



Is Economic Growth and Industrial Growth the Reason for Environmental Degradation in SAARC Countries?

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ABSTRACT

In the last four decades, the developing countries have built a heavy industrial base which is seen as a threat to the environment. The trade liberalization policies of the SAARC countries led them to increase the production for domestic use and exports. This increase in industrial output is a real threat to environmental degradation as the industrial share is quite significant in the GDP of the SAARC countries. The present study is designed to check the existence of the Environmental Kuznets Curve (EKC) hypothesis and then use industry output as a regressor to see how it is affecting the environment. The panel regression models are used for estimation by taking data from 1980 to 2018. The results are obtained by using Newey-West standard robust errors. The results suggested that there exists a U-shape relationship between economic growth and Carbon Dioxide (CO₂) while an inverted U-shape relationship is found between industrial growth and CO₂. Furthermore, a unidirectional causality was observed between industrial growth, human capital, energy consumption, and CO₂ while bidirectional causality was observed between urbanization and CO₂. The present study suggests that there is a need to adopt environmental protection policies related to the industrial sector in the SAARC region.

Keywords: Economic Growth, Industrial Growth, Environmental Degradation

JEL Classifications: Q43, Q54, R11

1. INTRODUCTION

The increase in industrial production and advancement in technology has raised the standards of living of the people and the Gross Domestic Production (GDP) of the world. On the contrary, the increased industrial production is also causing Environmental Degradation (ED) due to Carbon Dioxide (CO₂) emissions (Rauf et al., 2018). Energy is a significant input for production and is used intensively in the production process causing ED. Moreover, the major source of energy comes from non-renewable fossil fuels which are largely used for industrial production in developing countries (Wang et al., 2020). In this contemporary era, growth-led policies are creating an alarming situation for global warming (Tsaouri, 2018). In literature, the relationship

between Economic Growth (EG) and ED is extensively explored using the Environmental Kuznets Curve (EKC) hypothesis (Al-Mulali and Che Sab, 2018; Apergis and Ozturk, 2015a; İşik et al., 2020; Stern et al., 1996). The quadratic relationship by using the EKC hypothesis shows an inverted U-shape curve between both variables, which shows that at the initial stage of EG, the ED increases while at later stages, ED decreases due to the advanced technology and use of renewable energy sources (Mahmood et al., 2019; Sultan et al., 2021). The present study is designed to check the EKC hypothesis by taking EG and industrial growth as independent variables.

Global warming is a result of the increased temperature of the earth. Greenhouse Gases (GHG) are the main contributors to

global warming and CO₂ emissions is a significant contributor among these (Matthew et al., 2018), and policymakers are trying to propagate the concept of green growth in developing countries (Zhang and Cheng, 2009). According to the report “Trends in global CO₂ and total greenhouse gas emissions (2020),” the major share in GHG emissions is CO₂ which constitutes 75% of the total share in global emissions with a growth rate of 0.9% in 2019. Due to this rising concern, different attempts have been made in the past to combat this problem. The most significant one is the Protocol (1997) which explicitly stressed limiting CO₂ emissions worldwide (Protocol, 1997). The Paris agreement (2015) targets to reduce the average temperature by keeping it underneath 1.5°C (2.7°F) from the pre-industrial level and to accomplish the objective of worldwide net-zero discharges by keeping a balance between the GHG transmitted in air and GHG eliminated from climate. It is also written in the agreement to bring CO₂ emissions somewhere around about 45% till 2030 while eliminating it by 2050. In addition to this, the Sustainable Development Goals (the plan of the United Nations 2030 agenda) also stressed to control the CO₂ emissions by using environment friendly techniques (Murshed, 2020).

CO₂ emissions are causing unsafe climate changes and the SAARC region is among the world’s most vulnerable regions to climate change that is already experiencing a warming level of 1°C above the pre-industrial levels (Analytics, 2019). SAARC is a group of seven nations i.e. Bhutan, Bangladesh, Nepal, Pakistan, India, Maldives, and Afghanistan. These countries have formed a geopolitical union. Similar to other developing economies, the member countries of the SAARC region have also put more focus on growth-led policies after the third wave of globalization in the fourth quarter of the last century. In 2018, the average growth rate of these economies was 6.1% which was mainly due to the high growth rates in India, Bhutan, and Bangladesh. The high average growth rate in the SAARC region needs more energy as input for production and to fuel its exports (Zeshan and Ahmed, 2013). The sector-wise CO₂ emissions for all the SAARC countries are presented in Figures 1-5.

