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RESEARCH ARTICLE

Dynamic relationship among economic growth, energy, trade openness, tourism, and environmental degradation: fresh global evidence

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Abstract

This study analyzes the impact of economic growth, energy consumption, trade openness, and tourism on environmental degradation measured by CO_2 emissions by using annual data of 112 countries for the period 1995 to 2017. Furthermore, the study also analyzes the relationship of the variables as mentioned above in four income and five regional groups of the world. The findings confirm the existence of environmental Kuznets curve (EKC), and level of income (turning point) is also determined, which helps in the improvement of the environmental quality of selected sample countries. The results of the overall sample show that economic growth, use of energy, and tourism are proved to be harmful to the environment, whereas the result of trade openness is not statistically robust. Results of sub-samples are mixed. Findings of this study highlight some essential steps which must be taken by the government and international environmental agencies for the protection of the environment through efficient utilization of energy and sustainable tourism.

Keywords EKC hypothesis · Energy consumption · Trade · Tourism

Introduction

Due to the increased emission levels of greenhouse gases (GHG), global warming has become a significant risk to the global environment and living organisms. These greenhouse gases include carbon dioxide (CO_2), methane, and nitrous oxide. The amount of carbon dioxide in the atmosphere was 90% while that of methane and nitrous oxide was 9% and 1%, respectively (IEA 2017). Different human activities are responsible for these increased emissions, and one of the main consequences is extreme weather. The average temperature has been increasing, which results in changing the pattern of rain and melting the snow and glaciers, which in turn raises the water level in the sea and oceans. All these changes badly affect the environment and human life (Boutabba 2014).

The relationship between income and any type of pollution is studied under the environmental Kuznets curve (EKC) hypothesis. It states that the relationship between growth and emissions is quadratic, which means that in early phases of growth, CO_2 emission increases, but after reaching some threshold, it starts decreasing. The reason behind this decrease is that due to the increase in income, individuals started demanding a cleaner environment. Thus, it can be said that economic progress solves the problem of environmental degradation (Appiah 2018; Mercan and Karakaya 2015; Soytas et al. 2007).

Energy is considered a vital determinant of economic growth but excessive use of the energy to sustain economic growth also harms the environment by raising the amount of different GHGs in the air. According to IEA (2017), the global energy demand for production had increased 150% from 1971

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to 2015, while the total amount of CO_2 in the atmosphere was increased by 40% in 2016 compared with 1800 with an average growth of 2 ppm/year in the last decade which severely affected the environment. The share of the non-renewable fuel sources in the world total energy supply remained unchanged for the last many years and accounting for 82% of total primary energy supply (TPES) until 2015, even though renewable energy sources have grown considerably consisting of 34% of total energy supply in the world.

Over time, countries are moving towards trade liberalization, which also affects the environment through raising emissions. Free trade has three types of effect on the environment, i.e., scale, technique, and composition effect. Environmental quality deteriorates due to expansion in the economic activities and demands for exported products whose production harms the environment or for imported products whose use can damage the environment. It is considered the scale effect of trade. Thus, the quality of the environment deteriorates as the scale of trade expands. On the other hand, composition effect of free trade on the environment can be either good or bad. Composition of products (dirty or cleaner) in the gross domestic product (GDP) determines the scale of the positive and negative effect of free trade on the environment. Due to free trade, countries can use advanced, better, and cleaner technologies that helped reduced pollution and improves environmental quality whereas free trade can influence environment negatively if free trade helped in moving polluting industries from high-income to low-income nations.

Trade's composition effect is similar to the concept of "pollution heaven hypothesis" (PHH), meaning that the countries having strict environmental laws shift their industries to nations having lenient environmental laws. As for technique effect, the impact on the environment is positive as the import of the cleaner techniques of production can reduce the pollution level in the country. Technique effect of trade also referred to as technology transfer view which states that free trade enhances mobility of advanced technologies which are suitable for the environment, and this mobility can improve the environment in the long run (Keho 2016; Kukla-Gryz 2009).

International tourism is the third top export category worldwide after chemicals and fuels and amounts 7% of world export of goods and services and has become the fastest-growing economic sector of the world. The emergence of new destinations and continued expansion in the tourism sector has brought the total volume of this sector up to 1.4 trillion US dollars in 2016 (UNWTO 2017). Importance of tourism for economic development cannot be denied, but this enormous growth of the tourism sector has also negatively impacted the destination's environment. The increased use of energy as a direct consequence of increased tourism is resulting in environmental degradation. For example, energy is needed for different purposes such as traveling and construction of infrastructure like hotels, roads, etc. that adversely impact the quality of the environment (Katircioglu 2014). These constructions affect the environment and life of all living things in a negative way (Apergis and Ozturk 2015), and these impacts are most probable to occur in those countries which welcome the tourists from other countries (Butler 1991).

Considering the adverse consequences of the CO_2 emissions, previous researches have studied numerous determinants of pollution and environmental degradation by combining one or two independent variables and by using different time periods, estimation techniques, and sample countries. The present study investigates the effect of GDP, trade liberalization, energy use, and tourism on CO_2 emissions. To the best of our knowledge, only two studies have been conducted to explore the impact of all variables mentioned above on the environment. Dogan and Aslan (2017) investigated the effect of trade liberalization, growth, tourism, and the use of energy on emissions by covering the data from 1995 to 2010 for OECD countries. Their study is criticized on different grounds such as they only focus on OECD countries which are 27 and their contribution in the world CO_2 emission was only 36% while non-OECD countries contributed 60% in 2015 (IEA 2017). According to the report of WTO (2017), the share of less developed countries in the world trade was 41% in 2016. On a regional basis, Europe, Asia, and North America are three important regions which performed well in trade. Concerning tourism, growth in the number of tourists who traveled to Europe is only 2% while the growth of tourist traveled to Asia and Pacific, Americas, Sub-Saharan Africa, and South Asia was 9%, 3%, 10%, and 8% respectively (UNWTO 2017). The second study was conducted by Ben Jebli et al. (2014) who analyzed the relation among GDP, tourism, renewable energy consumption, trade, and CO_2 emissions from 1995 to 2010 using a sample of 22 nations of Central and South America. Their research was also limited in terms of selection of sample and study period. The present study is more comprehensive because it used not only an extended study period from 1995 to 2017 but also data of 112 countries.

Moreover, the present study also studied the relationship between the variables in low-income, lower-middle-income, upper-middle-income, and high-income countries. Further, the current study also examined the relationship of the variable in the five regions, i.e., East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, and Sub-Saharan Africa. This study is essential because it not only explained the role of GDP, trade liberalization, energy use, and tourism on CO_2 emissions at world level but also at different income and geographical regions. The finding of this study will help policymakers and concerned parties to understand the role of these variables in different regions and income groups.

