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The impact of tourism developments on CO_2 emissions: An advanced panel data estimation

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ABSTRACT

Vulnerability and interaction between tourism and climate change are among the most important issues discussed recently. In this context, this study focuses primarily on how CO_2 emissions, the main source of global warming and climate change, react to tourism developments. To this end, the impact of tourism developments on CO_2 emissions in the most visited countries is examined from 1995 to 2014 by conducting the continuously updated fully modified (CUP-FM) and the continuously updated bias-corrected (CUP-BC) estimators. Empirical results indicate that tourism arrivals have an increasing effect on CO_2 emissions, while tourism receipts have a reducing effect on CO_2 emissions. Results also reveal a possible co-movement and causal relationship between tourism developments and CO_2 emissions in the long-run.

1. Introduction

Significant changes have emerged in the global climate system recently. According to the *State of Climate* report prepared by American Meteorological Society and edited by Blunden, Arndt, and Hartfield (2018), global surface temperature has been 0.38°–0.48 °C above the 1981–2010 average and the 10 warmest years on record have all occurred since 1998, with the four warmest years occurring since 2014. The report underlines that the global growth rate of CO_2 emissions, as an important contributor to global warming, has nearly quadrupled since the early 1960s. Observed changes such as decreases in the amount of snow and ice, rises in sea levels and lengths of seasons, deviations in the precipitation regime in tropical regions are also noticed by IPCC (Intergovernmental Panel on Climate Change).reports on climate change (IPCC, 2014, 2018). This problem directly affects the economy, politics, lifestyle, social and geopolitical development (Bilgili et al., 2016). Global warming and climate change have caused millions of people to suffer from hunger, disease, floods, and water shortages (Escobar et al., 2009). Today, there is a consensus among scientists that the main reason for global warming and climate change is the rapid increase in human-induced CO_2 emissions over the last 50 years (Anderson, Hawkins, and Jones, 2016; Mossler, Bostrom, Kelly, Crosman, and Moy, 2017).

At present, global warming and climate change are some of the key issues focused by policy authorities, civil society organizations, and scientists. Along with increasing global awareness of environmental problems, the drivers of CO_2 emissions have become one of the main interest areas for researchers. Relevant literature provides evidence that there is a significant relationship between CO_2 emissions and many factors such as economic growth, population, urbanization, trade, energy consumption, foreign direct investment and financial development (Cetin, Ecevit, and Yucel, 2018; Dong, Sun, and Dong, 2018; Li and Lin, 2015; Nasrollahi, Hashemi, Bameri, and Mohamad Taghvaee, 2018; Park, Meng, and Baloch, 2018). Remarkably, although there is a significant relationship between tourism and environmental quality, the problem of a rapid increase in CO_2 emissions has not been sufficiently considered in tourism researches (Solarin, 2014). Studies mainly focus on the negative effects of global warming and climate change on the tourism sector (Scott, Gössling, and Hall, 2012). In particular, it is emphasized that the climate affects the tourist activities, the choice of destination of tourists, and the overall satisfaction of the holiday (Hamilton, Maddison, and Tol, 2005; Hoogendoorn and Fitchett, 2018). According to the literature, undesirable climatic conditions are a push for tourism development, while suitable climatic conditions are considered as an attractive factor (Amelung, Nicholls, and Viner, 2007). It is also clear that the impact of global warming and climate change in coastal regions (especially through the rise in sea levels) has serious consequences for the tourism industry (Akadiri, Lasisi, Uzuner, and Akadiri, 2018; Atzori, Fyall, and Miller, 2018).

In the context of the climate change-tourism relationship, it becomes important to seek answers to the following questions. (i) What is the impact of tourism on CO_2 emissions while global warming and