The data presented through Figures 1-5 shows that industry has remained one of the major sources of CO₂ emissions in SAARC countries. The industrial sector has remained the leading sector for Bangladesh, Nepal, and Pakistan for CO₂ emissions while in India and Sri Lanka the industry is the second-largest source of CO₂ emissions. One major source of CO₂ emissions in SAARC

countries is the electricity and heat sector because the usage of fossil fuels has increased in past years. In the SAARC region, the industrial sector is considered as the main contributor towards the ED because it uses the traditional methods of production as well as relies on fossil fuel combustion which is the main source of CO₂ emissions. In literature, a significant number of studies have checked the relationship between EG and ED but as per the author’s knowledge, no study has yet attempted to explore the effect of the industrial sector solely on the ED for the SAARC region.

2. LITERATURE REVIEW

The Kuznets curve was introduced by a Russian economist Simon Kuznets in the 1950s who explored the inverted U-shape curve between income inequality and growth. After his work, the empirical work with the modification to capture the ED is done by Grossman and Krueger (1995) who adopted the similar phenomena of quadratic relationship but between EG and ED. The authors used GDP per capita for measuring growth and air pollutants (Sulfur dioxide and Smoke) for measuring ED. The results showed that there exists an inverted U-shape relationship between two variables. After this empirical work, a significant number of studies were conducted to test the relationship between these two variables by using different methodologies and different proxies for ED. Among all, the most common pollutant is CO₂ emissions as found in studies of Zeshan and Ahmed (2013); Halliru et al., (2020); Nasir and Rehman (2011); Pao and Tsai (2011); Apergis and Ozturk (2015b); Kang et al., (2016); and Mehmood and Tariq (2020).

After the initial empirical work, extensive research has been done on linking growth and environment as Ahmed and Long (2013) explore the phenomena of the environmental Kuznets curve in the case of Pakistan. They use the CO₂ as a measure to investigate the environmental quality and annual GDP rate to measure growth, energy consumption was also used as a determinant of ED. Their results show the inverted U-shaped curve. So, they conclude that Pakistan has the potential to overcome the issue of ED with economic development. Similarly, Rauf et al., (2018) explore the relationship between industrial growth, energy consumption, and the environment concerning the OBOR projects for the Chinese economy. They use industrial, manufacturing, and services value-added for measuring the development of different sectors as well as

