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Transport Energy Consumption and Climatic Challenges in SAARC Countries

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Abstract: The main objective of this study is to find the influencing role of road transport energy consumption on carbon dioxide (CO_2) emissions and climatic challenges in SAARC countries through the inverted U-Shaped Environmental Kuznets Curve (EKC) hypothesis. For empirical outcomes, the balanced panel data related to transport energy consumption, climatic factors, and productivity was collected from 1990 to 2016. According to Pedroni and Kao's cointegration tests, this study found a long-run association among estimated variables. Based on Panel Autoregressive Distributed Lag (PARDL) model, the early stage EKC hypothesis holds in SAARC countries during the long period. However, the study could not find evidence of inverted U-shaped EKC in SAARC countries. The EKC hypothesis in inverted U-shaped does not exist in the long or short run in the SAARC region. The road transport energy consumption has increased the CO_2 emissions, which creating environmental harmfulness in SAARC countries. Moreover, energy consumption, foreign direct investment (FDI), and population growth are found as the significant influencing indicators for climatic vulnerability in selected countries. The error correction term is negative and significant, which shows a convergent behavior of select environmental factors towards equilibrium in the long run. Based on research findings, it is suggested that both public and private sectors should be focused on alternative renewable energy consumption. Through the adoption of innovative transport technology, CO_2 production can reduce. It is suggested the government and research institutions in SAARC countries pay attention to R&D innovation in green technology with alternative road transports and green technology to protect the climate from harmful gases. Further, the SAARC countries should be focused on innovative alternative green transportation technology, to save the country from climate vulnerability.
Keywords: Transport Energy Consumption, Economic Growth, Green Technology, Climate Vulnerability

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Introduction

Economic stability with a lower inflation rate, unemployment, and poverty is considered a key to success for every economy. In this context, economic stability cannot achieve without energy efficiency. The non-renewable energy consumption creates the problem of climatic vulnerability, which has controversy between economic growth (EG) and environmental sustainability. Strong policy implementations for green energy consumption are required to achieve such goals simultaneously. The reliance on non-renewable energy resources in the road transportation sector may enhance the EG, but it also creates environmental pollution. To achieve a sustainable EG, developing countries tried to become industrialized economies to to pertain the higher output. The transformation of developing countries into industrialized has increased the demand for energy, which is environmentally harmful.

Globally, the energy sector is considered the leading sector with two main segregations: non-renewable and renewable energy resources. Non-renewable energy is more powerful and commonly used in road transportation both in developed and developing countries. Generally, fossil fuels energy is a largely consumable non-renewable energy that has a low cost of production with excessive supply and availability to fulfill the demand of the road transportation sector. However, renewable energy is costly, difficult to produce, and not easily available and accessible for road transportation (Girod et al., 2013). The shift from dirty energy consumption to green energy is one of the fundamental sustainable development goals until2050 for sustainable growth through renewable energy consumption. Renewable energy is environment-friendly and high-income countries focusing on Research and Development (R&D) innovation to convert the dirty technologies into green technologies with energy savings and environment protection policies (Mulali, 2014). Such climate protection policies provide sustainable economic growth in long run. Moreover, R&D innovation in renewable energy is costly as compared to non-renewable energy. That is why the developing countries cannot afford to shift the non-renewable road transport to the renewable energy consumptions sector. However, developing countries are highly vulnerable to climatic changes, so the need of the current situation focuses on green technological innovation to protect the environment from harmful emissions and attain long-running environmental and economic sustainability.

Road transportation is a leading energy consumable sector and consumes about a quarter of world energy because it has greater significance to run the economy and share in EG globally (Batur et al., 2019). The evidence shows that road transportation energy consumption holds one-third share of the total energy (Georgatzi et al., 2020). Currently, the environmental protection is a major concern for developing countries, while the emerging and developing economies are focusing on EG by neglecting the environmental quality because of easily accessible fossil energy. The excessive consumption of liquid fossil fuels in the road transport energy sector (like diesel, gasoline, or petrol, and liquefied petroleum gas) causes CO_2 emissions, which are harmful to the environment. So, higher energy consumption is an indication of higher production level as much energy is consumed in industrial, agricultural, and services sectors, and by transportation machinery. The domestic production will increase which leads to higher EG. The issue is that energy consumption affects the environment through the production of CO_2 emission (Jebli& Youssef, 2015). Additionally, EG has a direct positive relationship with environmental pollution (Menyah&Rufael 2010; Uddin &Wadud, 2014).

Similarly, Pandey and Mishra (2015) found that increments in Gross Domestic Product(GDP) caused environmental degradation, and that energy consumption is a key source for higher GDP growth (Ahmed & Long, 2012), which increases environmental pollution in Pakistan. The increased growth level with environment depletion validates the EKC hypothesis (Rehman& Rashid 2017). The higher industrial production with dirty technology causes high consumption of energy, which produces

CO_2emissions and other emissions. In contrast, Lau et al. (2014) found a negative effect of squared GDP growth on CO_2 emission in Malaysia. Similarly, urbanization has an affirmative effect on EG and CO_2emission (Zarzoso&Maruotti, 2011; Fujii et al., 2018).

Road transport is compulsory for individual movement and the transfer of goods and services within or across the country, andboth require more energy consumption. The use of road transport-produced emissions can reduce through innovative green technology. Additionally, the alternative renewable energy required to protect air quality (Siddiqui & Pant, 2008; Uherek et al., 2010; Saboori et al., 2014; Fuglestvedt et al., 2010). Talbi (2017) argues that road transports are the largest contributor to the CO_2emissions and the need of the economy and transport grows dramatically. Further, Solis and Sheinbaum (2013) highlight the road transport sector's utmost environmental and climatic damaging indicators such as CO_2emission, noise pollution, water quality, soil quality, biodiversity, urban expansions, and hazardous materials. Moreover, Farhani et al. (2014) explored that energy consumption and trade have a positive influence on CO_2 emissions and, further, transportation increased air pollution and caused degradation of the environment, reduction in quality of life, and EG (Profillidis et al., 2014). The road transport value-added raises the CO_2emission and confirms the existence of long-run EKC (Shahbaz et al., 2015), transport energy consumption, population size, and technical progress. Energy intensity harmed the environment, which is evidence of inverted U-shaped EKC (Xie et al., 2016; Yang et al., 2015; Mustapa&Bekhet, 2016).

The R&D innovation-based green transportation adoption, carbon taxes implementations, and sophisticated public transportation are beneficial to limited energy consumption and alternative shift on green energy (He et al., 2013; Girod et al., 2013). Conversely, renewable energy, financial factors, environmental prices, and implementations are essential tools to reduce fossil fuel energy and environmental protection. Renewable energy has reduced nitrous oxide emissions, however the monotonic shifts in income and fossil fuels, income and nitrous oxide, renewable energy, and greenhouse gases are worked simultaneously. Moreover, Batur et al. (2019) suggested that the adoption of renewable energy resources, fuel-saving travelers, and opting for green freight technologies are fundamental tools to reduce pollution production. The inverted U-shaped EKC hypothesis is validated the EG and greenhouse gases relationship (Nassani et al., 2017; Lu et al., 2019). Abundant use of road transport has adverse impacts on climate and environmental changes, especially on global warming, melting glaciers, rise in sea levels, increasing CO_2emission, and damaging the ozone layer (Grannkis et al., 2020; Giannakis et al., 2020). Romero et al. (2017) argues that the EKC does not validate transportation energy consumption in the European Union Nations.

