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DOES USAGE OF INEFFICIENT ENERGY RESOURCES HARM THE ENVIRONMENT IN SAARC REGION? THE IMPACT OF RENEWABLE AND NON-RENEWABLE ENERGY CONSUMPTION USING PANEL DATA TECHNIQUES

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ABSTRACT

The purpose of this study is to analyze the inefficient usage of energy resources in the SAARC region. For this study, the panel data are collected for the year from 1995 to 2021. Panel Padroni Co-integration Test and Fully-Modified Ordinary Least Square test have been incorporated in order to get the desired results. The empirical findings reveal the existence of a significant influence of fossil fuel energy consumption and population growth on the environment of SAARC region. However, the impact of renewable energy consumption is found negative. As a policy option, fossil fuel energy consumption is needed to be reduced for a better and healthy living society.

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INTRODUCTION

Economic growth in the SAARC region is essential to lower inflation and unemployment. However, it is strongly linked with the climatic vulnerability. The reason is that the economic growth cannot be achieved without the usage of energy resources. This scenario leads to the matter of environmental sustainability. The climate change issue has become a global concern and it is forcing the world to use the green energy resources in order to reduce the CO_2 emission. It is said that carbon emission will be coming from the developing economies due to the rapid use of inefficient energy consumption. Reduction in the trade barriers and massive usage of technology is not only mobilizing capital and labor but also increasing the burden of pollution due to the heavy reliance on the energy consumption. Therefore, turning the economies from use of fossil fuel energy consumption to the renewable energy resources is the need of the time.

Globalization and non-renewable energy consumption increase CO_2 in the SAARC countries. Energy growth is the main reason for the environmental vulnerability (Jun, et al., 2021). The renewable energy consumption has an adverse effect on the CO_2 emission and a substantial positive impact of economic growth on the CO_2 (Naseem & Ji, 2020). The outcomes of energy consumption, FDI and population growth have harmful impact on the CO_2 emission in the SAARC region. The study found the nonexistence of environmental Kuznets curve hypothesis in three countries of SAARC like Bangladesh, Pakistan, and India (Ahmad, et al., 2021). Another important factor that increases CO_2 emission is urbanization. Inefficient industrial technologies and transportation are the main causes of environmental damage (Yasin et al., 2021).

Moreover, industrialization increases air pollution in Pakistan, India, and Nepal (Ahmad, Iqbal, & Mahmood, 2013). A new mathematical model like grey relational model analyzes that the renewable energy consumption reduces CO_2 emission in SAARC countries (Ikram, Zhang, Shrouf, & Shah, 2020). Electrical power consumption is increasing environmental degradation in Bangladesh and Nepal. Moreover, average precipitation is increased in India, and methane emission in Pakistan (Akhmat, Zaman, Shukui, Irfan, & Khan, 2014). Financial development has positive impact on SAARC countries. Trade openness has significant and negative impact on the environment (Khalid, Usman, & Mehdi, 2020). Negative impact has been confirmed in case of renewable energy consumption and CO_2 in SAARC (Adebayo & Kirrikkaleli, 2021).

LITERATURE REVIEW

Jun, et al. (2021) has tried to explore the impact of globalization on environmental degradation. The study was conducted on the selected South Asian countries from the time period 1985 to 2018 under the framework of environmental Kuznets curve hypothesis. The empirical analysis of this paper concluded with the positive association between the dependent variable CO_2 and the independent variables like non-renewable energy consumption, urbanization and gross domestic product.

Ahmad, et al. (2021) investigated the impact of road transport energy consumption on the CO_2 emission. The study used the balanced panel data from 1900 to 2016 to estimate the empirical outcome through inverted U-shaped environmental Kuznets curve. The study concluded that road transport increases CO_2 emission; moreover, energy consumption, FDI and population growth are having positive association with the climate vulnerability.

Yasin, et al. (2021) endeavored to examine the role of financial development, political institutions, urbanization and trade openness on the CO_2 emission on 59 less developed economies. The data was collected from the period 1996 to 2016. The empirical results found that there exists positive association between environmental degradation and financial development, urbanization capital labor ratio and energy consumption by incorporating Arellano Bond Generalization Method (A-B GMM), Orthogonal deviation Generalized Method of Moment (O-D) GMM and Cross Sectional Weighted Estimated Generalization Least square (EGLS). Moreover, institutions and foreign trade were found beneficial for the environment.