Figure 1: Sector-wise CO₂ emissions by Bangladesh

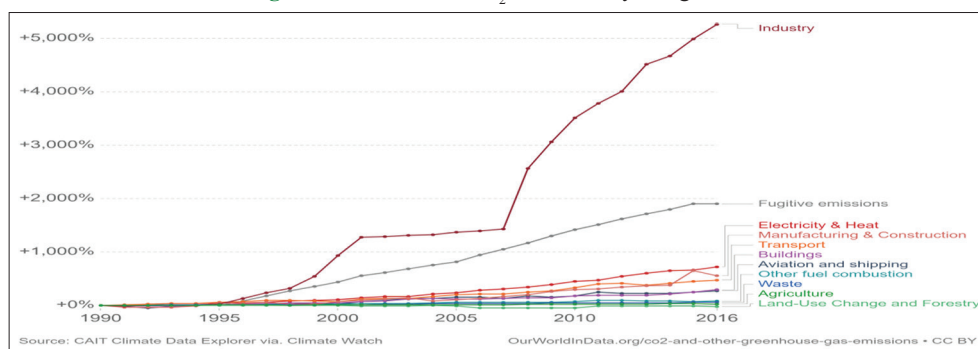


Figure 2: Sector-wise CO₂ emissions by India

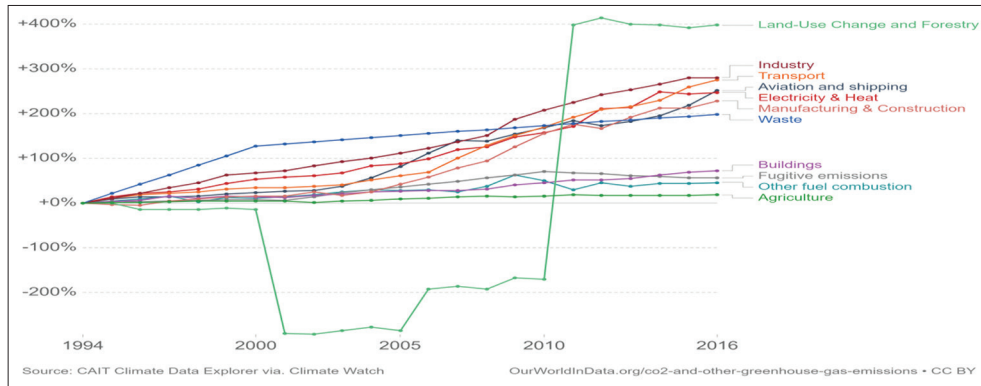


Figure 3: Sector-wise CO₂ emissions by Nepal

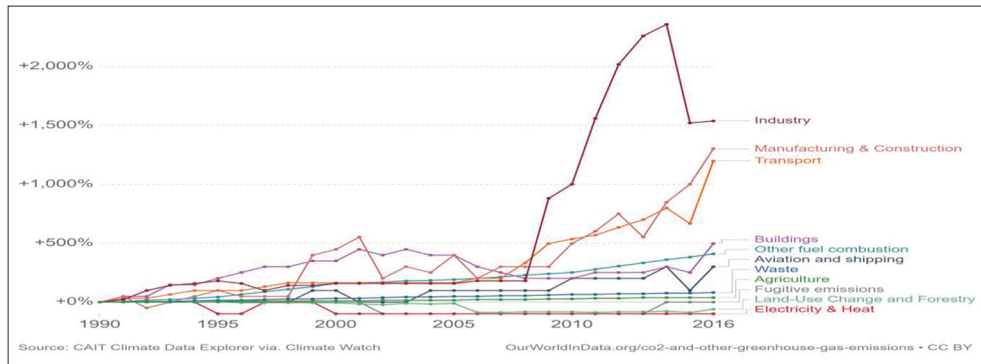


Figure 4: Sector-wise CO₂ emissions by Pakistan

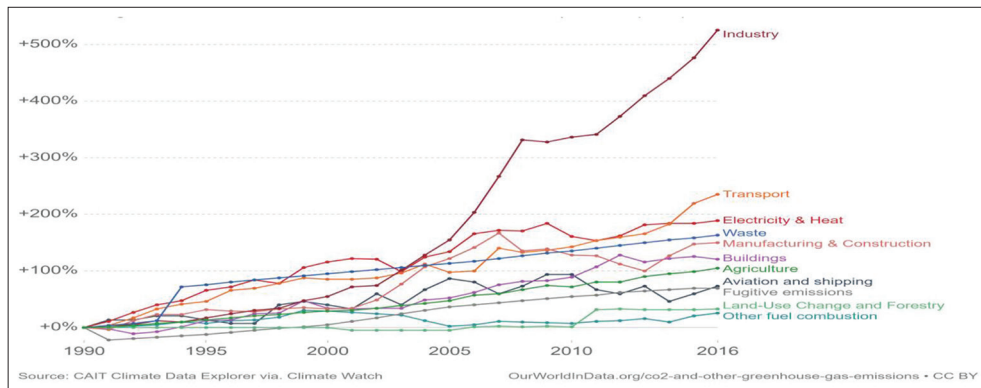
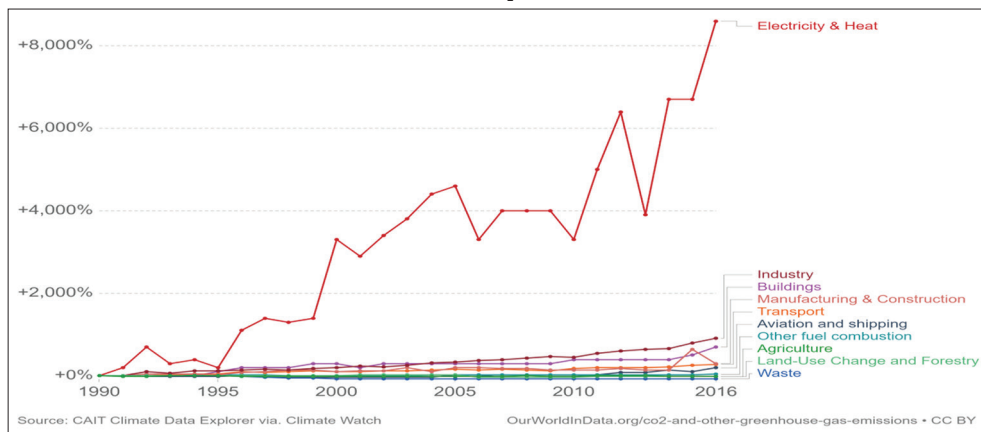