In developing countries, the demand for industrial, agriculture, and transportation technology has increased, which has a vital role in higher EG and environmental pollution. The industrial value-added has a direct positive relationship with CO_2emission production (Zaman&Moemen, 2017). To gain the potential level of output, there are numerous opportunities for technological transformation such as FDI inflow, international trade, technology imports, and domestically produced technologies. The adoption of dirty technology also causes CO_2emissions. Ahmad et al., (2013) found a long-run relationship and unidirectional causality among the population, industrial growth, and pollution emissions. Similarly, Chandran& Tang (2013) and Abas et al. (2017) explored a positive association between the long-run GDP growth and road transport energy consumption with a significant increase in CO_2 emission. In contrast, Banerjee and Rehman (2012) discovered that the FDI has positive causality with CO_2emission and suggested that to increase FDI inflow, the country should focus on green technology imports to protect the environment. Similarly, Tang and Tan (2015) concluded that green FDI played a significant role in environmental protection in developing nations through environment-friendly and pollution-free technology. Waqih et al. (2019) found that energy consumption creates the problem of environmental degradation and confirmed the EKC existence.

According to existing literature relevant to South Asian Association for Regional Cooperation (SAARC) countries, there is ambiguity about the role of road transport energy consumption, EG, and climatic vulnerability. We found limited and country-based literature specific to SAARC countries, and most studies have not properly developed the connections between EG, transport energy consumption, and environmental pollution. Such studies have failed to confirm the exact role of road transport energy consumption in terms of environmental degradation. This research's novelty is that we redefined the methodology with additional variables through theoretical support, which is the main reason for the selection of SAARC countries quantitative analysis. Further, the uniqueness of this research is specific model selection with innovative dimensions and variables. Innovative models permitted theoretical and empirical justification for new modification regarding the role of EG, road transportation energy consumption on climatic harmfulness. This study also detects the early stages of the EKC hypothesis.

Numerous questions are not properly addressed in the existing literature. The following fundamental questions are missing in existing studies: What is the influence of road transport energy consumption and economic growth on CO_2emissions in SAARC countries? Doesthe hypothesis of the EKC validate in SAARC countries? In the context of the research gap and research questions, the purpose of this research is to examine the effective role of road transport energy consumption and economic growth on CO_2 emissions in SAARC countries. Additionally, this study empirically examines the validation of the inverted U-shaped EKC hypothesis in SAARC countries. The motivation of this research is that SAARC countries are among the top of the list of those are highly vulnerable to climatic challenges, and road transport energy consumption is one of the reasons for environmental degradation.

Methodology

This research is focused on the impact of road transport energy consumption (RTEC) on environmental degradation in SAARC counties. Initially, to measure the economic performance, capital and labor were considered as endogenous variables while technological innovation was treated as an exogenous variable (Solow, 1957), though both internal and external technology transfer prove essential in the success of an economy (Romer, 1990). So, the endogenous growth model is adopted to examine the behavior of energy consumption and environmental damages in SAARC countries. In this research, technological adoption is considered through proxy energy consumption, while inward FDI is the form of capital and population growth. The validation of the EKC hypothesis is a major concern of this research and identifies the environmental degradation that arises because of a higher level of economic output. According to the theoretical back grounding, the increased EG and RTEC are degrading the environment. For this purpose, the EKC hypothesis introduced by Kuznets (1955) is used in this research. Later on, the EKC hypothesis was explained by Grossman and Krueger (1991) to explain the affiliation between economic success and environmental deprivation. So, in this research, we have practiced the EKC hypothesis model to detect the inverted U-shaped hypothesis of the EKC model in SAARC countries (Shahbaz et al., 2015; Waqih et al., 2019). We adopt the EKC model as follows:

$$CO_2 = f\,(GDP, GDP^2, RTEC, TEC, FDI, PG) \qquad 1$$

In Equation 1, the CO_2emission is a function of GDP, squared GDP, road transport energy consumption (RTEC), total energy consumption (TEC), FDI inflow, and population growth (PG). The EG refers to the U-shaped EKC hypothesis. While GDP^2 is taken to justify the hypothesis of EKC in inverted U-shaped. Further, we express the quadric form of the equation to identify the relationship among climatic damages influence from RTEC and GDP growth in SAARC economies. Based on EKC hypothesis (Waqih et al., (2019), the quadratic equations as follows:

$$CO_{2it} = \alpha_0 + \alpha_1 GDP_{it} + \alpha_2 GDP_{it}^2 + \alpha_3 RTEC_{it} + \alpha_4 TEC_{it} + \alpha_5 FID_{it} + \alpha_5 PG_{it} + u_t + v_i + \varepsilon_{it} \qquad 2$$

The linear quadric 2,highlights the EKC hypothesis to identify the influence of EG, RTEC, TEC, FDI and PG on environmental degradation in SAARC countries. In above equation, α0is intercept and the rest ofα_1 to $\alpha_5$refers to the slope coefficient of endogenous variable. While 't' represents time, 'i' represents cross section dependency of panel data, and u_t, v_i and ε_{it}refer the time, cross and panel residuals are terms in estimated model. The description of variables is given in Table 1.

Table 1:

Variables and Description

Abbreviations	Description of Variable	Measuring Unites	Data Sources
CO_2	CO_2 emission as proxy of environmental degradation		World Development Indicators (WDI)
GDP	Economic Growth as GDP per capita	In US dollars	WDI
GDP^2	Squared GDP per capita	Squared per capita GDP	WDI
RTEC	Road Transport Energy Consumption		Statistical Review of World Energy
TEC	Total Energy Consumption		Statistical Review of World Energy
FDI	Inward Foreign Direct Investment	Measured in US dollars	WDI
PG	Population Growth	Annual Growth in total population	WDI

Source: Authors Owns

For quantitative analysis, we applied the Panel Autoregressive Distributed Lag (PARDL) model to investigate the long run and short run effects of GDP, RTEC and FDI on environmental degradation through the detection of EKC hypothesis in SAARC nations. The equations of PARDL long run and short run in the form oferror correction model (ECM)(Saboori&Sulaiman, 2013;Waqih et al., 2019), in the form of the EKC hypothesis is as follow:

$$CO_{2it} = \alpha_0 + \alpha_1(CO_{2it-1}) + \alpha_2(GDP_{it-1}) + \alpha_3(GDP^2{}_{it-1}) + \alpha_4(RTEC_{it-1}) + \alpha_5(TEC_{it-1}) + \alpha_6(FDI_{it-1}) + \alpha_7(PG_{it-1}) + u_t + v_i + \varepsilon_{it} \qquad 3$$