Naseem & Ji, (2020) examines the relationship of various variables that affect the environment in South Asian Association for Regional Countries. The study incorporated the annual cross sectional data from the year 2000 to 2017. Various econometric techniques were applied such as fixed panel effect regression and two step generalized method of moments (GMM) to estimate the parameters. The results showed the negative association between CO_2 emission and renewable energy consumption, while the positive association was present in case of economic growth.

Ikram, et al. (2020) determined the complex relationship between ISO 14001 certification, renewable energy consumption, access to electricity and CO_2 emission on SAARC countries. The study analyzed the data from 2000 to 2014 by using various econometric techniques including Grey Rationale Analysis (GRA). The outcomes showed that India is the most vulnerable nation in CO_2 emission problems.

Rahman, et al. (2020) demonstrated the possibility of global carbon leakages consumption based CO_2 emission. The data was collected from 1972 to 2015 for five member countries of SAARC region. The study showed that the household consumption emission were 62.39 percent and 0.61 percent of CO_2 emission in India and Nepal respectively. The study suggested to use combustible renewable resources.

Bakar, et al. (2019) examined the impact of two types of FDI such as Greenfields (GF) Mergers and Acquisition, and energy consumption on the environment. The study gathered the data for the eight selected countries of SAARC and ASEAN regions spanning from 2003 to 2014. The study incorporated the Environmental Performance Index (EPI) to estimate the effects of these variables on the environmental performance. The study confirmed the population Haven Hypothesis (PHH). Population and energy consumption showed positive relationship with Environmental performance index.

Ahmad, et al. (2013) emphasized on the effects of two important variables population and industrial growth on the CO_2 emission. The panel data were taken spanning over 1980 to 2018 of the selected SAARC countries. Panel Padroni co-integration test and Fisher Johansen to co-integration methodology was used to check the co-integration among the variables. The statistical results confirmed that industry and population were significant causing air pollution in the SAARC countries.

METHODOLOGY

This section has been designed to provide the data collection sources, methodological framework and the model specification.

Data Sources

The present study has taken the panel data for all eight countries of SAARC spanning over 1995 to 2021. Source of data is World Development Indicator.

Methodological Issues

The study has applied panel unit root tests, panel Padroni co-integration test and fully modified ordinary least square test considering the panel data. The general form of the model is as follows:

$$Y_{it} = \alpha_1 + \alpha_2 X_{it} + \sim_{it}$$

Here "Y" and "X" are variables and they are attached with subscripts "i" and "t", i =, 2, 3,…, N and t= 1, 2, 3, …, T time periods.

Panel Unit Root Tests

Panel unit root tests have been applied in order to check and resolve the problems of stationarity and non-stationarity.

The Levin, Lin, and Chu Test

This test is an expansion of DF and is proposed by Levin, Lin and Chu back in 2002. Based upon the work of Levin, Lin and Chu in 1992, and 2002, the following equation is presented for unit root test:

$$\Delta Y_{it} = \omega_i + \mathrm{r} Y_{i,t-1} + \sum_{k-1}^{n} \emptyset_k \, \Delta Y_{i,t-k} + \delta_i t + \theta + e_{it}$$

The Im, Pesaran and Shin (IPS) test

The LL test does not restrict r to be homogeneous across all I, It allow for heterogeneity in the coefficient of $Y_{i,t-1}$ variable and gives a best test based upon the average of the individual unit root test statistic.

$$\Delta Y_{it} = \omega_i + \mathrm{r}_i Y_{i,t-1} + \sum_{k-1}^{n} \emptyset_k \, \Delta Y_{i,t-k} + \delta_i t + e_{it}$$

The Maddala and WU (MU) test

Maddala and WU in 1999 proposed the following test in order to solve the problem of all other tests.

$$\Pi = -2 \sum_{i=1}^{N} In\pi_i$$

Panel Padroni Co-Integration Test

Padroni (1997, 1999, and 2001) has proposed the following regression model. This co-integration test permit heterogeneity.

$$Y_{i,t} = \mathrm{r}_i + U_t + \sum_{m=1}^{M} \alpha_{mi} \, Xm_{i,t} + e_{i,t}$$

Fully Modified Ordinary Square

Fully modified ordinary least square test is used to estimate the coefficient of the model. This test is applied after the confirmation that the long run relationship is present among the variables.

