6921495.
Std. Dev.	0.402	2.128	15.301	17.369	21.346	6.186	1.57E+08

Skewness	0.836	-0.245	1.175	0.555	-0.777	-0.254	1.521
Kurtosis	3.474	2.900	4.338	2.310	2.268	3.941	3.512
Jarque-Bera	18.259	10.513	44.209	10.332	17.832	6.920	57.525
Probability	0.000***	0.004***	0.000***	0.005***	0.000***	0.031**	0.000***

Table 4.2: Correlation Matrix

	CO_2	ECG	ECG^2	RNC	FFC	GCF	LPR
CO_2	1						
ECG	0.240	1					
ECG^2	-0.311	0.916	1				
RNC	-0.718	-0.211	-0.247	1			
FFC	0.638	0.175	0.197	-0.968	1		
GCF	-0.101	0.621	0.523	-0.181	0.188	1	
LPR	0.715	0.276	0.294	-0.479	0.518	0.167	1

Table 4.3: Cross-section Dependence Test

Variables: CO_2, ECG, ECG^2, RNC, FFC, GCF, and LPR		
	stat	**prob**
Pesaran CD	0.0005	0.997
Note: Null Hypothesis: No Cross-section Dependence		

Before moving to unit root testing, an initial step in Table 4.3 indicates that all variables of interest have undergone hypothesis testing of cross sectional dependence. The findings illustrate that all the variables' Pesaran CD statistic value is 0.0005, which is insignificant, rejecting the alternative hypothesis while approving that variables have no cross sectional dependence.

Table 4.4: Unit Root Tests (Intercept & Trend)

Variables	**Tests**	**I & T Levels**	**I & T First Difference**	**Conclusion**
CO_2	**Levin, Lin & Chu**	0.767 (0.875)	-4.091*** (0.000)	**CO_2, ECG, ECG^2, RNC, FFC, GCF and LPR are Stationary at First Difference I (1)**
	Im, Pesaran & Shin	1.878 (0.896)	-4.998*** (0.000)	
ECG	**Levin, Lin & Chu**	0.499 (0.756)	-8.990*** (0.000)	
	Im, Pesaran & Shin	1.554 (0.902)	-12.068*** (0.000)	
ECG^2	**Levin, Lin & Chu**	0.599 (0.702)	-9.924*** (0.000)	
	Im, Pesaran & Shin	0.990 (0.648)	-12.071*** (0.000)	
RNC	**Levin, Lin & Chu**	0.899 (0.789)	-4.001*** (0.000)	
	Im, Pesaran & Shin	0.991 (0.901)	-4.291*** (0.000)	

FFC	**Levin, Lin & Chu**	1.009 (0.798)	-3.141*** (0.005)	
	Im, Pesaran & Shin	0.709 (0.699)	-7.067*** (0.000)	
GCF	**Levin, Lin & Chu**	-1.215 (0.778)	-6.704*** (0.000)	
	Im, Pesaran & Shin	-0.274 (0.502)	-7.627*** (0.000)	
LPR	**Levin, Lin & Chu**	-1.008 (0.681)	-2.101* (0.066)	
	Im, Pesaran & Shin	1.179 (0.868)	-2.524* (0.032)	
Note: Values indicate probabilities in parentheses. ***,** &* direct to significance levels at 1, 5, and 10 percent.				

Table 4.4 demonstrates the variables' stationarity orders by applying Levin, Lin & Chu, and Im, Pesaran & Shin unit root techniques. For this purpose, both tests monitor the intercept and trend to measure the stationary level. The outcomes of both methods illustrate that CO_2, ECG, ECG^2, RNC, FFC, GCF, and LPR are ordered at the first difference, and the same order of integration leads to cointegration.

Table 4.5: Pedroni and Kao Tests

Pedroni Cointegration				
Within-dimension				
	Stat	**prob**	**W-stat**	**prob**
Panel v-Statistic	-0.890	0.813	0.076	0.469
Panel rho-Statistic	-2.097***	0.031	-1.874***	0.040
Panel PP-Statistic	0.338	0.632	1.494	0.932
Panel ADF-Statistic	-1.789*	0.056	-1.601*	0.076
Between-dimension				
	stat	**prob**		
Group rho-Statistic	-4.531***	0.000		
Group PP-Statistic	2.126	0.983		
Group ADF-Statistic	2.771	0.997		
Kao Cointegration				
ADF	-1.831**	0.030		
Residual variance	0.323			
HAC variance	0.168			
Note: Null Hypothesis: No Cointegration Alternative Hypothesis: Cointegration Exists ***,** &* direct to significance levels at 1, 5, and 10 percent.				

Table 5.5 shadows the outcomes of Pedroni and Kao cointegration methods to approve cointegration among variables and ensure long run presence. In accordance with the results of the Pedroni method, within dimension's Panel rho statistic and Panel ADF statistic are significant and indicate cointegration in the model. However, between dimension's Group rho statistic significantly

signals the cointegration among variables and ensures the model's long run. Further, the Kao test approves the outcomes of the Pedroni method. Its ADF statistic value is significant and accepts the alternative hypothesis of approving cointegration in the model. However, the Pedroni and Kao methods approve of the empirical model's long run existence.