Equation 3represents the long run PARDL, to estimate the EKC. We formulated the ECM, which is based on adjustment tools. The adjustment tools basically known as speed of adjustment and convergence behavior of the model and stability shocksshort. The equation ECM equation is as follow:

$$ECM_{it-1} = CO_{2it} - (\alpha_0 + \sum^k{}_{i=1} \alpha_1 \Delta(CO_{2\,it-1}) + \sum^k{}_{i=0} \alpha_2 \Delta(GDP_{it-1}) + \sum^k{}_{i=0} \alpha_3 \Delta(GDP_{it-1}^2) + \sum^k{}_{i=1} \alpha_4 \Delta(RTEC_{it-1}) + \sum^k{}_{i=0} \alpha_5 \Delta(TEC_{it-1}) + \sum^k{}_{i=0} \alpha_6 \Delta(FDI_{it-1}) + \sum^k{}_{i=0} \alpha_7 \Delta(PG_{it-1})) \; 5$$

Finally, theinverted U-shaped EKC in PARDL form is as follows:

$$\Delta(CO_{2it}) = \beta_0 + \sum^k{}_{i=1} \beta_1 \Delta(CO_{2\,it-1}) + \sum^k{}_{i=0} \beta_2 \Delta(GDP_{it-1}) + \sum^k{}_{i=0} \beta_3 \Delta(GDP_{it-1}^2) + \sum^k{}_{i=1} \beta_4 \Delta(RTEC_{it-1}) + \sum^k{}_{i=0} \beta_5 \Delta(TEC_{it-1}) + \sum^k{}_{i=0} \beta_6 \Delta(FDI_{it-1}) + \sum^k{}_{i=0} \beta_7 \Delta(PG_{it-1}) + \psi(ECM_{it-1}) + \varepsilon i \qquad 6$$

In equation 6 is the final estimated model, where $\beta_0$is intercept and β's are slope coefficients while the 'ψ'is coefficient of speed of adjustment. Equation 6 isa PARDL model which is used to identify the influence of EG and energy consumption on environmental degradation, and also checks the validation of theEKC hypothesis in SAARC economies.

Data and Data Source

This research used the panel data for authentication of the EKC hypothesis from RTEC, TEC, EG, and FDI influence on environmental pollutions. The balance panel data wascollected from 1990 to 2016 to investigate the influence of rising GDP growth of SAARC countries and high intake of RTEC on the degradation of the environment. For panel analysis anddata limitation,the following SAARC countries are selected: Bangladesh, India, Nepal, Pakistan, and Sri Lanka. The empirical data is collected from World Development Indicators (WDI) and Statistical Review of World Energy. The variables like CO_2emissions, GDP, FDI inflow, population growth, and energy consumption data are composed of the well-recognized source as World Development Indicators, whereas the Statistical Review of World Energy is used to get the latest observations of emissions and energy consumption.

EstimationTechnique

Suitable analysis technique provides unbiased and consistent outcomes to advocate the real term economic policy for socio-economic development of the society. There is a list of econometric techniques available for the analysis of panel data.We adopted the techniques according to the study nature and investigate the empirical model to clarify the influence of EG on environmental degradation through validation or rejection of EKC and inverted U-shaped hypothesis in SAARC countries. Initially, the panel unit root test is applied to investigate the behavior of integration. The different stationarity level found among estimated variables suggests that the PARDL test is appropriate and valid for nature of the study. To test the cointegration relationship among variables, the Pedroni and Kao residual tests are adopted. The cross-sectional dependency test is applied to examine the cross-sectional unbiasedness among variables. After clarification of clearance cointegration and long-term affiliation among variables in the defined model, the ARDL technique is adopted for the identification of inverted U-shaped EKC both in the long and short term. The stationarity of all variables was examined separately through two-panel unit root tests Levin et al. (2002) and Lm et al. (2003). Cross-sectional dependency is tested through Pesaran et al. (2001) with the null hypothesis of "variables have a cross-sectional dependency". The long-run panel cointegration relationship is investigated by using the Pedroni (2004) and Kao (1999) tests. Finally, the short run and long coefficient behavior test through the Panel ARDL model (Pesaran et al., 2001).

Results and Discussion

The descriptive statistic of all selected variables is presented in Table 2, which indicates the initial behavior of variables for further empirics. The value of mean, median, maximum, minimum, and standard deviation of all variables show normal behavior with respect to measures of central tendency. The standard deviation is a measure of dispersion which shows that most of the given variables have average standard deviation values except a few. The mean value of CO_2 is 29.01, GDP is 3.45, RTEC is 47.28, TEC is 373.87, FDI IS 0.88 and PG is 1.59. The mean value of all variables islies in between maximum and minimum value. The standard deviation of all given variables is less than the mean value as the standard deviation of CO_2 is 16.2, GDP is 2.13, RTEC is 21.21, TEC is 126.225, FDI is 0.75 and PG is 0.74.

Table 2

Summary Statistics

	CO_2	GDP	GDP^2	RTEC	TEC	FDI	PG

Mean	29.010	3.452	16.448	47.280	373.871	0.880	1.599
Median	26.743	3.338	1.145	55.849	397.378	0.764	1.615
Maximum	67.889	9.003	81.069	74.692	668.238	3.668	2.955
Minimum	10.396	-2.243	0.102	5.051	118.898	-0.098	-0.266
Std. Dev.	16.270	2.135	14.975	21.219	126.255	0.754	0.743
Skewness	0.653	-0.240	1.253	-0.778	-0.375	1.345	-0.170
Kurtosis	2.303	2.890	4.769	2.267	2.689	5.257	2.307

Source: Authors Own

Panel Unit Root Test

The panel unit root test wasused to examine the stationarity of given variables, to avoid spurious analysis. Levin et al. (2002) and Lm et al. (2003) wereused to test the stationarity.The results are given in Table (see Appendix A). Both tests suggested that the CO_2emission has an insignificant p-value at the level but significant at first difference. So, the $CO_2$is stationary at the first difference with the I (1) order of integration. The unit root test value in the case of GDP, GDP square, and PG is significant at a level with an integration order of I(0). While, RTEC, TEC, and FDI variables are first-order stationarityI(1). So, the dependent variable is stationary at the first difference and independent variables show mixed behavior, which suggested that PARDL is an appropriate technique for empirical results.

Cross Section Dependence (CD) Test

The CD of the empirical model wasinvestigated through the Pesaran test.The null hypothesis of the CD test refers to "no cross-section dependence among variables". The result of the CD test is presented in Table (see Appendix B). The CD results highlight that variables in the panel model have no dependency relationship, which causes the spurious and inefficiency in model estimation. According to analysis results of the CD test, the statistic value is 0.97 with a 0.33 probability; this insignificant estimate leads to accepting the null hypothesis and validatesthat variable are serial independence,whilethe problem of serial dependence does not exist in the estimated model.