Model Specification

In the present study, the model for the environmental degradation is given below.

$$CO_2 = f(FE, INAG, RE, FFEC, POPL, HCI)$$

Econometric Model

An econometric model is presented as follows:

$$CO_{2_{it}} = \alpha_0 + \alpha_1 FE_{it} + \alpha_2 INAG_{it} + \alpha_3 RE_{it} + \alpha_4 FFEC_{it} + \alpha_5 POPL_{it} + \alpha_6 HCI_{it} + \mu_{it}$$

VARIABLES DESCRIPTION

Variables	Notation	Data Sources
Carbon dioxide emission	CO2	World Development Indicator
Fossil fuel energy export	FE	World Development Indicator
Industrial growth	INAG	World Development Indicator
Renewable energy consumption	RE	World Development Indicator
Fossil fuel energy consumption	FFEC	World Development Indicator
Population	POPL	World Development Indicator
Human Capital Index	HCI	World Development Indicator

UNIT ROOT TESTS

Table 1: ADF Fisher- Chi Square

	At Level		At First Difference		
Name of Variables	ADF Values	P-Value	ADF Values	P-Value	Result
CO2	14.0706	0.5935	195.393	0.0000	I(1)
FE	21.8508	0.1481	144.722	0.0000	I(1)
INAG	6.37228	0.9836	76.8666	0.0000	I(1)
RE	8.65507	0.9269	108.375	0.0000	I(1)
FFEC	10.3079	0.4139	62.7717	0.0000	I(1)
POPL	7.07871	0.8524	103.294	0.0000	I(1)
HCI	6.94013	0.9370	116.819	0.0000	I(1)

Table 2: PP- Fisher Chi Square

	At Level		At First Difference		
Name of Variables	ADF	P-Value	ADF	P-Value	Result
CO2	24.0295	0.0889	302.050	0.0000	I(1)
FE	32.6468	.0082	243.115	0.0000	I(1)
INAG	3.87688	0.9991	123.706	0.0000	I(1)
RE	12.5130	0.7080	228.500	0.0000	I(1)
FFEC	9.59169	0.4770	146.252	0.0000	I(1)
POPL	1.95393	0.9995	131.361	0.0000	I(1)
HCI	11.9687	0.6088	175.523	0.0000	I(1)

Table 3: Pesaran and Shin W-stat

	At Level		At First Difference		
Name of Variables	ADF	P-Value	ADF	P-Value	Result
CO2	3.42216	0.9997	14.5040	0.0000	I(1)
FE	-1.33963	0.0902	-11.2688	0.0000	I(1)
INAG	10.2639	1.0000	-5.16985	0.0000	I(1)
RE	0.88419	0.8117	-8.90875	0.0000	I(1)
FFEC	0.23092	0.5913	-6.54815	0.0000	I(1)
POPL	6.53666	1.0000	-9.42515	0.0000	I(1)
HCI	3.06746	0.9989	-9.50838	0.0000	I(1)

Table 4: Levin, Lin & Chu

	At Level		At First Difference		
Name of Variables	ADF	P-Value	ADF	P-Value	Result
CO2	2.28485	0.9888	-12.5824	0.0000	I(1)
FE	-1.58386	0.0566	-10.9821	0.0000	I(1)
INAG	10.5291	1.0000	-2.23512	0.0127	I(1)
RE	0.02515	0.5100	-7.14526	0.0000	I(1)
FFEC	-3.51016	0.0002	-2.30342	0.0106	I(1)
POPL	5.97846	1.0000	-11.8473	0.0000	I(1)
HCI	3.75436	0.9999	-8.20068	0.0000	I(1)

Table 1 to 4 show the results of unit root tests for all the variables. The variables included in this table are Fuel export, Industrial output, renewable energy consumption, fossil fuel energy consumption, population and HCI. The results of Levin Lin and Chu test confirms that all the variables are stationary at first difference. Moreover, the results of Pesaran and Shin-W statistic show that null hypothesis is rejected at first difference which shows that all he variables are not stationary at level. However, variables becomes stationary after taking the first difference by Pesaran ad Shin-W statistic. The results of ADF-Fisher-Chi-Square show that all the variables are stationary at first difference. Lastly, PP-Fisher-Chi square has been applied and it also show that all the variables are stationary at first difference.