Literature review

Among recent literature, Danish and Wang (2018) argued that the tourism sector significantly encourages economic growth; however, it also negatively impacts the environment in BRICS economies between 1995 and 2014. Moreover, they proved the existence of EKC in BRICS economies. The similar negative impact of tourism on the environment quality is reported for Egypt by Sghaier et al. (2019). However, they also reported a positive impact of tourism on the quality of environment for Tunisia. They suggested an inverted U-shaped relationship between CO_2 emissions and level of income for Morocco and Egypt and a U-shape relationship for Tunisia. For a panel of top ten induced countries from 1995 to 2016, the presence of EKC is confirmed by Shaheen et al. (2019). Furthermore, their study also supported the feedback hypothesis, i.e., the link between tourism and energy demand and CO_2 emissions and international tourism departure.

Qureshi et al. (2017) revealed that inbound tourism has a positive effect on energy demand, per capita income, trade, and CO_2 emissions while tourism receipts increase GHG emissions and CO_2 emissions. Whereas, in economic growth and trade openness, both increase inbound tourism. The study further confirmed the EKC hypothesis for CO_2 and GHG emissions, respectively. Brahmasrene and Lee (2017) proved the long-run impact of CO2 emissions, tourism, industrialization, urbanization, globalization, and economic growth in Southeast Asian countries. Doğan (2017) concluded that renewable energy mitigates pollution, whereas real GDP and tourism contribute to the level of emissions for the top 10 most visited countries. For a panel of 11 transition economies from 1995 to 2013, Zaman et al. (2017) showed that per capita income escalates CO_2, which deteriorates the natural environment of these countries. Furthermore, they found that international tourism receipts and international tourism expenditures for travel items are associated with the intensifying CO_2 emission and per capita income in the region.

Empirical studies investigating the factors influencing environmental degradation have addressed different economics, and political factors, e.g., GDP, trade openness, economic liberalization, types and use of energy, tourism, economy and industrial growth, and financial development under different methodological settings, and have reported diverse findings.

The following table has summarized the relevant empirical literature in the context of different countries, study periods, variables, and econometric techniques.

The literature reviewed revealed that only two studies (Dogan et al. 2017; Ben Jebli et al. 2014) had examined the effect of GDP, trade liberalization, energy use, and tourism on CO_2 emissions (Table 1). All other studies analyzed the effect of either one or two of these factors on environmental degradation by using the different study periods, estimation techniques, and sample countries. Therefore, it is desired to conduct a study that used not only a large sample and an extended time period but also different econometric specifications to check the robustness of the results. The current study is aiming to fulfill this gap by using the data from 112 nations and an extended study period, i.e., from 1995 to 2017 (22 years).

Data and methodology

The current study used yearly data of all variables from 1995 to 2017 for the sample of 112 countries. These countries were further divided into groups based on regions and income. World Bank divides countries into seven regions, namely, East Asia and Pacific (EAP), Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), Middle East and North Africa (MENA), North America (NA), South Asia (SA), and Sub-Saharan Africa (SSA). North America and South Asia were excluded from the sample because the number of countries in these two regions is less than the variables. On an income basis, countries were divided into four groups. According to the World Bank income classification 2019, low-income countries (LIC) are those whose per capita income is equal or less than \$995. Lower-middle-income countries (LMIC) have a per capita income between \$996 and \$3895. The range of the income of upper-middle countries (UMICs) is between \$3896 and \$12,055, and high-income countries (HIC) have a per capita income of more than \$12,055. Data on the required variables were obtained from World Development Indicators (WDI) 2018. Statistical package EViews 9 was used for estimation.

The estimation model based on Dogan et al. (2017) is as follows

$$(CO_2)_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 (GDP_{it})^2 + \beta_3 EGY_{it} + \beta_4 TR_{it} + \beta_5 TOUR_{it} + e_{it} \quad (1)$$

where β_0 is the intercept, while β_i shows slopes of their respective variables. CO_2 represents CO_2 emission per capita metric ton, GDP is GDP in constant 2010 US dollar, GDP^2 is the square of GDP, EGY is energy consumption in kg of oil equivalent per capita, TR is trade as a percentage of GDP, and TOUR is the number of international tourist arrivals. All variables were log-transformed for econometric estimation. The error term is represented by "*e*," time by "t," and countries by "*i*."

This study hypothesized that GDP, energy, trade openness, and tourism have a positive influence while GDP^2 has a negative influence on CO_2 emissions.

Initially, the econometric model is estimated by pooled ordinary least square, which pooled all observations and