Figure 5: Sector-wise CO₂ emissions by Sri Lanka



GDP and CO₂ were used for measuring growth and environmental quality. The results show that the industrial sector has a positive while growth has a negative relationship with CO₂. In another study Rauf et al., (2018) explored the effect of OBOR projects in 65 economies of Asia, Africa, and Europe. The EKC hypothesis was tested for Belt and Road Initiative (BRI) countries and studied how mega projects in these countries are affecting the environment. The results of this study confirmed the EKC hypothesis for the panel of 65 countries. The authors also test the EKC hypothesis regions-wise by using various estimators. According to results, EKC hypothesis was not proved in Central Asia, East Asia, Middle East, North Africa, and Southeast Asia. The results also confirmed the existence of EKC hypothesis for the case of South Asia only by two estimators.

In another study Abokyi et al., (2019) tested the EKC hypothesis for Ghana by taking industrial growth instead of EG as the independent variable. The use of energy in the industrial sector of Ghana is highest among all the sectors compels the authors to undertake this study. The study used the Autoregressive Distributed Lag (ARDL) approach of co-integration with structural breaks and Bayer-Hanck joint co-integration to test the EKC hypothesis. The results showed that there exists a U-shaped EKC between industrial growth and CO₂ emissions. The U-shaped relationship was further confirmed by Lind and Mehlum U-test. Similarly, Attari et al., (2016) conducted a study for Pakistan, in this study researchers incorporated per capita industrial income rather than EG and the result showed that there exists a U-shape relationship between CO₂ and industrial growth.

Bibi and Jamil (2021) validated the EKC hypothesis for 122 countries of six regions including Latin America and the Caribbean, East Asia and the Pacific, Europe and Central Asia, South Asia, the Middle East, and North Africa, and Sub-Saharan Africa. For measurement of environmental quality, they use CO₂ emissions and aggregate GDP for growth. Results showed that all regions can overcome ED overtime except the Sub-Saharan African region where EKC is not valid. Similarly, Munir et al., (2020) conducted an empirical study for five ASEAN countries i.e. Indonesia, Malaysia, Philippines, Singapore, and Thailand by examining the relationship between growth, environment, and energy consumption. The results showed that there exists an inverted U-shaped relationship between EG and ED.

In the case of the SAARC region, studies like Nasreen et al., (2017) tested the EKC hypothesis and investigated the importance of financial stability for EG. EG was used for measuring growth and CO₂ was used as a proxy of ED. The study was conducted by taking five selected SAARC economies i.e. Bangladesh, India, Pakistan, Sri Lanka, and Nepal due to data constraints. The results suggested EKC exists in all economies except Nepal where it shows a U-shape curve. On similar grounds, Waqih et al., (2019) conducted an empirical study to test the EKC hypothesis and Pollution Haven Hypothesis (PHH) for the four selected SAARC countries including Bangladesh, India, Pakistan, and Sri Lanka. The results showed the existence of EKC and PHH in the case of the SAARC region.

In addition to energy consumption, international trade and globalization variable are also used in literature as control variables to test the EKC hypothesis in single-country studies and panel data studies. In this regard, Murshed and Dao (2020) conducted an empirical study to test the EKC hypothesis in five South Asian countries namely Bangladesh, India, Pakistan, Sri Lanka, and Nepal. The study also checked the role of export quality in ED. Like other many studies, this study also used CO₂ emissions as a proxy for ED. The data from 1974 to 2014 was used to conduct panel data analysis and time series analysis for each country. The results of the panel data studies validated the EKC hypothesis for five countries but the results of time-series data only validated the EKC hypothesis for Bangladesh and India. In the case of Pakistan, the results suggested a U-shaped relationship between CO₂ and EG. The interaction term of export quality and EG was found significant that shows the impact of EG on CO₂ emissions is conditional to the quality of exports. Pandey and Mishra (2015) explored the effect of EG on ED for the five South Asian economies and their result shows that there exists a U-shape relationship between EG and CO₂ in selected South Asian economies. In literature, some of the studies have even found N-shaped EKC. In this regard, Afridi et al., (2019) found N-shape EKC for the SAARC region. This study has used data from seven countries from 1980 to 2016 to test the EKC hypothesis. The results of the study suggested a negative relationship between trade openness and CO₂. Moreover, the study also found out a positive relationship of energy consumption and urbanization with CO₂.