Results of Panel Co-integration Test

Empirical outcome of panel cointegration tests are given in Table 3. Pedroni and Kao's residual cointegration tests wereapplied for the long-run co-integration relationship, with their null hypothesis being"no cointegration relationship". The analysis value of the Pedroni test significantly rejects the null hypothesis of no cointegration and variables in each model are in cointegration relation. Similarly, the results of the Kao residual cointegration test also show the existence of cointegration among variables. Both tests, the Pedroni and Kao tests, lead the PARDL test for long-term association in the empirical model, to ingestion of RTEC and environmental deprivation through the EKC and inverted U-shape in long term SAARC.

Table 3

Cointegration Estimates of Pedroni and Kao Residual Test

Statistics	Coefficient	W statistic
Panel V statistic	1.74	-0.18
	(0.0021)	(0.0034)
Panel rho statistic	-0.66	-0.77
	(0.7458)	(0.4328)
Panel PP statistic	-1.62	-1.45
	(0.0241)	(0.0015)
Panel ADF statistic	-1.68	-1.57

	(0.0460)	(0.0383)
Group Rho statistics		
Statistics		Coefficient
Group Rho statistic		1.65
		(0.9503)
Group PP statistic		-1.08
		(0.0390)
Group ADF statistic		-1.25
		(0.0246)
Residual Cointegration Test by Kao		
Test		t statistic
ADF		-2.83
		(0.0023)

Source: Authors Own

Panel-ARDL Long Run and Short Run dynamics

The analysis results of long and short-run PARDL are given in Table 4. The long-run analysis highlights that the coefficient value of GDP is 1.83 and significant at 1 percent. A one-unit increase in GDP leads to an increase in the CO_2emissions by 1.83 units. The increasing EG is valuable for the economy, but it is also harmful to the environment and the increasing CO_2 emissions. The estimates show that higher EG is environmentally damaging for SAARC countries, which validates the early stages of the EKC hypothesis.The findings are similar to existing literature Ahmed & Long (2012) and Waqih et al. (2019) who found the existence of early stage of the EKC hypothesis. In addition, the coefficient value of squared GDP is 0.22 and insignificant, so the increase in squared GDP has not damaged the environment in SAARC economies. The estimates are consistent with previous studies by Zarzoso and Maruotti (2011) and Fujii et al. (2018) who provide evidence of the non-existence of inverted U-shaped EKC.

Road transport energy consumption (RTEC) coefficient value is 0.24 and has a significant impact on CO_2emission, this shows that a one-unit increase in RTEC has a quitter point effect on CO_2 emission. The effect of RTEC on environmental degradation is not severe, but its positive integration with CO_2emission shows RTEC is damaging selected countries' environments. This reliance is found in fossil fuel energy and utilized through non-renewable road transport technology has harmful for SAARC countries climate. For RTEC, non-renewable energy is easily accessible and less costly as compared to green energy, which is the foremost common reason for successive use of RTEC in SAARC countries. On the other hand, green energy can be attained through biofuels and solar energy, which is difficult to access, costly, and not affordable for every consumer for their transportation. Existing studies byAzlina et al. (2014) and Shahbaz et al. (2015) found similar results and conclude that the RTEC has a positive influence on CO_2, and road transport is the second largest energy consumer and CO_2producer sector in developing countries (Georgatzi et al., 2020).

The TEC coefficient value is 0.02 which has had a significantly increasing role in CO_2emission in SAARC countries. The TEC is a combination of both renewable and non-renewable energy consumption.The positive association between TEC and CO_2highlights that a major share of SAARC countries' energy consumption comes from non-renewable sources. In TEC manufacturing sector hold a high share and the manufacturing production process is SAARC countries are not adopted green and environment-friendly technology. The study outcomes are consistent with the findings of Waqih et al. (2019), who argued that TEC has a productive role in CO_2emission. This can overcome through innovative and green technology adoption. The estimated value of FDI is positive and statistically significant, therefore, a one-unit rise in FDI increases the CO_2emission by about 1.23 units. Inward FDI is a main source of imports of technological and transportation equipment's from developed to developing countries. Therefore, the positive impact of FDI on CO_2emission indicates that SAARC countries attract non-renewable technology and vehicles that are environmentally harmful. Additionally, the selected countries focused to attract foreign investors to increase their productivity to meet the domestic demand. The selected countries pay the cost of policy negligence regarding green technology in the form of environmental degradation. The outcomes are consistent with the findings of Lau et al. (2014) and Waqih et al. (2019) who argued that FDI performs a positive impact on climate change.

The population growth (PG) coefficient value is 8.32 and significant.The PG has a high impact on CO_2 emission, as one unit increase in PG rise the 8.32 units in CO_2emissions. Therefore, the increasing population put pressure on CO_2 emissions. The selected SAARC countries are highly populated.To fulfill the large population, demand the economy needs to produce more and rise in production with non-renewable energy positively affect CO_2. The estimates are in line with the results of Banarjee and Rahman (2012) who argued that rising population is the foremost reason for environmental deprivation in Bangladesh. The large population requires more road transportation and selected countries are not adoptinggreen technologies and directly raise CO_2 emissions.

The short-term analysis indicates almost the entire series the variables are found to have an insignificant effect of climatic damages. The short-run results of RTEC have no significant impact on environmental damages. Furthermore, the TEC, FDI, GDP, GDP^2, and their lag values show the insignificant effect on CO_2 emission in a short period. It is difficult to measure the macroeconomic indicators and their inter-relationship in the short run. Therefore, the economic impact of RTEC, TEC, FDI, and EG is not significant on climatic factors. The consequence of economic and energy consumption factors highlights climatic variation in the long run. However, the PG has a substantial effect on CO_2emission in SAARC countries. The PG value is 18.05 and significant at 5 percent, which implies that one unit increase in the PG has increased the CO_2 emissions by about 18.05 units. The estimates are in line with the results of Banarjee and Rahman (2012), who argued that rising population is the foremost reason for environmental deprivation in Bangladesh. The large population requires more road transportation and selected countries are not adoptinggreen technologies, which directly raisesCO_2emissions.

Furthermore, the long-run analysis has not proved the inverted U-shaped hypothesis of the EKC in SAARC nations. In short-run analysis, both EG and its square are found insignificant and do not influence CO_2 emissions. It is concluded that the EG detects the early stage of the EKC hypothesis, while its doubled effect is failed to detect the inverted U-shaped hypothesis of EKC in SAARC economies. The overall findings of Panel-ARDL show that the EKC early stages hypothesis is confirmed, while the inverted U-shaped hypothesis is not proved in the long run. The early stages of EKC are evident of the positive influence of EG on climatic vulnerability in SAARC countries. However, the squared effect of EG is unable to reflect the reduction in the releases of CO_2 emissions. The short-run analysis shows that there is no indication of early stages of EKC and inverted U-shaped hypothesis validation. The ECM(-1) coefficient is significantly negative at one percent, therefore the given model has a speed of adjustment of any disequilibrium. The ECM (-1) coefficient is negatively significant, which is evidence of the Co-integration relationship and convergent behavior of the estimated model.