Table 1 Tabulated literature review

Author/year	Countries/region/time	Variables	Estimation technique	Results
Ang (2007)	France; 1960–2000	GDP, energy, and CO_2	VECM and ARDL	EKC exists. EC increases CO_2 emissions.
Jalil and Mahmud (2009)	China; 1975–2005	Trade, energy, GDP, and CO_2	ARDL	EKC exists. Growth causes CO_2, and trade degrades the environment, but this impact is not significant.
Menyah and Wolde-Rufael (2010)	USA; 1960–2007	GDP, NE, REC, and CO_2	Toda and Yamamoto Granger non-causality test	NEC causes emissions, whereas REC does not cause emissions.
Shahbaz et al. (2012)	Pakistan; 1971–2009	Trade, energy, GDP, and CO_2	Granger causality and ARDL	EKC exists. Energy was negatively related with environment, whereas trade significantly decreases emissions in the long run.
Hwang and Yoo (2014)	Indonesia; 1965–2006	Energy, GDP, and CO_2	ECM	$CO_2 \leftrightarrow$ energy; GDP $\rightarrow$ energy and emissions
Katircioğlu (2014)	Singapore; 1971–2010	Tourism and CO_2	Quasi generalized least square, dynamic ordinary least square, and ECM	Tourism decreases emissions, tourism causes emissions, and EKC exists in Singapore.
Katircioglu (2014)	Turkey; 1960–2010	Use of energy, tourism, and CO_2	ARDL, impulse response, and variance decompositions	Tourism degrades the environment by increasing the use of energy.
de Vita et al. (2015)	Cyprus; 1970–2009	Tourism, energy use, CO_2	ARDL, ECM	Tourism increases CO_2 and energy use.
de Vita et al. (2015)	Turkey; 1960–2009	GDP, energy use, tourism, and CO_2	DOLS, and ECM	All variables increase carbon dioxide emissions, and EKC was valid.
Ali et al. (2016)	Nigeria; 1971–2011	GDP, energy, urban population, trade, and CO_2	ARDL	Prosperity of economy and energy increases emissions while trade negatively affects this level.
Attari et al. (2016)	Pakistan; 1971–2009	Growth of industrial sector and CO_2	ARDL and Granger causality	EKC does not exist. Industrial growth $\rightarrow CO_2$
Zaman et al. (2016)	Portugal; 1971–2011	GDP, credit to the private sector, energy intensity, and CO_2	ARDL, VECM, and innovative accounting approach	Impact of energy and growth was positive, whereas that of financial development was negative.
Yorucu (2016)	Turkey; 1960–2010	Tourism, electricity use, and CO_2	ARDL	Tourism increases CO_2.
Bélaïd and Youssef (2017)	Algeria; 1980–2012	Renewable and non-renewable electricity use GDP and CO_2	ARDL	GDP and NREC put positive, while REC has a negative impact on emission. GDP $\rightarrow$ NREC
Cherni and Essaber Jouini (2017)	Tunisia; 1990–2015	GDP, REC, and CO_2	ARDL and Granger causality	Income $\leftrightarrow$ REC and emissions; $CO_2 \neq$ REC
Mikayilov et al. (2018)	Azerbaijan; 1992–2013	GDP and CO_2	FMOLS and DOLS	GDP increases CO_2.
Khan et al. (2019)	Pakistan; 1972–2013	GDP, trade, use of energy, financial development, urbanization, and CO_2	ARDL and ECM	EKC exists. All variables have a detrimental impact on the environment via increasing pollution level. Trade $\leftrightarrow CO_2$
Apergis and Payne (2009)	Six Central American nations; 1971–2004	GDP, energy, and CO_2	VECM	EKC exists. Impact of energy on the environment is negative.
Apergis et al. (2010)	19 countries	GDP, REC, nuclear energy (NE), and CO_2	ECM and Granger causality	REC increases CO_2 while nuclear energy mitigates this level.
Pao and Tsai (2010)	Brazil, India, China, and Russia; different periods	GDP, use of energy, and CO_2	VECM	Energy usage increases CO_2, and EKC was supported.
Arouri et al. (2012)	12 MENA countries; 1981–2005	GDP and CO_2	ECM	Weak evidence of the presence of EKC
Lee and Brahmasrene (2013)	27 EU countries; 1988–2009	Tourism, GDP, FDI, and CO_2	Fixed effects models and Fisher-type Johansen panel cointegration test	FDI, CO_2, and tourism stimulate growth. Tourism and FDI improve environmental quality while GDP degrades it.
Mehrara and Rezaei (2013)	Brazil, Russia, India, China, and South Africa; 1960–1996	GDP, trade, and CO_2	Kao panel cointegration test	Emissions are increasing due to trade openness while the association between economic welfare and environment is non-linear, but these findings are weak proof of EKC.
Saboori and Sulaiman (2013)	Five Southeast Asian Nations; 1971–2009	Energy, GDP, and CO_2	ARDL and VECM	A positive impact of energy on emissions was found. EKC exists in Singapore and Thailand only.

Table 1 (continued)

Author/year	Countries/region/time	Variables	Estimation technique	Results
Akin (2014)	85 countries; 1990–2011	Trade, energy use, GDP, and CO_2	OLS, FMOLS, DOLS, and VECM	CO_2 increases energy use, and GDP promotes trade. In the long run, trade is negatively related to emissions. $CO_2 \rightarrow$ trade. Growth $\rightarrow CO_2$ and energy. GDP $\leftrightarrow$ trade and square of trade.
Ben Jebli et al. (2014)	22 nations of Central and South America; 1995–2010	GDP, tourism, REC, trade, and CO_2	FMOLS, DOLS, and pairwise Granger causality	Tourism and REC improve environmental quality while trade and income degrade it. REC $\rightarrow CO_2$, and trade, GDP $\rightarrow$ tourism and liberalization, tourism $\rightarrow$ trade in short run. Two-way relation was found among variables in the long run.
León et al. (2014)	14 advanced and 31 less developed countries; 1998–2006	Tourism and CO_2	STIRPAT approach	Tourism increases the level of CO_2 emission in both types of sample nations.
Uçak et al. (2015)	19 countries; 1961–2004	GDP and CO_2	FMOLS and DOLS	There is a positive relationship between GDP and environmental degradation in 19 countries except Norway.
Al-mulali et al. (2015)	129 nations; 1980–2011	Trade openness and CO_2	DOLS and Granger causality test	Free trade decreases emissions in upper-middle-income and high-income countries while in lower-middle-income nations, it harms the environment.
Bilgili et al. (2016)	17 OECD countries; 1977–2010	GDP, REC, and CO_2	DOLS and FMOLS	EKC exists. REC improves the quality of the environment.
Dizaji et al. (2016)	D8 countries; 1975–2012	GDP and CO_2	Fixed effects model	EKC exists.
Dogan and Seker (2016a)	16 OECD countries; 1975–2011	GDP, energy, trade, development of financial sector, and CO_2	Seemingly unrelated regression, LM bootstrap cointegration test, and the Emirmahmutoglu-Kose Granger causality test	Results support the EKC. Energy consumption was positively related to gas emission while domestic credit to private sector and openness improves environmental quality.
Dogan and Seker (2016b)	15 states of the European Union; 1980–2012	GDP, liberalization, REC, NREC, and CO_2	DOLS and Dumitrescu-Hurlin non-causality test	EKC exists. NREC deteriorates while REC and trade improve the quality of the environment. REC $\leftrightarrow CO_2$, Trade$\rightarrow CO_2$. $CO_2 \rightarrow$ NREC and GDP $\rightarrow CO_2$
Ben Jebli et al. (2015)	25 OECD countries; 1980–2010	GDP, trade, energy, and CO_2,	Granger causality, FMOLS, and DOLS	EKC was valid, and NREC enlarges the level of emission while REC and trade negatively affect this level.
Keho (2016)	11 West African states; 1970–2010	Trade and CO_2	ARDL and Granger Causality	Liberalization improves environmental quality in Benin and Gambia while it harms the environment in Burkina Faso, Ghana, Senegal, and Togo.
Lee and Brahmasrene (2016)	14 Sub-Saharan African countries; 1988–2010	GDP, energy, tourism, and CO_2	Johansen panel cointegration and random effects model	Findings for the whole panel revealed that tourism increases GDP. Energy utilization, growth, and tourism degrade the environment.
Dogan and Aslan (2017)	25 EU countries; 1995–2011	GDP, EC, tourism, and CO_2	LM bootstrap panel cointegration, FMOLS, DOLS, OLS, group mean estimator, Emirmahmutoglu-Kose panel Granger causality	Findings showed a negative impact of energy, whereas a positive impact of tourist arrivals and growth on the environment. Tourism$\rightarrow CO_2$. $CO_2 \leftrightarrow$ energy and growth.
Dogan et al. (2017)	27 OECD countries; 1995–2010	CO_2, real GDP, energy use, trade, and tourism	DOLS, Dumitrescu-Hurlin causality, and LM bootstrap panel cointegration test	Use of energy and tourism stimulate pollution while free trade decreases CO_2. EKC was not present. GDP $\leftrightarrow CO_2$, energy use, tourism, and trade. Energy $\leftrightarrow CO_2$. Tourism $\rightarrow CO_2$, energy and trade. Trade $\rightarrow CO_2$ and energy.
Cai et al. (2018)	G7 countries; different time periods	GDP, use of clean energy, and CO_2	Bootstrap ARDL bounds test and Granger causality	$CO_2 \rightarrow$ energy in Germany. Energy $\rightarrow CO_2$ in the USA. Growth hypothesis was supported in Canada, Germany, and the USA. $CO_2 \leftrightarrow$ clean energy in Germany.
Khoshnevis Yazdi and Ghorchi Beygi (2018)	25 African countries; 1985–2015	GDP, REC, use of energy, FD, trade, growth of urban population, and CO_2	Pooled mean group approach and Granger causality	Findings support EKC. Renewable energy and trade liberalization improve environmental quality. GDP $\leftrightarrow CO_2$. Financial development $\leftrightarrow CO_2$. Renewable energy$\rightarrow CO_2$
Sghaier et al. (2019)	Egypt, Morocco, and Tunisia; 1980–2014	Number of tourist, GDP, and CO_2	ARDL	Results affirmed the presence of EKC in Egypt and Morocco only. Tourism has good, bad, and no impact on the environment in Tunisia, Egypt, and Morocco, respectively.