DESCRIPTIVE STATISTICS RESULTS

Table 5:

	CO2	FE	INAG	RE	FFEC	POPL	HCI
Mean	0.579369	7.863184	6.798179	51.57741	26.01930	4827990.	0.089038
Median	0.381425	2.479946	6.202532	51.54000	18.81256	1035354.	0.000000
Maximum	4.072103	48.91751	89.21741	756.3825	74.23874	31181377	0.983473
Minimum	0.012764	1.23E-06	-46.68485	1.110000	0.000000	0.000000	0.000000

Table 5 describes all the descriptive statistic results of the variables used in this study. The table shows the mean, median maximum and minimum of all the values of the observations. The first row gives the names of the various variables. The second row is showing the mean values. The overall mean score of CO2 in the SAARC region is 0.5793. The median value of CO2 is 0.3814, Moreover, the values for maximum and minimum are 4.072 and 0.01276. Similarly, the values of FE have also been estimated. The mean value for FE is 7.8631. The median for FE is 2.4799. The maximum and minimum for FE are 48.9175 and 1.23 respectively. The values of mean is 6.7981 for INAG. The median of INAG is 6.2025. Furthermore, the values of maximum and minimum of INAG are 89.2174and -46.6848 respectively. The mean and median values are also calculated for RE and they are 51.5774 and 51.5400. The maximum value for RE is 756.38. The minimum value for RE is 1.1100. Similarly, the mean value of FFEC is 26.0193. The median value of the same variable is 18.8125. The maximum value for FFEC is 74.2387. The minimum value for FFEC is 0.00. The mean value of POPL is 48279. The median value of POPL is 103535. The maximum and minimum values for POPL are 31181 and 0.00 respectively. The mean value of HCI is 0.089. Its maximum value is 0.9834.

CORRELATION MATRIX

Table 6:

	CO2	FUEL_E	IND_AG	REC	FFEC	POP_LC	HCI_LB
CO2	1.000000	-0.010291	-0.080893	-0.292584	0.059267	0.161498	0.231907
FE	-0.010291	1.000000	0.102831	0.040805	-0.403317	-0.178997	-0.022074
INAG	-0.080893	0.102831	1.000000	-0.012845	-0.089426	-0.051887	-0.121240
RE	-0.292584	0.040805	-0.012845	1.000000	0.007708	-0.101328	-0.048536
FFEC	0.059267	-0.403317	-0.089426	0.007708	1.000000	0.826382	0.450068
POPL	0.161498	-0.178997	-0.051887	-0.101328	0.826382	1.000000	0.585765
HCI	0.231907	-0.022074	-0.121240	-0.048536	0.450068	0.585765	1.000000

The correlation matrix has also been included to check the degree of correlation among the variables. The results of correlation analysis are shown in the table 6 and the purpose of this table is to examine that whether the problem of multicollinearity exists or not. The relationship between CO2 and FE is negative. The correlation coefficient of CO2 and FFEC is 0.059. Moreover, the correlation between POPL and CO2 has been examined positive and its value is 0.161. The relationship between CO2 and RE is negative and its correlation coefficient is -0.2925. The association between FE and CO2 is observed negative. However, the association between FE and INAG is positive. The relationship between RE and FFEC is positive and its correlation coefficient is estimated as 0.7708. The link between POPL and RE is negative and its coefficient value is -0.1013. The relationship between POPL and HCI is positive and its correlation coefficient value is estimated as 0.5857. Moreover, the relationship between POPL and FFEC is also positive and its coefficient value is 0.5857.