Table 4

Long Run and Short Run Panel-ARDL

Variable	Coefficient	Std. Error	Prob.*
GDP	1.83	0.65	0.0041***
GDP^2	0.22	0.08	0.1953
RTEC	0.24	0.12	0.0427**
TEC	0.02	0.01	0.0423**
FDI	1.23	0.54	0.0273**
PG	8.32	2.17	0.0003***
Short Run Coefficients			
Variable	Coefficient	Std. Error	Prob.*
D(CO_2(-1))	-0.03	0.19	0.8568
D(GDP)	-0.42	0.80	0.5971
D(GDP(-1))	-0.35	0.31	0.2567
D(GDP^2)	-0.13	0.10	0.1864
D(GDP^2(-1))	-0.10	0.06	0.1093
D(RTEC)	-0.28	0.67	0.6807
D(RTEC(-1))	-0.67	0.52	0.2094
D(TEC)	-0.01	0.030	0.8432
D(TEC(-1))	-0.12	0.09	0.1764
D(FDI)	-1.28	0.96	0.1873
D(FDI(-1))	-0.65	0.43	0.1376
D(PG)	18.05	8.98	0.0494**
D(PG(-1))	18.99	12.42	0.132
C	-1.10	6.06	0.8571
ECM(-1)	-.35	0.19	0.0677*

*, **, *** represents the level of significance at 10, 5, and 1 percent, respectively.

Source: Authors Own

Histogram Normality Test

The histogram normality test wasapplied based on cross-sectional JarqueBera (JB). The JB test is a good fit for symmetric data, and distributions that have a long tail. The results of the JB test are given in table (see Appendix C) and enlighten the findings of the histogram normality test for each cross-section. The cross-sections JB test probability value is 0.25, which indicates that the selected cross-section is normally distributed. While the second cross-section has a 0.91 JB test value with a probability of 0.63. Similarly, the cross-sections 3, 4, and 5 are also insignificant at 0.87, 0.26, and 0.35, respectively. So, all five cross-sections show the evidence of normality of the series.

Individual Country Base Analysis

The EKC hypothesis examined both in the short and long run for each country separately. The ARDL is applied to all selected SAARC countries separately to investigate the effects of energy consumption on environmental performance. The dependency relationship is measured both in the long-run and short-run effect ofRTEC, TEC, FDI, PG, GDP, and GDP^2 on CO_2 emission. The results of ARDL country-wise analysis of the EKC inverted U-shaped hypothesis are presented in table 5. The bound test is used to detect the cointegration association among estimated variables. The analysis value of F-statistics is greater than the critical values of upper bound, which is evidence of the long-run Co-integration relationship in case SAARC countries, separately. The outcomes are consistent with the findings of Narayan (2005).

Table 5

Country-based Bound Test Results

Bangladesh			India		Nepal		Pakistan		Sri Lanka	
F-statistic	**Value**	**K**	**Value**	**K**	**Value**	**K**	**Value**	**K**	**Value**	**K**
	5	6	7.2	6	7	6	7.46	6	5.76	6
Critical Value Bounds										
Sig.	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound
10%	2.37	2.79	3.15	4.23	2.87	3.14	3.18	4.54	2.12	3.23
5%	3.17	4.14	3.56	4.65	3.49	4.55	3.98	4.76	2.45	3.61
2.5%	3.21	4.67	3.87	4.97	4.71	5.82	4.85	5.47	2.75	3.99

Source: Authors Own Calculation

Long run ARDL Country Analysis

The long-run country-based ARDL analysis results are shown in Table 6. The long-run analysis of Bangladesh shows there is no evidence of the existence of the environmental EKC hypothesis. The estimated value LGDP value is 0.123 and significant, which showsthat a one percent increase in GDP has positively increased the CO_2 by 0.123 percent. However, squared GDP has no contribution towards CO_2 emissions, and there is no evidence of EKC found in the long-run in Bangladesh. Both the RTEC and TEC have a positive influence on CO_2 emissions, while FDI has an insignificant impact on CO_2emissions. Bangladesh is one the most populated countries, so the coefficient of PG affects the CO_2 emission positively.In the case of India, the GDP performs a significantly positive impact on CO_2 emission with a coefficient value of 0.49, and the increasing GDP has damaging the environment. However, the squared GDP has an insignificant effect in the long-run. The investigated results of GDP and GDP^2 show there is no evidence of existence of EKC in India. Additionally, the RTEC, TEC, FDI, and PG have a significant influence on environmental deprivation in long run in India.

In the case of Nepal, the ARDL results show there is no evidence of the existence of long-run EKC. The coefficient value of GDP is negative and significant, and highlights that the increasing GDP of Nepal presents a decreasing role in CO_2 emission. The results of GDP^2 shows the increasingdamaging the climate and not fulfilled the hypothesis of EKC in Nepal. However, TEC and FDI both have a positive and significant impact on CO_2 emission, while the RTEC has a negative influence on climate emissions in Nepal. Nepal has a very small population, and the estimated value shows that PG does not haveany significant impact on climate degradation in long run.The long-run analysis of Pakistan shows a positive and significant effect of GDP on CO_2 emission; therefore, the rising GDP causes environmental depletion in Pakistan. The analysis value of GDP^2 has no significant relation with CO_2 emissions in long run. There is no evidence of an inverted U-shaped EKC hypothesis in Pakistan. Additionality, RTEC, TEC, FDI, and PG show positive and significant impacts on climate damages.This shows that all such indicators are harmful to the environment in Pakistan. The long-run findings of Sri Lanka are showing that the GDP and its square have not shown significant effects on CO_2 emissions. Whereas RTEC and FDI have not influenced environmental degradation in long run. However, TEC and PG are found negative and significant on environmental degradation in long run in Sri Lanka.

Table6

Long Run Estimates

Countries	**Bangladesh**	**India**	**Nepal**	**Pakistan**	**Sri Lanka**
Variable	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
LGDP	0.123 (0.018)**	0.4984 (0.0038)***	-2.3859 (0.0041)***	0.3218 (0.0048)***	-0.3456 (0.2986)

$LGDP^2$	0.031 (0.589)	0.0949 (0.3324)	0.9935 (0.0080)***	0.0626 (0.5597)	0.1936 (0.0332)**
LRTEC	0.041 (0.048)*	3.6523 (0.0441)	-0.5128 (0.0177)**	3.6860 (0.0493)**	-0.0003 (0.0588)*
LTEC	0.367 (0.041)	0.9159 (0.0443)*	3.8590 (0.0020)***	2.5190 (0.0406)	-0.6267 (0.0236)**
LFDI	-0.014 (0.486)	0.1474 (0.0466)	0.1789) (0.0028)***	0.0820 (0.0357)	-0.1145 (0.1872)
LPG	0.156 (0.021)	0.0082 (0.0099)	0.0558 (0.4861)	0.1818 (0.0207)	-0.1211 (0.0324)**
C	4.541 (0.000)***	11.852 (0.3917)	-17.166 (0.0083)***	3.627 (0.5883)	7.6949 (0.0000)***

*, **, *** represents the level of significance at 10, 5, and 1 percent, respectively.