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climate change have a negative influence on the tourism sector? (ii) Does the development of the tourism sector contribute to global carbon emissions? The contribution of tourism to global greenhouse gases was first discussed by Bach and Gössling (1996) in a theoretical framework, and it was emphasized that the aviation sector contributes significantly to greenhouse gas emissions in this study. Due to the multidisciplinary nature of the debate, the volume of research with new and different perspectives increased continuously in the 2000s (Scott et al., 2012). However, the current literature does not provide statistically satisfactory evidence of the impact of tourism on CO_2 emissions (Nepal, Indra al Irsyad, and Nepal, 2019; Shakouri, Khoshnevis Yazdi, and Ghorchebigi, 2017). However, Lenzen et al. (2018) reveal what extent the tourism sector may be responsible for carbon emissions, and they provide an important contribution to the calculation of tourism-related carbon flows. According to their carbon footprint calculations, global tourism accounts for about 8% of global greenhouse gas emissions. On the other hand, some studies discuss the environmental effects of tourism by presenting qualitative judgments (Paramati, Sudharshan, Alam, and Chen, 2017). One may claim that empirical studies have been newly carried out to account for the effect of developments in the tourism sector on CO_2 emissions. To this end, this study investigates the impact of tourism developments on CO_2 emissions for the 10 most visited countries in the period 1995–2014 based on annual data provided by the World Bank. This study is expected to contribute to the literature in three ways:

(i) Tourism sector has shown a brilliant growth performance in the last four decades at the globe (Gössling, Scott, and Hall, 2015; Meo, Chowdhury, Shaikh, Ali, and Masood Sheikh, 2018) and this sector has been of utmost importance in the economic development process of both developed and developing countries (Cannonier and Burke, 2018; Dogru and Bulut, 2018; Dogru and Sirakaya-Turk, 2017; Dogru, Sirakaya-Turk, and Crouch, 2017; Martins, Gan, and Ferreira-Lopes, 2017). Because, tourism creates employment and job opportunities, facilitates access to foreign exchange and external financing, improves infrastructure, and provides significant contributions to the development of manufacturing, agriculture, and service sectors (Zaman, el Moemen, and Islam, 2017; Zuo and Huang, 2018). According to current statistics, international tourist arrivals showed a record growth of 7% in 2017. International tourism receipts increased by 4.9% in real terms to $ 1340 billion in the same year. Besides, tourism provided revenues of US $ 240 billion from international passenger transport services. Moreover, tourism ranks third in the global export earnings category after chemicals-fuels and the automotive sector in 2017 (UNWTO, 2018). Given the economic importance of the tourism sector, the estimation of its contribution to CO_2 emissions is important to design sustainable tourism policies, considering that it is affected negatively by global warming and climate change.

(ii) Investigation of tourism-CO_2 relationship in most visited countries (France, Spain, USA, China, Italy, Mexico, UK, Turkey, Germany, Thailand) is another expected contribution of this study since the most visited countries represent the world tourism sector in an ideal way. The share of these 10 countries in international tourist arrivals and international tourism receipts was 41.6% and 45.3% in 2017, respectively (see Table 1). Sustainable tourism policies of these 10 countries will no doubt guide global tourism policies. For this reason, this study is expected to provide significant outputs to researchers and policy authorities through its empirical findings.

(iii) This paper performs the advanced panel data method that takes cross-sectional dependence into account to achieve robust findings. Traditional panel data estimators, such as ordinary least squares (OLS), fixed effects (FE), random effects (RE), generalised method of moments (GMM), dynamic least squares (DOLS) and full modified least squares (FM-OLS) assume that there is no dependence between sections in the panel and they are based on the assumption that a shock in one of the sections/countries does not affect other cross-sections/countries. Countries are, however, closely linked to each other economically, politically, and socially. Due to the fact that a shock that occurs in one of the countries/sections affects other sections/countries, taking cross-sectional dependence into account is required to produce more consistent and unbiased results (Bilgili, Koçak, Bulut, and Kuloğlu, 2017; Liddle, 2014; Ulucak and Bilgili, 2018). This study conducts continuously updated full modified (CUP-FM) and continuously updated bias-corrected (CUP-BC) estimators suggested by Bai, Kao, and Ng (2009) in order to obtain robust results.

The rest of the paper is organized as follows: Section 2 with two subtitles of country-specific studies and multi-country studies summarizes literature findings on tourism-CO2 emissions after underlining main theoretical perspectives on tourism and environmental degradation. Then, the model, data and methodologies are explained in Section 3. Then, estimation results are presented, and findings are discussed in section four. Finally, the study is concluded.