Most of the studies in the literature have tested the EKC hypothesis for a single country or multiple countries and found U-shaped, inverted U-shaped, or even N-shaped relationships between CO₂ and EG. Some of the studies have tested the relationship between industrial and CO₂ omissions but as per the author's knowledge, no study has checked this relationship for SAARC countries. The present study intends to fill this gap by exploring the relationship between industrial growth and CO₂ omissions and testing the traditional EKC hypothesis for SAARC countries.

3. DATA AND METHODOLOGY

3.1. Data

The present study has used data from the period 1980 to 2018 and considers five countries of the SAARC region namely Bangladesh, India, Nepal, Pakistan, and Sri Lanka. Bhutan and Afghanistan and excluded from the analysis due to the unavailability of the data. Data on the variables used in the study is taken from World Development Indicator and Penn World Table.

3.2. Model Specification

It is evident in the literature that the SAARC region is sensitive to global warming and CO₂ is the main contributor to it (Anser et al., 2020). The present study has used CO₂ emissions as a proxy for ED. GDP per capita is used to measure EG and industrial value-added is used to measure industrial growth. Furthermore, energy consumption, urbanization, and human capital are taken as control variables as suggested by the literature on ED. For estimation purposes, we have constructed the two models as:

3.2.1. Model 1

$$LCO_2 = \beta_0 + \beta_1 LGDP + \beta_2 (LGDP)^2 + \beta_3 LEC + \beta_4 LHC + \beta_5 LURB + \mu \tag{1}$$

Where,

LCO_2 = log of CO_2 emissions per capita

$LGDP$ = log of GDP per capita (Constant LCU)

$(LGDP)^2$ = square of GDP per capita after taking the natural log

LHC = log of human capital (Index, based on years of schooling and returns to education)

$LURB$ = log of urban population (% of the total population)

3.2.2. Model 2

$$LCO_2 = \beta_0 + \beta_1 LIND + \beta_2 (LIND)^2 + \beta_3 EC + \beta_4 HC + \beta_5 URB + \mu \tag{2}$$

$LIND$ = log of industrial value-added (Constant 2010 US\$)

3.3. Methodology

Panel captures the two dimensions, the temporal and spatial. It has the advantage to capture more information than time series or cross-section data due to this reason in applied work the use of panel models has been increased (Hsiao, 2007). The present study has used panel data for five countries of SAARC. In conventional panel data modeling, the common constant model, Fixed Effects Model (FEM), and Random Effects Models (REM) are used for the estimation. Hausmann specification test was used to find out the appropriate model for the present study. Hausmann specification test suggested that the FEM model is more suitable for the data of this study.

3.3.1. Fixed effect model

FEM captures unobserved heterogeneity issues in intercept terms and even if these specifications correlate with regressors it will give consistent results. The fixed-effect model can be written as

$$y_{it} = \alpha_i + x_{it}' \beta_1 + u_{it}$$

Where α_i is the term that captures the individual effects and can correlate with the regressors. However, fixed effect assumes the strict exogeneity of idiosyncratic errors i.e. $E(x_{it}u_{it}) = 0$. Along with this, the fixed effect also assumes the homoscedasticity i.e. the error term is the same across all independent variables. This can be written as $E(u_{it}^2 | X_i, a_i) = \sigma_{ui}^2$, no cross-section and time-series correlation i.e. $cov(u_{it}, u_{jt} | x) = E(u_{it}u_{jt} | x) = 0$ where $i \neq j$; $t \neq s$ and errors are normally distributed.

FEM also assumes that time-invariant properties are unique and exclusive for each individual and must not have any correlation with other individual characteristics. This model has constant slopes but different intercepts for each entity (in this study country will be considered as an entity). In these types of models, there are not significant temporal effects; however, there exist significant differences among countries. So the intercept is cross-section (group) specific which differs from country to country while it may or may not differ over time.