Source: Authors Own Analysis

Short run ARDL Country Analysis

The empirical results of short run country based coefficient and ECM(-1) are reported in Table 7. The short-run results of the ARDL test show that GDP (-1) has a positive influence on CO^2 emission in Bangladesh. The PG has a positive influence, whereas the lag of PG has a negative influence on climate change. In Bangladesh, the RTEC, TEC, and FDI have insignificant relation with CO_2 emissions. The short-run outcomes showed no evidence of an inverted EKC hypothesis in Bangladesh. The ECM (-1) has a significant coefficient and negative, which shows the model has convergent behavior.In the case of India, the short-run GDP findings have confirmation of environmental damages in India. The lag coefficient of GDP is significantly positive and the previous year's GDP is reason for the rising current CO_2 emission. Moreover, the previous year's FDI and PG have an increasing impact on CO_2 emission in the short run. The estimated value of ECM (-1) is evidence of the cointegration and convergence behavior of the estimated model.According to the short-run findings of Nepal, the previous year's increased CO_2 emissions are harmful to the climate. In this regard, current and previous year GDP has increased the secretions of CO_2 emission and proved the early stages of EKC in the short run. In the current year, RTEC and TEC have reduced environmental degradation. The emission of CO_2 is increased due to the previous year's RTEC. The FDI has reduced the emissions of CO_2 in the short run in Nepal because of imports of green technology. The ECM(-1) coefficient indicates the cointegration and convergent behavior of the estimated model.

The short-run findings of Pakistan also have not shown the early stages of EKC evidence. Both the GDP and GDP squared have not shown any influence on CO_2 emissions in the short run. The RTEC has a significant effect on the CO_2emissions in the short run in Pakistan. While, the TEC, FDI, and PG have not shown influence on environmental degradation in Pakistan. In Sri Lanka, the short-run findings of GDP and GDP squared have not proved the early stages of the EKC hypothesis. Moreover, RTEC, TEC, FDI, and PG are found insignificant and have no effect on environmental degradation in the short run. The ECM(-1) coefficient shows a cointegration relationship and converging behavior towards equilibrium.

Table7

Short Run Estimates

Countries	**Bangladesh**	**India**	**Nepal**	**Pakistan**	**Sri Lanka**
Variable	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
$L(CO_2(-1))$	0.031	0.490	1.840	0.455	-0.032

	(0.872)	(0.1342)	(0.0002)***	(0.1791)	(0.8980)
L(GDP)	0.040	0.023	1.229	-0.062	-0.157
	(0.106)	(0.7062)	(0.0130)**	(0.4299)	(0.4415)
L(GDP(-1))	0.079	0.113	0.775	-0.069	-0.199
	(0.001)***	(0.0223)**	(0.0914)*	(0.0123)**	(0.0480)**
L(GDP^2)	0.061	-0.009	0.527	-0.003	0.109
	(0.152)	(0.6944)	(0.0718)**	(0.8382)	(0.2569)
L(GDP^2(-1))	-0.030	-0.038	0.307	0.037	0.090
	(0.265)	(0.0464)**	(0.1411)	(0.0228)**	(0.0022)***
L(RTEC)	-1.953	-1.113	-1.456	1.831	0.594
	(0.104)	(0.5874)	(0.0008)***	(0.0837)*	(0.2445)
L(RTEC(-1))	1.913	-0.745	1.886	0.177	-0.594
	(0.046)**	(0.0327)**	(0.0026)***	(0.8674)	(0.1634)
L(TEC)	0.247	-0.004	-2.941	0.297	-1.270
	(0.741)	(0.9969)	(0.0245)**	(0.7813)	(0.0268)**
L(TEC(-1))	-0.603	0.470	-0.301	-1.670	0.623
	(0.470)	(0.0221)**	(0.6715)	(0.0191)**	(0.5289)
L(FDI)	0.004	0.014	-0.131	-0.022	-0.067
	(0.795)	(0.5369)	(0.0112)**	(0.5123)	(0.1762)
L(FDI(-1))	-0.018	0.060	-0.018	-0.022	-0.050
	(0.147)	(0.0449)**	(0.4692)	(0.4843)	(0.3948)
L(PG)	1.244	-2.738	-0.012	0.844	-0.043
	(0.021)**	(0.0410)**	(0.8365)	(0.2493)	(0.5912)
L(PG(-1))	-1.093	2.734	-0.034	-0.745	-0.081
	(0.033)**	(0.0354)**	(0.5879)	(0.2335)	(0.1701)
C	4.396	6.034	14.428	1.976	7.948
	(0.010)**	(0.1913)	(0.0204)**	(0.4987)	(0.0030)***
ECM(-1)	-1.279	-0.882	-0.981	-0.7165	-0.0040
	(0.0065)***	(0.0070)***	(0.0110)**	(0.0399)**	(0.0014)***

*, **, *** represents the level of significance at 10, 5, and 1 percent, respectively.

Source: Authors Own Analysis

Conclusion and PolicySuggestions

The global temperature is continuing to rise, there is high vitiation, and extreme climate events have occurred inlast decades. The SAARC countries are the most climate-vulnerable countries on the globe. The purpose of this research is to examine the influential role of non-renewable energy consumption on climatic vulnerability in selected SAARC countries. In addition, this research investigates testimony of the EKC theory. The data screening tests, and diagnostic analysis suggested that the panel ARDL model is more suitable and reliable for quantitative analysis. The analysis outcomes of the unit root test and cointegration tests ostensibly highlight the existence of a long-run relationship among variables. The panel analysis shows that there is no presence of the initial stage EKC hypothesis and that GDP growth has a positive influence on climate depletion. Additionally, the growth square results indicate that no existence of inverted EKC theory in SAARC countries. The results of energy consumption found a positive and increasing factor of CO_2 emission. The outcomes of FDI and population growth are evident of harmful impact on environment degradation in SAARC countries. The ECM coefficient claimed high speed of adjustment and convergent behavior of the estimated model, which shows the alarming climatic situation in SAARC countries. For further justification to draw suitable policy suggestion, this study opted for individual country base analysis for selected countries. The country-based analysis highlights the presence of early stage of EKC hypothesis in Bangladesh, Pakistan, and India in the long run, but no evidence found in Nepal and Sri Lanka. Furthermore, the country-based analysis does not indicate the existence of the inverted U-shaped EKC hypothesis in the long run. The time series estimates concluded that energy consumption is responsible for environmental damages except in Nepal. Environmental degradation is increasing because of energy consumption in India, Pakistan, and Bangladesh in long run. The overall results of the country-based analysis are similar to the Panel ARDL findings.