PANEL PADRONI CO-INTEGRATION TEST

Table 7:

Panel Statistic	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-1.346293	0.9109	-1.374153	0.9153
Panel rho-Statistic	-2.308199	0.0105	-1.724832	0.0423
Panel PP-Statistic	-5.902482	0.0000	-5.109809	0.0000
Panel ADF-Statistic	-5.741612	0.0000	-5.042770	0.0000
Group Statistic	Statistic	Prob.	_	
Group rho-Statistic	-1.091458	0.1375		
Group PP-Statistic	-5.161903	0.0000		
Group ADF-Statistic	-4.717105	0.0000		

After checking unit root of all the variables, Panel Padroni Co-Integration test has been applied. It helps to confirm that whether there exists long run association between the variables or not. This test has been used after confirming that all the variables are not stationary at level. The results of Panel Padroni Co-integration are reported in the table 7. The values of Panel PP-Statistic and Panel ADF-Statistic are showing that there exists long run relationship among the variables. Therefore, the alternative hypothesis is accepted of co-integration. On the other hand, the results of group pp-statistic and group ADF pp-statistic also confirms that there exists a long run relationship. Next, we will estimate the statistical coefficients of all the variables which show the long run relationship between them. It is done through the Fully-Modified Ordinary Least Square test.

RESULTS OF FMOL AND DOLS

Table 8:

FMOL Results				
Variable	Coefficient	Prob.	Std. Error	t-Statistic
FE	0.001440	0.2030	0.001124	1.280929
INAG	0.000948	0.0550	0.000489	1.940264
RE	-0.017517	0.0000	0.001593	-10.99811
FFEC	0.012827	0.0000	0.001909	6.718185
POPL	3.38E-07	0.0000	3.84E-08	8.805156
HCI	0.017516	0.2274	0.014425	1.214292

DOLS Results				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
FE	0.252946	1.60E-10	1.59E+09	0.0000
INAG	0.004741	1.57E-12	3.01E+09	0.0000
RE	0.004879	8.99E-12	5.43E+08	0.0000
FFEC	0.009463	8.20E-12	1.15E+09	0.0000
POPL	2.17E-06	1.95E-16	1.12E+10	0.0000
HCI	0.136139	8.06E-11	1.69E+09	0.0000

The FMOL results show that positive relationship exists between selected independent variables and the dependent variable that is CO2 emission. The study has included six variables. The relationship FE and Co2 is positive and its coefficient value is 0.1440. It shows that one percent increase in the fuel export in the SAARC region increases the CO2 emission by 14 percent. Moreover, the relationship between FFEC and CO2 is also calculated. It shows that one percent increase in FFEC increases the CO2 emission by 12 percent as its coefficient value is 0.01282. The coefficient of POPL is 3.38 and it is highly significant value with the lowest probability value. It shows that one percent increase in POPL increases CO2 by 3.38 percent. Furthermore, the coefficient of HCI is 0.017 but it is not significant. The negative relationship has been found between RE and CO2. Its coefficient value is estimated that is 0.0175 by FMOL. It is highly significant value which shows that one percent increase in RE will decrease the CO2 emission by 17 percent. In case of FE, the coefficient value is insignificant, however; it becomes significant by applying dynamic ordinary least square test. The coefficient value obtained by DOLS shows that one percent increase in FE increases CO2 emission by 0.2529. Moreover, the coefficient of INAG also becomes significant when estimated by DOLS. It shows that one percent increase in the INAG increases CO2 by 0.47 percent. The relationship between HCI and Co2 is found positive by DOLS. It shows that one percent increase in HCI increases CO2 emission by 13 percent and it is highly significant value also.

CONCLUSION

The current study has tried to analyze the impact of inefficient energy resources usage on the environment of SAARC countries by utilizing the data from 1995 to 20221. Results of the Fully-Modified Ordinary Least Square test signify that fossil fuel energy consumption has a positive relationship with the CO2 emission. Population growth is also a very important factor that contributes towards the environmental damage in all the eight countries like Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, India, and Sri-Lanka. On the contrary, renewable energy consumption has a strong negative relationship with the CO2E. Human capital index has shown a positive relationship but its value is highly insignificant. Therefore, it can be concluded that the SAARC region should move from the inefficient usage of fossil fuel to eco-friendly renewable energy resources. This transition may help to achieve the Kyoto Protocol targets. In addition, domestic and industrial energy needs are overwhelming the carbon emission leading to the deterioration of natural resources due to fossil fuel, As a result, this region needs to formulate clean and green policies by initiating the co-operation at regional level. These countries should increase the renewable energy production to impede the usage of dirty energy. In this way, clean and green environment that will be pure and dirty free also can be achieved leading to the sustainable atmosphere in SAARC.

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