Table 4.6: FMOLS and DOLS Tests

Dependent Variable: CO_2				
Method: Panel Fully Modified Least Squares (FMOLS)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
ECG	0.390***	0.046	3.847	0.000
ECG^2	-0.161*	0.006	-1.833	0.068
RNC	-0.091***	0.001	-3.762	0.000
FFC	0.108***	0.001	5.629	0.000
GCF	-0.012**	0.070	-2.395	0.023
LPR	0.370***	0.027	4.904	0.000
Method: Panel Dynamic Least Squares (DOLS)				
ECG	0.350***	0.030	3.164	0.003
ECG^2	-0.126*	0.003	-2.006	0.054
RNC	-0.031***	0.008	-3.955	0.000
FFC	0.060***	0.007	3.842	0.000
GCF	-0.003*	0.005	-1.697	0.085
LPR	0.340***	0.070	3.011	0.004

Note: ***,** &* directs to significance levels at 1, 5 and 10 percent.

In table 4.6, outcomes of FMOLS and DOLS have shown a significant long run relationship between selected indicators of interest. The values of ECG in FMOLS and DOLS are 0.390 and 0.350, significant at 1 percent and indicating that one unit increase in economic growth contributes to CO_2 emissions of about 0.390 and 0.350 units in the long run. This indicates that ECG is a momentous source of environmental deterioration in developing South Asian economies and proves the U shape of the EKC hypothesis. However, the squared term of economic growth ECG^2 is taken to approve the existence of an inverted U shape. ECG^2 coefficient values are -0.161 and -0.126, significant at 10 percent. It means that an upsurge in squared term growth mitigates CO_2 secretions of about 0.161 and 0.126 units, leading to environmental sustainability and admiring the inverted U shape of the EKC hypothesis in South Asian emerging nations. The finding of approving EKC inverted U shape, in the long run, is in line with past references (Jammazi and Aloui, 2015; Nasreen *et al.*, 2017; Khan *et al.*, 2019; Khan *et al.*, 2020; Hanif *et al.*, 2019; Sharif *et al.*, 2019).

In this research, energy is classified into renewable and non-renewable to measure the environmental quality. Renewable energy (RNC) values are -0.091 and -0.031, indicating a significant influence on carbon dioxide emissions at 1 percent in both FMOLS and DOLS models. The findings illustrate that renewable energy has considerably mitigates CO_2 secretions and leads to environmental sustainability in South Asian countries. The findings align with past studies (Gozgor *et al.*, 2018; Tugcu and Topcu, 2018; Carfora *et al.*, 2019;

Kahia *et al.*, 2019; Zafar *et al.*, 2019; Ridzuan *et al.*, 2020; Saidi and Omri 2020). In contrast, non-renewable energy, taken in the form of fossil fuels (FFC), has deteriorated the environment of developing economies in the long run, evident in both FMOLS and DOLS models. FFC values 0.108 and 0.060 are positively significant at 1 percent, indicating that the high fossil fuel ingestion escalates carbon releases and hurts environmental quality. The findings are also evident in past research (Al-mulali *et al.,* 2015; Hanif *et al.,* 2019). Furthermore, gross capital formation (GCF) negatively, while Labor productivity (LPR) positively influences CO_2 in both FMOLS and DOLS models. This indicates that GCF directs to environmental protection, and LPR contributes to environmental degradation in the long run.

CONCLUSION AND RECOMMENDATIONS

This study objects to ascertain the inverted U shape of EKC in emerging South Asian economies. It is also to explore which indicator leads to environmental sustainability and which supports environmental deterioration. For these purposes, the data of five developing South Asian economies (Bangladesh, India, Nepal, Pakistan, and Srilanka) is taken for the period of 1995 to 2018 from the World Development Indicators of the World Bank. The findings of FMOLS and DOLS illustrate that economic growth adds to environmental deterioration and directs to the U shape of EKC. In contrast, the squared term of economic growth contributes to environmental sustainability and ascertains the inverted U shape of EKC in evolving South Asian economies. Further, renewable energy, renowned as clean energy, benefits environmental protection in the long run. On the other hand, fossil fuels assist in deteriorating the environment of selected South Asian countries. Moreover, gross capital formation mitigates carbon dioxide emissions, while labor productivity help in degrading the environment of South Asian economies. In the end, findings suggest that the availability of low-cost renewables should be possible to reduce the demand for fossil fuels at the domestic level. This will possibly assist in fulfilling the energy demand and help to reduce energy poverty, direct to environmental sustainability. It is essential and needs the time to provide the benefits of solar paneling and electrification to households, which help sustain the environment and reduce the demand for oil, gas, and wood in emerging South Asian countries.

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