FEM deals with the unobserved time-invariant individual specifications (culture, religion, race, colonial past, etc.) by eliminating these from estimation. The estimation process is as follows

Consider equation (i) i.e.

$$y_{it} = \alpha_i + x_{it}' \beta + u_{it} \quad i=1,2,\dots,N, t=1,2,\dots,T \tag{1}$$

For eliminating the individual-specific effects, we first take an average of the equation. So, averaging equation (1) over time gives

$$\bar{y}_i = \bar{\alpha}_i + \bar{x}_i' \beta + \bar{u}_i \tag{2}$$

Where $\bar{y}_i = \frac{\sum_t y_{it}}{T}$, $\bar{x}_i = \frac{\sum_t x_{it}}{T}$ and $\bar{u}_i = \frac{\sum_t u_{it}}{T}$

Now, subtracting equations (1) and (2) gives

$$y_{it} - \bar{y}_i = \alpha_{it} - \bar{\alpha}_i + (x_{it} - \bar{x}_i)' \beta + u_{it} - \bar{u}_i$$

Now, we can write this transform equation as

$$y_{it} - \bar{y}_i = x_{it}' \beta + u_{it} \tag{3}$$

The above equation is the final equation after transformation. Now, on this transformed equation, OLS is applicable. In this model, the estimator β is called the within-group fixed effect estimator because this estimator is only based on the variation within each country. The advantage of this approach is that it gives consistent estimates but the disadvantage is that they are not always efficient because it gives large variances.

3.3.2. Hausman test

Hausman (1978) introduced a test that is generally used to choose between fixed and random effect models. Hausman test is widely used in econometrics and is also called the Hausman test for endogeneity. This test detects endogenous regressors in the model and accordingly gives results about the model selection.

Thus, the Hausman test decides about the model selection by checking the presence of endogeneity in the regressors.

The test statistics for the Hausman test is as

$$[\hat{\beta}_{FE} - \hat{\beta}_{RE}]' [Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})]^{-1} (\hat{\beta}_{FE} - \hat{\beta}_{RE}) \sim \chi^2 K$$

With the degree of freedom equal to the rank of

$$[Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})]$$

This test has two hypotheses which are

H_0 : Random effect model is appropriate or $Cov(\alpha_i, x_{it}) = 0$ i.e. Exogeneity

H_1 : Fixed effect model is appropriate or $Cov(\alpha_i, x_{it}) \neq 0$
i.e. Endogeneity

If the null hypothesis is rejected, we use FEM otherwise REM.

3.3.3. Robustness check

After estimating the model, we have applied the diagnostic tests like Breusch and Pagan- LM test of independence, Wald test for group-wise heteroscedasticity, and Wooldridge test for autocorrelation.

The results suggested that these problems existed in both models that would lead to spurious results. To avoid spurious results, the present study has applied the Newey-West Standard Errors technique which gives robust results in the form of estimating correct standard errors. Newey-West Standard Errors approach is robust to the general type of cross-section as well as temporal dependencies is more appropriate (Driscoll and Kraay, 1998). This provides robust standard errors that are known as Heteroscedasticity and Autocorrelation Corrected (HAC) standard errors.

3.3.4. Causality test

For causality analysis, we use the Granger causality test Granger (1969). This test tells us about the causal linkages among variables and the direction of causality. For testing this causal relationship, the model can be used as

$$y_t = \alpha + \sum_{k=1}^k \tilde{\alpha}_k y_{t-k} + \sum_{k=1}^k \beta_k x_{t-k} + \varepsilon_t \text{ With } t=1, 2 \dots T$$

By using this model, the causality can be estimated using the F test with the null hypothesis as:

$$H_0: \beta_1 = \beta_2 \dots = \beta_k = 0$$

The null hypothesis shows that causality does not exist from x to y and the alternative shows that it exists from x to y. In this test bi-directional causality can be checked as well as causality can be checked by changing directions i.e. interchanging variables x and y.

4. RESULTS

Before estimating panel data, it is imperative to check either FEM or REM is appropriate for the selected data for any study. The Hausman identification test is used to check which of the two models is best suited for the analysis. The null hypothesis of the Hausman test states that the REM is appropriate while the alternative hypothesis stated that FEM is appropriate for the data. The results of the Hausman test for both models are given in Table 1.

The results show that the fixed effect model is appropriate as the probability value (p<0.01) in both models. So, the null hypothesis is rejected in both models stating that the specific effects are not correlated with the regressors (Random effect) and thus, the fixed-effect model is more appropriate for both models.

To avoid spurious results, different diagnostic tests are applied i.e. the Breusch-Pagan LM test for cross-sectional dependence, Modified Wald statistics for group-wise heteroscedasticity, and serial correlation to both models. The results of diagnostic tests are presented in Table 2.