Based on empirical results, it is suggested that SAARC countries required comprehensive environmental protection policies. The following policies are suggested based on analysis results:

1) The SAARC countries should be focused on development and adoption on green technology in road transportation.
2) The SAARC Governments must focusonan alternative shifts in their production units from non-renewable technology to renewable technology.
3) It is recommended that the selected countries should impose the carbon taxes to overcome the non-renewal energy consumption.
4) For road transport energy consumption, an alternative shift is required in the form of renewable energy resources such as hydrogen and electric vehicles.Electric vehicles should be used to reduce the consumption of diesel,petrol,coal, and other fusel fuels.
5) The selected countries should introduce sophisticated public transport to reduce private road transport consumption.
6) A suitable policy is needed for FDI inflow,to reduce the non-renewable technology imports.
7) The population control programs are required to reduce population pressure which has increasing effect on consumption on road transport, causing vehicle congestions, noise, and air pollution.

Reference

Abas, N., Kalair, A., Khan, N., &Kalair, A. R. (2017). Review of GHG emissions in Pakistan compared to SAARC countries. Renewable and Sustainable Energy Reviews, 80, 990-1016.https://doi.org/10.1016/j.rser.2017.04.022

Ahmad, N., Iqbal, A., &Mahmood, H. (2013). CO_2 Emission, population and industrial growth linkages in selected South Asian countries: A co-integration analysis. World Applied Sciences Journal, 21(4), 615-622. https://DOI.org/10.5829/idosi.wasj.2013.21.4.1989

Ahmed, K., & Long, W. (2012). Environmental Kuznets curve and Pakistan: an empirical analysis. Procedia Economics and Finance, 1, 4-13.https://doi.org/10.1016/S2212-5671(12)00003-2

Al-Mulali, U., & Tang, C. F. (2013). Investigating the validity of pollution haven hypothesis in the gulf cooperation council (GCC) countries. Energy Policy, 60, 813-819. https://doi.org/10.1016/j.enpol.2013.05.055

Azlina, A. A., Law, S. H., & Mustapha, N. H. N. (2014). Dynamic linkages among transport energy consumption, income and CO_2 emission in Malaysia. Energy Policy, 73, 598-606.https://doi.org/10.1016/j.enpol.2014.05.046

Banerjee, P. K., & Rahman, M. (2012). Some determinants of carbon dioxide emissions in Bangladesh. International Journal of Green Economics, 6(2), 205-215.https://doi.org/10.1504/IJGE.2012.050345

Batur, İ., Bayram, I. S., &Koc, M. (2019). Impact assessment of supply-side and demand-side policies on energy consumption and CO_2 emissions from urban passenger transportation: The case of Istanbul. Journal of Cleaner Production, 219, 391-410.https://doi.org/10.1016/j.jclepro.2019.02.064

Chandran, V. G. R., & Tang, C. F. (2013). The impacts of transport energy consumption, foreign direct investment and income on CO_2 emissions in ASEAN-5 economies. Renewable and Sustainable Energy Reviews, 24, 445-453. https://doi.org/10.1016/j.rser.2013.03.054

Farhani, S., Chaibi, A., &Rault, C. (2014). CO_2 emissions, output, energy consumption, and trade in Tunisia. Economic Modelling, 38, 426-434. https://doi.org/10.1016/j.econmod.2014.01.025

Fuglestvedt, J. S., Shine, K. P., Berntsen, T., Cook, J., Lee, D. S., Stenke, A., ...&Waitz, I. A. (2010). Transport impacts on atmosphere and climate: Metrics. Atmospheric Environment, 44(37), 4648-4677. https://doi.org/10.1016/j.atmosenv.2009.04.044

Fujii, H., Iwata, K., Chapman, A., Kagawa, S., &Managi, S. (2018). An analysis of urban environmental Kuznets curve of CO_2 emissions: Empirical analysis of 276 global metropolitan areas. Applied energy, 228, 1561-1568. https://doi.org/10.1016/j.apenergy.2018.06.158

Georgatzi, V. V., Stamboulis, Y., &Vetsikas, A. (2020). Examining the determinants of CO_2 emissions caused by the transport sector: Empirical evidence from 12 European countries. Economic Analysis and Policy, 65, 11-20. https://doi.org/10.1016/j.eap.2019.11.003

Giannakis, E., Serghides, D., Dimitriou, S., &Zittis, G. (2020). Land transport CO_2 emissions and climate change: evidence from Cyprus. International Journal of Sustainable Energy, 1-14. https://doi.org/10.1080/14786451.2020.1743704

Girod, B., van Vuuren, D. P., Grahn, M., Kitous, A., Kim, S. H., & Kyle, P. (2013). Climate impact of transportation A model comparison. Climatic change, 118(3-4), 595-608. https://doi.org/10.1007/s10584-012-0663-6

Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American free trade agreement (No. w3914). National Bureau of Economic Research.

He, D., Liu, H., He, K., Meng, F., Jiang, Y., Wang, M., ...& Wang, Q. (2013). Energy use of, and CO_2 emissions from China's urban passenger transportation sector–Carbon mitigation scenarios upon the transportation mode choices. Transportation Research Part A: Policy and Practice, 53, 53-67. https://doi.org/10.1016/j.tra.2013.06.004

Jebli, M. B., & Youssef, S. B. (2015). The environmental Kuznets curve, economic growth, renewable and non-renewable energy, and trade in Tunisia. Renewable and Sustainable Energy Reviews, 47, 173-185. https://doi.org/10.1016/j.rser.2015.02.049

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. Journal of econometrics, 90(1), 1-44. https://doi.org/10.1016/S0304-4076(98)00023-2

Kao, C., Chiang, M. H., & Chen, B. (1999). International R&D spillovers: an application of estimation and inference in panel cointegration. Oxford Bulletin of Economics and statistics, 61(S1), 691-709. https://doi.org/10.1111/1468-0084.0610s1691

Khan, M. A., Khan, M. Z., Zaman, K., Khan, M. M., &Zahoor, H. (2013). Retracted: Causal links between greenhouse gas emissions, economic growth and energy consumption in Pakistan: A fatal disorder of society. https://doi.org/10.1016/j.rser.2013.04.002

Kuznets, S. (1955). Economic Growth and Income Inequality. The American economic review, 1-28.

Lau, L. S., Choong, C. K., &Eng, Y. K. (2014). Investigation of the environmental Kuznets curve for carbon emissions in Malaysia: do foreign direct investment and trade matter? Energy Policy, 68, 490-497. https://doi.org/10.1016/j.enpol.2014.01.002

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. Journal of econometrics, 108(1), 1-24. https://doi.org/10.1016/S0304-4076(01)00098-7

Lu, Q., Chai, J., Wang, S., Zhang, Z. G., & Sun, X. C. (2020). Potential energy conservation and CO_2 emissions reduction related to China's road transportation. Journal of Cleaner Production, 245, 118892. https://doi.org/10.1016/j.jclepro.2019.118892

Menyah, K., &Wolde-Rufael, Y. (2010). Energy consumption, pollutant emissions and economic growth in South Africa. Energy economics, 32(6), 1374-1382. https://doi.org/10.1016/j.eneco.2010.08.002

Mulali, U., Weng-Wai, C., Sheau-Ting, L., & Mohammed, A. H. (2015). Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. Ecological Indicators, 48, 315-323. https://doi.org/10.1016/j.ecolind.2014.08.029

Mustapa, S. I., &Bekhet, H. A. (2016). Analysis o CO_2 emissions reduction in the Malaysian transportation sector: An optimisation approach. Energy Policy, 89, 171-183. https://doi.org/10.1016/j.enpol.2015.11.016

Nassani, A. A., Aldakhil, A. M., Abro, M. M. Q., &Zaman, K. (2017). Environmental Kuznets curve among BRICS countries: spot lightening finance, transport, energy and growth factors. Journal of Cleaner Production, 154, 474-487. https://doi.org/10.1016/j.jclepro.2017.04.025

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxford Bulletin of Economics and statistics, 61(S1), 653-670.