provided a regression impact without considering the problems of cross-sections and time series in the data. Hausman test is then used to decide between fixed effects or random effects model. Redundant test is used to decide that between time and country differences, i.e., which one should be treated as constant. Two types of variations exist in panel data. The first one is differences among countries due to different economy sizes, geographical locations, area, etc., while the second types of variations are due to some sudden policy shocks in a specific period. These variations affect empirical results; therefore, it is essential to find out whether these variations exist in the data and if variations exist then whether these significantly affect the results or not. When independent variables are correlated with the error term, fixed effects test is used to keep this correlation constant. In other cases, when they are not correlated, random effects model is used. Generalized least square (GLS) is used to check the robustness of a fixed effects model. Further, GLS estimators are robust even if the data is being autocorrelated and heteroskedastic.

Results and discussion

Table 2 contains descriptive statistics. The minimum value of CO_2 emissions is of Congo in 2001, and the maximum value was of Kuwait in 1995. Among sample countries (Table 7 in the Appendix), the USA in 2017 had the highest GDP while Eritrea in1995 had the lowest GDP. During the study period, Bahrain had the highest energy consumption in 1998; whereas, Bangladesh had the lowest energy consumption in 1996. Singapore in 2008 was the most open nation because of its highest trade volume while Iraq was a closed economy in 1995 due to its lowest volume of trade. France had the maximum number of tourists in 2015, whereas the least traveled destination was Turkmenistan in the year 2000.

Table 3 reports the correlation matrix. CO_2 emissions are positively correlated with GDP, energy consumption (EGY), trade (TR), and tourism (TOUR). GDP is positively correlated with EGY and TOUR, whereas it is negatively correlated with TR. Use of energy has a positive but weak significant correlation with trade, whereas it has a positive correlation with tourism. Correlation among all variables is statistically significant.

Table 2 Descriptive statistics (1995–2017)

	Mean	Std. dev.	Max.	Min.	Obs.
CO_2	5.093	5.235	34.037	0.017	2576
GDP (bn)	513	1590	17,300	1.67	2576
EGY	2188.52	2128.25	12,406.71	131.891	2576
TR	86.65	52.733	441.604	0.021	2576
TOUR (bn)	0.007	0.013	0.084	3400	2576

Table 3 Correlation matrix

	1	2	3	4	5
$LnCO_2$	1.000				
LnGDP	0.521^a	1.000			
LnEGY	0.920^a	0.536^a	1.000		
LnTR	0.233^a	-0.314^a	0.240^a	1.000	
LnTOUR	0.522^a	0.756^a	0.497^a	-0.047^b	1.000

The letters a and b in superscript show significance at 1% and 5%, respectively

Whole sample results of fixed effects (FE) and GLS are reported in Table 4. According to the results of both models, a quadratic relationship is validated between economic growth and environmental degradation, as the coefficient of GDP is positive, whereas GDP square's coefficient is negative. The presence of the EKC suggests that the prosperity of an economy is good for the environment when an economy achieves the threshold level of income. Higher utilization of energy has a detrimental impact on the environment via increasing emissions. This result is similar to Dogan and Aslan (2017), Dogan and Seker (2016b), Dogan et al. (2017), and Pao and Tsai (2010). More use of energy is harmful to the environment because mostly used energy is oil-based and non-renewable. Energy is used for different purposes like production, traveling, and heating, resulting in increased gas emissions. Trade increases pollution in the fixed effects model while it is insignificant in GLS. Increased CO_2 emissions are linked to increased arrival of tourists. This positive impact has also been reported by the number of previous studies (Dogan et al. 2017; León et al. 2014; Shakouri et al. 2017). Tourism also degrades

Table 4 Relationship among GDP, energy consumption, trade, tourism, and CO_2 emissions in the whole sample

Variables	Fixed effects	GLS
Constant	-11.940^a (0.428)	-7.913^a (0.220)
LnGDP	1.293^a (0.075)	0.901^a (0.039)
LnGDPsq	-0.039^a (0.004)	-0.040^a (0.002)
LnEGY	0.825^a (0.030)	1.040^a (0.017)
LnTR	0.041^a (0.012)	-0.005 (0.006)
LnTOUR	0.041^a (0.004)	0.013^a (0.003)
Turning point (constant 2010 US$)	15,807,265.02	71,300.422
Test statistics		
R-squared	0.992	0.998
Adjusted *R*-squared	0.991	0.998
F-statistics	2093.104^a	8894.234^a
Hausman statistics	23.088^a	---

The letter "a" in superscript shows significance at 1%. Values in parentheses show standard error. Dependent variable is CO_2 emissions. Turning point is found by using the formula $e^{-\beta}{}_1/^{2\beta}{}_2$

the environment by affecting the ecosystem through the mismanagement in the disposal of wastes.