The null hypotheses of the LM test of independence, the Wald test for group-wise heteroscedasticity, and the Wooldridge test for autocorrelation states that there is no problem of cross-sectional dependence, heteroscedasticity, and autocorrelation respectively. The results show the rejection of null hypotheses of all the diagnostic tests as the p < 0.01. The rejection of null hypotheses suggests that the problem of cross-sectional dependence, heteroscedasticity, and autocorrelation exists in the data and estimated results will be spurious.

It is imperative to have robust and efficient results and these problems must be addressed by using an alternative method of estimation (Hoechle, 2007). In this regard, Parks (1967) proposed the Feasible Generalized Least Squares (FGLS) approach to cater to the problems of autocorrelation, heteroscedasticity, and cross-sectional dependence. But this technique contains some drawbacks as this produces smaller standard errors that are not acceptable (Beck and Katz, 1995). Newey-West Standard Errors technique is best to solve the problem of smaller standard errors (Driscoll and Kraay, 1998).

The present study has used the Newey-West Standard Errors technique which gives robust results by estimating correct standard errors which are also called robust standard errors or Heteroscedasticity and Autocorrelation Corrected (HAC) standard errors. The robust results by using the Newey-West standard errors technique are presented in Table 3 for both models.

In the first model, the traditional EKC hypothesis was tested by taking GDP per capita and the results showed that EKC is U-shaped for SARRC countries. The results indicate that the GDP of the sample countries considered for the analysis is increasing ED. These results are in line with the study of Pandey and Mishra (2015) but opposite to the studies of Murshed and Dao (2020), Nasreen et al. (2017), and Waqih et al. (2019). In

Table 1: Hausman test results for both models

Test summary	Chi-square statistics	P-value
Model 1	40.72	0.0000
Model 2	41.62	0.0000

Table 2: Results of diagnostic tests

Tests	Model 1		Model 2	
	Chi-square value	P-value	Chi-square value	P-value
LM test of independence	39.784	0.0000	81.713	0.0000
Wald test for group wise heteroscedasticity	2392.95	0.0000	271.87	0.0000
Wooldridge test for autocorrelation	F-value: 124.410	0.0004	F-value: 123.970	0.0004

Table 3: Regression results with Newey-West standard errors

Dependent variable (CO ₂)	Model (1)		Model (2)	
	Coefficients	N-W St. Er.	Coefficients	N-W St. Er.
LGDP	-5.90122****	1.216096		
L(GDP) ²	0.2660606****	0.0520244		
LIND			2.670491****	0.4056006
L(IND) ²			-0.0505245****	0.0081522
LEC	0.7529448****	0.0843273	0.8100993 ****	0.0442938
LHC	0.6322671	0.414156	0.343759 ****	0.0938131
LUR	2.269211****	0.1283083	0.6173879 ****	0.1143628
Cons	19.79123****	6.514896	-42.46174 ****	4.791618

Values with ****Show that the variables are highly significant.

the second model, industrial growth was taken instead of GDP as the industrial sector is a significant part of the GDP of SAARC countries. The results of the second model showed the existence of an inverted U-shaped relationship between industrial growth and CO₂ emissions. The results implied that the industrial sector has remained one of the major sources of CO₂ emissions but with the advancement in production methods it is decreasing ED in SAARC region.

The energy consumption in both models has a significant and positive effect on ED. The main source of energy production in SARRC countries is fossil fuels which contribute significantly to the ED. The elasticity coefficient of energy consumption in model 1 and model 2 is 0.75% and 0.81% respectively. The results are in line with the studies of Afridi et al. (2019), Ahmed et al., (2017), and Khalid et al., (2021). The human capital variable shows a positive but insignificant relationship with CO₂ emissions in the first model while in the second model; it shows a positive and significant impact on CO₂ emissions. The urban population shows a positive and significant impact on CO₂ emissions in both models. The urbanization rate is quite high in the SAARC region which is causing rapid ED.

The Granger (1969) test is used to check the causal linkages among the variables of the study. The causality analysis is done for the variables i.e. LCO₂, LGDP, LIND, LEC, LURB, and LHC. Table 4 is showing the results of causality analysis.