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric theory, 597-625. https://doi.org/10.1017/S0266466604203073

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. Journal of applied econometrics, 16(3), 289-326.

Profillidis, V. A., Botzoris, G. N., &Galanis, A. T. (2014). Environmental effects and externalities from the transport sector and sustainable transportation planning-a review. International Journal of Energy Economics and Policy, 4(4), 647.

Rehman, M. U., & Rashid, M. (2017). Energy consumption to environmental degradation, the growth appetite in SAARC nations. Renewable Energy, 111, 284-294. https://doi.org/10.1016/j.renene.2017.03.100

Romero M. P., Cruz, L., &Barata, E. (2017). Testing the transport energy-environmental Kuznets curve hypothesis in the EU27 countries. Energy Economics, 62, 257-269. https://doi.org/10.1016/j.eneco.2017.01.003

Saboori, B., &Sulaiman, J. (2013). CO_2 emissions, energy consumption and economic growth in Association of Southeast Asian Nations (ASEAN) countries: A cointegration approach. Energy, 55, 813-822. https://doi.org/10.1016/j.energy.2013.04.038

Saboori, B., Sapri, M., & bin Baba, M. (2014). Economic growth, energy consumption and CO_2 emissions in OECD (Organization for Economic Co-operation and Development)'s transport sector: A fully modified bi-directional relationship approach. Energy, 66, 150-161. https://doi.org/10.1016/j.energy.2013.12.048

Shahbaz, M., Khraief, N., &Jemaa, M. M. B. (2015). On the causal nexus of road transport CO_2 emissions and macroeconomic variables in Tunisia: Evidence from combined cointegration tests. Renewable and Sustainable Energy Reviews, 51, 89-100. https://doi.org/10.1016/j.rser.2015.06.014

Solís, J. C., &Sheinbaum, C. (2013). Energy consumption and greenhouse gas emission trends in Mexican road transport. Energy for Sustainable Development, 17(3), 280-287. https://doi.org/10.1016/j.esd.2012.12.001

Solow, R.M. (1956). A Contribution to the Theory of Economic Growth. Quarterly Journal of Economics. Oxford Journals. 70 (1): 65–94.

Talbi, B. (2017) CO_2. emissions reduction in road transport sector in Tunisia. Renewable and Sustainable Energy Reviews, 69, 232-238. https://doi.org/10.1016/j.rser.2016.11.208

Tang, C. F., & Tan, B. W. (2015). The impact of energy consumption, income and foreign direct investment on carbon dioxide emissions in Vietnam. Energy, 79, 447-454. https://doi.org/10.1016/j.energy.2014.11.033

Török, Á. (2017). Comparative analysis between the theories of road transport safety and emission. Transport, 32(2), 192-197. https://doi.org/10.3846/16484142.2015.1062798

Uddin, M. M. M., &Wadud, M. A. (2014). CARBON emission and economic growth of SAARC countries: a vector autoregressive (VAR) analysis. Global Journal of Human-Social Science Research, 14(3).

Uherek, E., Halenka, T., Borken-Kleefeld, J., Balkanski, Y., Berntsen, T., Borrego, C., ...&Melas, D. (2010). Transport impacts on atmosphere and climate: Land transport. Atmospheric environment, 44(37), 4772-4816. https://doi.org/10.1016/j.atmosenv.2010.01.002

Waqih, M. A. U., Bhutto, N. A., Ghumro, N. H., Kumar, S., & Salam, M. A. (2019). Rising environmental degradation and impact of foreign direct investment: An empirical evidence from SAARC region. Journal of environmental management, 243, 472-480. https://doi.org/10.1016/j.jenvman.2019.05.001

Xie, R., Fang, J., & Liu, C. (2016). Impact and spatial spillover effect of transport infrastructure on urban environment. Energy Procedia, 104, 227-232. https://doi.org/10.1016/j.egypro.2016.12.039

Yang, W., Li, T., & Cao, X. (2015). Examining the impacts of socio-economic factors, urban form and transportation development on CO2 emissions from transportation in China: a panel data analysis of China's provinces. Habitat International, 49, 212-220. https://doi.org/10.1016/j.habitatint.2015.05.030

Zaman, K., &Abd-el Moemen, M. (2017). Energy consumption, carbon dioxide emissions and economic development: evaluating alternative and plausible environmental hypothesis for sustainable growth. Renewable and Sustainable Energy Reviews, 74, 1119-1130. https://doi.org/10.1016/j.rser.2017.02.072

Appendices

A

Panel Unit Root Test

Variables	**Levin-Lin-Chu test**		**IPS W-stat test**		**Integration Orders**
	At Level	At Difference	At Level	At Difference	
CO_2	-0.51	-5.91	0.44	-6.62	I(1)
	(0.5935)	(0.0000)	(0.9996)	(0.0000)	
GDP	-2.80	-7.61	-3.10	-8.59	I(0)
	(0.0025)	(0.0000)	(0.0010)	(0.0000)	
GDP^2	-1.94	-7.70	-2.76	-7.92	I(0)
	(0.0259)	(0.0000)	(0.0028)	(0.0000)	
TRER	-3.61	-2.40	-1.35	-3.89	I(1)
	(0.0002)	(0.0083)	(0.0874)	(0.0001)	
TER	-4.02	-4.72	-4.88	-5.15	I(1)
	(0.9999)	(0.0000)	(0.9999)	(0.0000)	
FDI	-1.80	-4.34	-2.77	-6.20	I(0)
	(0.0360)	(0.0000)	(0.0028)	(0.0000)	
PG	-1.83	-8.45	-0.98	-9.59	I(1)
	(0.0339)	(0.0000)	(0.1640)	(0.0000)	

Source: Authors Own

B

Cross-Section Dependence

Test	Statistic	Prob.
Pesaran CD	0.97	0.3315

Source: Authors Own

C

Histogram Normality Test

Cross Sections	Jarque-Bera	Prob.	Cross Sections	Jarque-Bera	Prob.
1	2.70	0.2597	2	0.91	0.6335
3	0.26	0.8796	4	2.68	0.2623
5	2.07	0.3557	-	-	-

Source: Authors Own