The turning point of EKC is 15,807,265 USD in column 1 and 71,300 USD in column 2. The explanatory power of the fixed effects model is excellent as 99% variation in CO_2 is explained by the independent variables. F-statistics of both models is significant at 1%, which shows that these models are statistically sound.

Table 5 presents the results of different income groups. Robustness of FE is tested by applying the GLS method while random effect (RE) model robustness is tested with the help of pooled ordinary least square (OLS). Results of low-income countries affirm EKC as GDP is positive while its square is negative and significant. In literature, the same quadratic relationship was reported by Apergis and Ozturk (2015), Dizaji et al. (2016), Pao and Tsai (2010), and Zaman et al. (2016). This result shows that the continuous process of the development of an economy is a cure for environmental degradation after reaching the turning point of environmental Kuznets curve. In lower-middle-income countries, GDP is negative, and GDP^2 is significantly positive, indicating that the relationship between growth and pollution is U-shaped. Thus, these results do not support the EKC hypothesis in pooled OLS while in RE, GDP, and its square are insignificant.

In upper-middle-income countries, economic growth turns out to be significantly positive for the level of emissions, while GDP^2 is insignificant. For high-income countries, the fixed effects model suggested that increase in growth increases emissions while GDP^2 is insignificant. Findings from GLS supported the presence of a non-linear relationship between income and environmental quality. Higher utilization of energy significantly increases the amount of carbon dioxide emissions in all groups, but the magnitude is different. This result is in line with Dogan and Aslan (2017), Dogan et al. (2017), and Pao and Tsai (2010). Energy is required mainly for production purposes, and this energy is oil-based, which harms the environmental quality; thus, this energy should be replaced with renewable and clean energy. Trade significantly increases emissions in the first three income groups while it is insignificant in low-income and upper-middle-income pooled OLS results. The negative impact of trade depicts that the scale effect of trade is dominant on technique and composition effect. For high-income countries, trade proves to be good for the environment by reducing the level of emissions. This result is also similar to Dogan and Aslan (2017) and Dogan et al. (2017).

In low-income countries, tourism has a beneficial impact on environment as it decreases emissions (Dogan and Aslan

Table 5 Relationship among GDP, energy consumption, trade, tourism, and CO_2 emissions in different income groups

Variables	Low-income countries		Lower-middle-income countries		Upper-middle-income countries		High-income countries	
	FE	GLS	Pooled OLS	RE	FE	GLS	FE	GLS
Constant	−41.065[a] (10.144)	−23.762[a] (5.752)	2.512 (2.152)	−6.091[a] (2.062)	−5.863[a] (0.833)	−3.347[a] (0.427)	−4.231[a] (0.631)	−4.477[a] (0.469)
LnGDP	6.649[a] (1.974)	3.359[a] (1.133)	−1.323[a] (0.397)	0.382 (0.375)	0.315[b] (0.131)	0.160[b] (0.075)	0.171[c] (0.102)	0.380[a] (0.076)
LnGDPsq	−0.292[a] (0.094)	−0.139[b] (0.055)	0.064 [a] (0.018)	−0.009 (0.017)	0.008 (0.006)	−0.005 (0.003)	−0.004 (0.004)	−0.021[a] (0.004)
LnEGY	1.428[a] (0.188)	1.462[a] (0.110)	1.230[a] (0.040)	0.970[a] (0.050)	0.569[a] (0.039)	0.849[a] (0.018)	0.996[a] (0.040)	1.124[a] (0.023)
LnTR	0.040 (0.055)	0.118[b] (0.046)	0.190[a] (0.055)	0.071[b] (0.029)	0.011 (0.010)	0.023[a] (0.006)	−0.003 (0.023)	−0.066[a] (0.010)
LnTOUR	−0.083[a] (0.028)	−0.082[a] (0.022)	0.088[a] (0.020)	0.043[a] (0.011)	0.034[a] (0.006)	0.004 (0.002)	0.020[b] (0.010)	−0.013[b] (0.007)
Turning point (constant 2010 US$)	87,097.362	179,428.987	---	---	---	---	---	9082.299
Test statistics								
R-squared	0.979	0.971	0.706	0.690	0.978	0.994	0.990	0.994
Adjusted *R*-squared	0.975	0.970	0.704	0.688	0.976	0.994	0.990	0.993
F-statistics	233.265[a]	505.530[a]	295.758[a]	274.063[a]	530.526[a]	3203.383[a]	1350.460[a]	3141.596[a]
Hausman statistics	12.181[b]	---	8.759	---	29.569[a]	---	10.606	---

The letters a and b in superscript show significance at 1% and 5%, respectively. Values in parentheses show standard error. Dependent variable is CO_2 emissions

Table 6 Relationship among GDP, energy consumption, trade, tourism, and CO_2 emissions in five regions of the world

Variables	East Asia and Pacific (EAP)		Europe and Central Asia (ECA)		Latin America and Caribbean (LAC)		Middle East and North Africa (MENA)		Sub-Saharan Africa (SSA)	
	Pool	RE	FE	GLS	FE	GLS	FE	GLS	FE	GLS
Constant	− 5.364[a] (1.475)	− 13.47[a] (1.416)	− 7.343[a] (0.508)	− 7.048[a] (0.242)	− 3.280[b] (1.516)	− 2.641[a] (0.684)	− 2.341 (2.607)	− 2.141 (1.539)	− 23.14[a] (2.157)	− 10.005[a] (1.812)
LnGDP	0.426 (0.278)	1.768[a] (0.245)	0.559[a] (0.112)	0.735[a] (0.044)	− 0.134 (0.278)	− 0.000 (0.129)	0.006 (0.481)	− 0.013 (0.283)	3.176[a] (0.429)	1.107[a] (0.347)
LnGDPsq	− 0.020 (0.013)	− 0.073[a] (0.010)	− 0.021[a] (0.005)	− 0.038[a] (0.002)	0.021[c] (0.012)	0.001 (0.006)	− 0.000 (0.023)	− 0.001 (0.013)	− 0.109[a] (0.022)	− 0.038[b] (0.016)
LnEGY	1.209[a] (0.032)	1.025 (0.109)	1.238[a] (0.034)	1.278[a] (0.020)	0.657[a] (0.041)	0.824[a] (0.028)	0.814[a] (0.060)	0.926[a] (0.022)	0.246[a] (0.056)	0.490[a] (0.045)
LnTR	− 0.185[a] (0.067)	− 0.068[c] (0.037)	0.059[a] (0.019)	− 0.053[a] (0.009)	0.160[a] (0.022)	0.054[a] (0.015)	0.038[a] (0.009)	0.028[a] (0.009)	0.225[a] (0.045)	0.274[a] (0.028)
LnTOUR	0.032 (0.039)	0.032 (0.030)	0.031[a] (0.004)	0.015[a] (0.002)	0.052[a] (0.014)	0.035[a] (0.012)	0.049[a] (0.018)	0.011[b] (0.005)	0.120[a] (0.024)	0.089 (0.017)
Turning point (constant 2010 US$)	---	193,671.158	491,795.798	15,598.735	---	---	---	---	2,253,035.87	2,415,805.88
Test statistics										
R-squared	0.916	0.783	0.988	0.995	0.986	0.992	0.994	0.997	0.984	0.990
Adjusted *R*-squared	0.914	0.779	0.987	0.994	0.984	0.991	0.993	0.997	0.982	0.989
F-statistics	588.09[a]	194.581[a]	1092.091[a]	3707.667[a]	630.841[a]	2172.865[a]	1194.515[a]	5622.697[a]	526.370[a]	1688.291[a]
Hausman statistics	---	6.201	20.158[a]	---	9.976[c]	---	40.728[a]	---	28.074[a]	---