The causality analysis shows that GDP is not causing CO₂ emissions. This might be because the share of the services sector in the total GDP of the SARRC is quite high and seems to reason for no causal effect of GDP on CO₂ emissions. Industrial growth is also not causing CO₂ emissions. One interesting result of the causality test can be seen in the shape of one way the causal relationship between CO₂ and energy consumption. One possible explanation can be as CO₂ causes global warming and due to global warming, the use of energy has increased in the last two decades. Bidirectional causality can be seen between GDP and industrial growth. This shows the importance of GDP for industrial growth and vice versa. The results also confirmed unidirectional causality running from GDP to urbanization and from human capital to GDP.

A unidirectional causality could be seen from industrial growth to energy consumption which referred to the conservative hypothesis. This implies that the conservative growth policies in the industrial sector could help in reducing energy consumption but, these

Table 4: Causality results

Null hypothesis	Stats	Prob.
LIND to LCO ₂	1.49013	0.2283
LCO ₂ to LIND	6.69955	0.0016
LRGDP to LCO ₂	0.12000	0.8870
LCO ₂ to LRGDP	2.29505	0.1039
LEC to LCO ₂	0.44433	0.6420
LCO ₂ to LEC	3.92904	0.0216
LUR to LCO ₂	0.10461	0.9007
LCO ₂ to LUR	2.24119	0.1095
LHC to LCO ₂	0.31531	0.7300
LCO ₂ to LHC	0.16914	0.8445
LIND to LRGDP	4.61886	0.0111
LRGDP to LIND	2.83920	0.0611
LEC to LIND	1.76190	0.1750
LIND to LEC	3.57594	0.0302
LEC to LRGDP	0.79801	0.4520
LRGDP to LEC	2.08223	0.1280
LUR to LRGDP	1.23558	0.2931
LRGDP to LUR	5.02098	0.0076
LUR to LIND	1.31402	0.2713
LIND to LUR	0.83055	0.4375
LHC to LIND	0.12685	0.8809
LIND to LHC	0.15985	0.8524
LHC to LRGDP	6.86046	0.0014
LRGDP to LHC	0.16828	0.8453
LUR to LEC	2.21772	0.1122
LEC to LUR	0.66848	0.5139
LHC to LEC	1.87088	0.1573
LEC to LHC	0.11492	0.8915
LHC to LUR	1.74506	0.1777
LUR to LHC	0.13557	0.8733

policies could also hamper the EG as clear from the bidirectional causal relationship between the two variables.

5. CONCLUSION AND RECOMMENDATIONS

SAARC region constitutes of developing economies that are famous for using traditional methods of production to get industrial output. These countries are providing energy through fossil fuels to their industrial sector which is causing ED. As discussed in the literature, most of the studies have used GDP to test the EKC hypothesis but some studies have also checked the nature of the relationship of industrial output with ED. The present study is intended to check the traditional EKC hypothesis by examining the relationship between EG and ED in the first model of the study. In the second model, the relationship between industrial growth

and ED is analyzed due to the significance of the industrial sector for ED. The present study has taking five SAARC countries out of seven due to data constraints and data from 1980 to 2018 is used for estimation of the models. Two models have been made with the same dependent variable CO₂ that is used as a proxy of environmental degradation. The Hausman specification test suggested FEM for both models. Diagnostic tests identified that assumptions of ordinary least square are violated which led the researchers to used the robust standard error method proposed by Newey and West (1987).

The results of the first model suggested U-shaped EKC (GDP as an independent variable) and these results are in line with the studies of Pandey and Mishra (2015) and contradict most of the studies in literature like Nasreen et al. (2017) and Waqih et al. (2019). On the other hand, the result of the second model suggested an inverted U-shaped relationship between industrial growth and ED. The control variables of the study namely energy consumption, human capital, and urbanization showed a positive relationship with ED in both models. The causality test highlighted bi-directional causality between GDP and CO₂. A unidirectional causality was found from CO₂ to industrial growth and energy consumption. Furthermore, unidirectional causality was found from industrial growth to energy consumption and GDP to urbanization.

Keeping in view the results of the study, it can be said that GDP, industrial growth, energy consumption, urbanization, and human capital are contributing towards ED. CO₂ is the largest contributor to ED and industrial output is one of the main reasons for CO₂ emissions in supply-side economics. Environmental protection policies related to the industrial sector should be adopted in the SAARC region. Renewable energy should be used as an input in industrial production instead of fossil fuels. The developing countries should not follow the footsteps of developed countries instead use environment friendly energy sources. Renewable energy sources must be used in industrial production. In this regard, the best example is China that sees renewable energy sources as an energy security issue and moving its energy mix towards renewable energy.

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