The letters a, b, and c show significance at 1%, 5%, and 10%, respectively. Values in parentheses show standard error. Dependent variable is CO_2 emissions

2017; Katircioglu 2014) while contradictory to this result, tourism increases emissions in lower-middle-income countries; these findings are aligned with those of Dogan et al. (2017) León et al. (2014), and Shakouri et al. (2017). Tourism is beneficial for the environment in low-income countries, suggesting that these counties should encourage tourism, while LMIC should make policies for sustainable tourism. In the upper-middle-income group, coefficient of tourism is positive in FE, whereas it is insignificant in GLS. In high-income group, the impact of tourism is positive in FE, whereas it is negative in GLS. The turning point of environmental Kuznets curve for low-income countries is USD 87,097 and USD 179,428 in fixed effects and GLS, respectively. For low and middle-income countries, the turning point cannot be calculated due to the absence of EKC. In GLS, USD 9082 is regarded as the turning point of EKC of high-income countries. Values of *R*-squared in all models are significantly high, and F-statistics shows that all models are statistically correct.

Table 6 reports the results of five regions included in this study. The results of the EAP regions are obtained through pooled OLS and random effects models while the results of the remaining four regions were obtained by fixed effects and generalized least square. In pooled OLS of the first group, both GDP and its square are insignificant. The results of East Asia and Pacific (in GLS), Europe and Central Asia, and SSA support a quadratic relationship between economic growth and CO_2 emissions. In the FE model, for LAC, GDP is insignificant while GDP^2 increases CO_2. Similar results were reported by Ben Jebli et al. (2015) for Sub-Saharan Africa. Both variables are insignificant in GLS and also in the results of MENA. Energy consumption degrades environmental quality via increasing carbon dioxide emissions in all groups except in RE results of the first group where it is insignificant. This result is aligned with previous studies of Dogan and Aslan (2017), Dogan et al. (2017), and Pao and Tsai (2010).

Trade proves to be beneficial for the environment because it decreases carbon dioxide emissions in the first group and the results from GLS of the second group (Dogan and Aslan 2017; Dogan et al. 2017), whereas trade positively affects pollution level in all the remaining groups (Shahbaz et al. 2017). Tourism increases emissions in all regions except in East Asia and the Pacific, where it is insignificant. This positive impact was also found by Dogan et al. (2017) and León et al. (2014). In the results of the random effect of the first group, the turning point of income is 193,671 US dollars, and after this level of income, increase in economic growth decreases CO_2. For the second group, income which is required for improving the environment is 491,795 and 15,598 US dollars in FE and GLS, respectively. In the last group, the turning point of EKC is 2,253,035 and 2,415,805 US dollars in FE and GLS, respectively. F-statistics of all models is significant which shows that these are the best fit while the value of *R*-squared is good enough in all models to accept.

Conclusion and policy implications

The present study analyzed a sample of 112 countries for the impact of economic growth, trade liberalization, energy use, and tourism on CO_2 emissions from 1995 to 2017. This study attempted to find out the existence of EKC in 112 sample nations, and then, the sample was divided on income and regional basis. Pooled OLS, fixed and random effects models, and GLS were used for estimations. The overall sample's outcomes showed that economic growth, energy use, and tourism are proved to be harmful to the environment, and these results remain unchanged in alternative estimation techniques. More use of energy increased emissions because this energy is non-renewable and oil-based. The increased arrivals of tourists degrade the environment and severely affect ecosystem. International tourism requires the construction of supporting infrastructure and requires energy not only in destination places but also for traveling through road and airways. All of this negatively affects environmental quality by increasing the level of emissions. Existence of EKC means that initially, the progress of the economy is detrimental for the environmental quality, but in later stages, it results in improving the environmental quality. The results of sub-samples are mixed. Based on the current study's findings, the following policy recommendations are suggested:

1. Tourism and the associated increase in energy usage negatively impact the environment via increasing emissions. Therefore, renewable or green energy such as solar, wind, or thermal should be used instead of non-renewable energy.
2. Those countries for which study results are supporting EKC existence should focus on increasing their economic growth, as citizens' income reaches some particular point, they will be more concerned for the environment.
3. Tourism degrades the quality of the environment via improper management of the disposal of wastes; thus, waste management requires strict policies and their implementation by the government.
4. The government should encourage investments in green energy projects by announcing subsidies and tax reductions on environmentally friendly energy projects.
5. The government should implement strict policies regarding environmental protection. Cooperation among different countries relating to design different policies for decreasing emission level is necessary.
6. Governmental and non-governmental organizations should hold awareness campaigns because any restriction and policy will not work until people understand and show responsible behavior towards the environment.

7. In upper-middle and high-income countries, economic growth hurts the environment suggesting that these countries should adopt environmentally friendly methods of production.
8. In Latin America and the Caribbean, MENA, and SSA, more trade liberalization is dangerous for the environment; thus, these countries should impose tariffs on those products which cause environmental degradation and decrease tariff rates on products made with the help of clean and environmentally friendly energy.

References

Akin CS (2014) The impact of foreign trade, energy consumption and income on Co2 emissions. Int J Energy Econ Policy 4(3):465–475 Retrieved from https://dergipark.org.tr/ijeeep/issue/31910/350827

Ali HS, Law SH, Zannah TI (2016) Dynamic impact of urbanization, economic growth, energy consumption, and trade openness on CO 2 emissions in Nigeria. Environ Sci Pollut Res 23(12):12435–12443. https://doi.org/10.1007/s11356-016-6437-3

Al-mulali U, Tang CF, Ozturk I (2015) Does financial development reduce environmental degradation? Evidence from a panel study of 129 countries. Environ Sci Pollut Res 22(19):14891–14900. https://doi.org/10.1007/s11356-015-4726-x

Ang JB (2007) CO2 emissions, energy consumption, and output in France. Energy Policy 35(10):4772–4778. https://doi.org/10.1016/j.enpol.2007.03.032

Apergis N, Ozturk I (2015) Testing environmental Kuznets curve hypothesis in Asian countries. Ecol Indic 52:16–22. https://doi.org/10.1016/j.ecolind.2014.11.026

Apergis N, Payne JE (2009) CO 2 emissions, energy usage, and output in Central America. Energy Policy 37(8):3282–3286. https://doi.org/10.1016/j.enpol.2009.03.048

Apergis N, Payne JE, Menyah K, Wolde-Rufael Y (2010) On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. Ecol Econ 69(11):2255–2260. https://doi.org/10.1016/j.ecolecon.2010.06.014

Appiah MO (2018) Investigating the multivariate Granger causality between energy consumption, economic growth and CO2 emissions in Ghana. Energy Policy 112:198–208. https://doi.org/10.1016/j.enpol.2017.10.017

Arouri MEH, Ben Youssef A, M'henni H, Rault C (2012) Energy consumption, economic growth and CO 2 emissions in Middle East and North African countries. Energy Policy 45:342–349. https://doi.org/10.1016/j.enpol.2012.02.042

Attari MIJ, Hussain M, Javid AY (2016) Carbon emissions and industrial growth: an ARDL analysis for Pakistan. Int J Energy Sector Manag 10(4):642–658. https://doi.org/10.1108/IJESM-04-2014-0002

Bélaïd F, Youssef M (2017) Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: assessing the evidence from Algeria. Energy Policy 102:277–287. https://doi.org/10.1016/j.enpol.2016.12.012

Bilgili F, Koçak E, Bulut Ü (2016) The dynamic impact of renewable energy consumption on CO2 emissions: a revisited environmental Kuznets curve approach. Renew Sust Energ Rev 54:838–845. https://doi.org/10.1016/j.rser.2015.10.080

Boutabba MA (2014) The impact of financial development, income, energy and trade on carbon emissions: evidence from the Indian economy. Econ Model 40:33–41. https://doi.org/10.1016/j.econmod.2014.03.005

Brahmasrene T, Lee JW (2017) Assessing the dynamic impact of tourism, industrialization, urbanization, and globalization on growth and environment in Southeast Asia. Int J Sust Dev World 24(4):362–371. https://doi.org/10.1080/13504509.2016.1238021

Butler RW (1991) Tourism, environment, and sustainable development. Environ Conserv 18(3):201–209. https://doi.org/10.1017/S0376892900022104

Cai Y, Sam CY, Chang T (2018) Nexus between clean energy consumption, economic growth and CO2 emissions. J Clean Prod 182:1001–1011. https://doi.org/10.1016/j.jclepro.2018.02.035

Cherni A, Essaber Jouini S (2017) An ARDL approach to the CO2 emissions, renewable energy and economic growth nexus: Tunisian evidence. Int J Hydrog Energy 42(48):29056–29066. https://doi.org/10.1016/j.ijhydene.2017.08.072

Danish, Wang Z (2018) Dynamic relationship between tourism, economic growth, and environmental quality. J Sustain Tour 26(11):1928–1943. https://doi.org/10.1080/09669582.2018.1526293

de Vita G, Katircioglu S, Altinay L, Fethi S, Mercan M (2015) Revisiting the environmental Kuznets curve hypothesis in a tourism development context. Environ Sci Pollut Res 22(21):16652–16663. https://doi.org/10.1007/s11356-015-4861-4

Dizaji M, Badri A, Shafaei M (2016) Investigate the relationship between economic growth and environmental quality in D8 member countries. Platform.Almanhal.Com 2(5):1–7 Retrieved from https://platform.almanhal.com/GoogleScholar/Details/?ID=2-95859

Doğan E (2017) CO2 emissions, real GDP, renewable energy and tourism: evidence from panel of the most-visited countries. Statistika 97(3):63–76 Retrieved from http://openaccess.agu.edu.tr/xmlui/handle/20.500.12573/80

Dogan E, Aslan A (2017) Exploring the relationship among CO2 emissions, real GDP, energy consumption and tourism in the EU and candidate countries: evidence from panel models robust to heterogeneity and cross-sectional dependence. Renew Sust Energ Rev 77:239–245. https://doi.org/10.1016/j.rser.2017.03.111

Dogan E, Seker F (2016a) An investigation on the determinants of carbon emissions for OECD countries: empirical evidence from panel models robust to heterogeneity and cross-sectional dependence. Environ Sci Pollut Res 23(14):14646–14655. https://doi.org/10.1007/s11356-016-6632-2

Dogan E, Seker F (2016b) Determinants of CO2 emissions in the European Union: the role of renewable and non-renewable energy. Renew Energy 94:429–439. https://doi.org/10.1016/j.renene.2016.03.078

Dogan E, Seker F, Bulbul S (2017) Investigating the impacts of energy consumption, real GDP, tourism and trade on CO2 emissions by accounting for cross-sectional dependence: a panel study of OECD countries. Curr Issue Tour 20(16):1701–1719. https://doi.org/10.1080/13683500.2015.1119103

Hwang JH, Yoo SH (2014) Energy consumption, CO2 emissions, and economic growth: evidence from Indonesia. Qual Quant 48(1):63–73. https://doi.org/10.1007/s11135-012-9749-5

IEA (2017) IEA. CO2 emissions from fuel combustion. Retrieved from https://webstore.iea.org/co2-emissions-from-fuel-combustion

Jalil A, Mahmud SF (2009) Environment Kuznets curve for CO2 emissions: a cointegration analysis for China. Energy Policy 37(12):5167–5172. https://doi.org/10.1016/j.enpol.2009.07.044

Jebli MB, Youssef SB, Apergis N (2014) The dynamic linkage between CO2 emissions, economic growth, renewable energy consumption, number of tourist arrivals and trade. Retrieved from https://mpra.ub.uni-muenchen.de/id/eprint/57261

Ben Jebli M, Ben Youssef S, Ozturk I (2015) The role of renewable energy consumption and trade: environmental Kuznets curve analysis for Sub-Saharan Africa countries. Afr Dev Rev 27(3):288–300. https://doi.org/10.1111/1467-8268.12147

Katircioglu ST (2014) International tourism, energy consumption, and environmental pollution: the case of Turkey. Renew Sust Energ Rev 36:180–187. https://doi.org/10.1016/j.rser.2014.04.058

Katircioğlu ST (2014) Testing the tourism-induced EKC hypothesis: the case of Singapore. Econ Model 41:383–391. https://doi.org/10.1016/j.econmod.2014.05.028

Keho Y (2016) Trade openness and the environment : a time series study of ECOWAS countries. J Econ 4(4):61–69. https://doi.org/10.15640/jeds.v4n4a6

Khan I, Khan N, Yaqub A, Sabir M (2019) An empirical investigation of the determinants of CO2 emissions: evidence from Pakistan. Environ Sci Pollut Res 26(9):9099–9112. https://doi.org/10.1007/s11356-019-04342-8

Khoshnevis Yazdi S, Ghorchi Beygi E (2018) The dynamic impact of renewable energy consumption and financial development on CO2emissions: for selected African countries. Energy Sources Part B Econ Plann Policy 13(1):13–20. https://doi.org/10.1080/15567249.2017.1377319

Kukla-Gryz A (2009) Economic growth, international trade and air pollution: a decomposition analysis. Ecol Econ 68(5):1329–1339. https://doi.org/10.1016/j.ecolecon.2008.09.005

Lee JW, Brahmasrene T (2013) Investigating the influence of tourism on economic growth and carbon emissions: evidence from panel analysis of the European Union. Tour Manag 38:69–76. https://doi.org/10.1016/j.tourman.2013.02.016

Lee JW, Brahmasrene T (2016) Tourism effects on the environment and economic sustainability of sub-Saharan Africa. Int J Sust Dev World 23(3):221–232. https://doi.org/10.1080/13504509.2015.1114976

León CJ, Arana JE, Hernández Alemán A (2014) CO2 emissions and tourism in developed and less developed countries. Appl Econ Lett 21(16):1169–1173. https://doi.org/10.1080/13504851.2014.916376

Mehrara M, Rezaei A a (2013) A panel estimation of the relationship between trade liberalization, economic growth and CO2 emissions in BRICS countries. Hyperion Econ J 1(4):3–27 Retrieved from http://www.hej.hyperion.ro/articles/4(1)_2013/HEJnr4(1)_2013.pdf#page=4

Menyah K, Wolde-Rufael Y (2010) CO2 emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy 38(6):2911–2915. https://doi.org/10.1016/j.enpol.2010.01.024

Mercan M, Karakaya E (2015) Energy consumption, economic growth and carbon emission: dynamic panel cointegration analysis for selected OECD countries. Procedia Econ Finance 23:587–592. https://doi.org/10.1016/s2212-5671(15)00572-9

Mikayilov JI, Galeotti M, Hasanov FJ (2018) The impact of economic growth on CO2 emissions in Azerbaijan. J Clean Prod 197:1558–1572. https://doi.org/10.1016/j.jclepro.2018.06.269

Pao HT, Tsai CM (2010) CO 2 emissions, energy consumption and economic growth in BRIC countries. Energy Policy 38(12):7850–7860. https://doi.org/10.1016/j.enpol.2010.08.045

Qureshi MI, Hassan MA, Hishan SS, Rasli AM, Zaman K (2017) Dynamic linkages between sustainable tourism, energy, health and wealth: evidence from top 80 international tourist destination cities in 37 countries. J Clean Prod 158:143–155. https://doi.org/10.1016/j.jclepro.2017.05.001

Saboori B, Sulaiman J (2013) CO2 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

Sghaier A, Guizani A, Ben Jabeur S, Nurunnabi M (2019) Tourism development, energy consumption and environmental quality in Tunisia, Egypt and Morocco: a trivariate analysis. GeoJournal 84(3):593–609. https://doi.org/10.1007/s10708-018-9878-z

Shahbaz M, Lean HH, Shabbir MS (2012) Environmental Kuznets curve hypothesis in Pakistan: cointegration and Granger causality. Renew Sust Energ Rev 16(5):2947–2953. https://doi.org/10.1016/j.rser.2012.02.015

Shahbaz M, Nasreen S, Ahmed K, Hammoudeh S (2017) Trade openness–carbon emissions nexus: the importance of turning points of trade openness for country panels. Energy Econ 61:221–232. https://doi.org/10.1016/j.eneco.2016.11.008

Shaheen K, Zaman K, Batool R, Khurshid MA, Aamir A, Shoukry AM, Sharkawy MA, Aldeek F, Khader J, Gani S (2019) Dynamic linkages between tourism, energy, environment, and economic growth: evidence from top 10 tourism-induced countries. Environ Sci Pollut Res 26(30):31273–31283. https://doi.org/10.1007/s11356-019-06252-1

Shakouri B, Khoshnevis Yazdi S, Ghorchebigi E (2017) Does tourism development promote CO2 emissions? Anatolia 28(3):444–452. https://doi.org/10.1080/13032917.2017.1335648

Soytas U, Sari R, Ewing BT (2007) Energy consumption, income, and carbon emissions in the United States. Ecol Econ 62(3–4):482–489. https://doi.org/10.1016/j.ecolecon.2006.07.009

Uçak H, Aslan A, Yucel F, Turgut A (2015) A dynamic analysis of CO2Emissions and the GDP relationship: empirical evidence from high-income OECD countries. Energy Sources Part B Econ Plann Policy 10(1):38–50. https://doi.org/10.1080/15567249.2010.514586

UNWTO (2017) UNWTO Tourism Highlights: 2017 Edition. https://doi.org/10.18111/9789284419029

WTO (2017) World trade statistical review 2017. In: WTO.org. Retrieved from https://www.wto.org/english/res_e/statis_e/wts2017_e/wts17_toc_e.htm

Yorucu V (2016) Growth impact of CO2 emissions caused by tourist arrivals in Turkey: an econometric approach. Int J Clim Change Strategies Manag 8(1):19–37. https://doi.org/10.1108/IJCCSM-12-2014-0148

Zaman K, Shahbaz M, Loganathan N, Raza SA (2016) Tourism development, energy consumption and environmental Kuznets curve: trivariate analysis in the panel of developed and developing countries. Tour Manag 54:275–283. https://doi.org/10.1016/j.tourman.2015.12.001

Zaman K, el Moemen MA, Islam T (2017) Dynamic linkages between tourism transportation expenditures, carbon dioxide emission, energy consumption and growth factors: evidence from the transition economies. Curr Issue Tour 20(16):1720–1735. https://doi.org/10.1080/13683500.2015.1135107