2. Literature review

The current literature explains the effect of tourism on CO_2 emissions through various channels based on energy use. Gössling et al. (2015) emphasized that the most energy-consuming aspect of global tourism is international tourism trips. Gössling and Peeters (2015) stated that the tourism sector meets almost all energy needs with fossil resources such as oil, natural gas, and coal. They underlined that tourism uses fossil energy sources, mainly in transportation, accommodation, and destination activities. Especially in recent years, airline travels have been growing faster than other types of transportation, thus increasing the contribution of the aviation sector to global CO_2 emissions (Gössling et al., 2015). Furthermore, tourism destinations consume a significant amount of energy to import food and other material goods, to transport water and to dispose of wastes. Similarly, attraction centers, ski destinations, and theme parks are the areas of high energy intensity due to the use of mechanized activities (Dwyer, Forsyth, Spurr, and Hoque, 2010). Another important channel is changes in land-use due to tourism investments (Al-Mulali, Fereidouni, and Mohammed, 2015; Raza, Sharif, Wong, and Karim, 2017; Sharif, Afshan, and Nisha, 2017; Zaman et al., 2017). Land-use change causes decreases in forest areas, and it is the second important reason for emission increases after fossil energy consumption (Bilgili, Koçak, Bulut, and Kuloğlu, 2017).

On the other hand, the literature states that well-managed tourism can contribute to the protection of the environment by promoting the use of environmentally friendly technology and transportation. More lanes, higher quality road pavement, wider and safer roads, and rail transport can reduce CO_2 emissions by contributing to less fuel consumption (Paramati, Alam, and Lau, 2018). In addition to these arguments, theoretical approaches emphasize that the service sector that is cleaner than industrial one contributes to improving environmental quality (Grossman and Krueger, 1991, 1995). According to this viewpoint, there is a transition from industry and agriculture to the service sector in the ongoing development process. That is production in the economy shifts from relatively polluted sectors (industry and agriculture) to a cleaner sector (services). Therefore, the tourism sector may increase environmental quality, or it produces less pollution than other dirty ones. According to Paramati, Sudharshan, et al. (2017), sustainable tourism policies can raise awareness to protect the environment and can be a tool to finance their efforts against environmental degradation.

As a result, in the light of theoretical explanations, one may claim that the effect of tourism on CO_2 emissions may have a reducing or an increasing form. So, empirical facts are of importance in discussions on the relationship between tourism and CO_2 emissions.

2.1. Country-specific studies on tourism-CO_2 emissions nexus

Country-specific researches on the tourism-CO_2 relationship provide

Table 1
Top 10 most visited countries in 2017.

Countries	International tourist arrivals (millions of visitors/ 2017)	Change (%) 2017/ 2016	Share (%)	International tourism receipts (US$ billion/ 2017)	Share (%)
France	86.9	5.1	6.5	60.7	4.5
Spain	81.7	8.6	6.1	67.9	5.0
USA	76.9	0.7	5.7	210.7	15.7
China	60.7	2.5	4.5	32.6	2.4
Italy	58.2	11.2	4.3	44.2	3.2
Mexico	39.2	12.0	2.9	21.33	1.6
UK	37.7	5.1	2.8	51.2	3.8
Turkey	37.6	24.1	2.8	22.4	1.7
Germany	37.4	5.6	2.8	39.8	2.8
Thailand	35.3	8.6	2.7	57.4	4.2
Most visited countries (total)	551.6	7.1	41.6	608.2	45.3
World	1326	7.0	100	1340	100

Source: UNWTO (2018).

some important outputs for shaping future tourism policies. These studies generally examine the impact of tourism on CO_2 emissions in the context of causality relationships between energy consumption, economic growth, and the environment. Solarin (2014) investigated the effects of tourist arrivals, real GDP, energy consumption, financial development, and urbanization on CO_2 emissions in Malaysia for the period 1972–2010 through autoregressive distributed lag (ARDL) cointegration and Granger causality methods. Results show that tourist arrivals have an enhancing effect on CO_2 emissions. Katircioglu, Feridun, and Kilinc (2014) checked out the relationship between tourist arrivals, energy consumption and CO_2 emissions in Cyprus for the period 1970–2009 with the ARDL approach and causality test. Research findings suggest that tourism and energy consumption have a significant contribution to the increase in CO_2 emissions. Katircioglu (2014) explored the relationship between international tourist arrivals, energy consumption, GDP and carbon emissions in Turkey for the period 1960–2010 using ARDL and causality methods. The findings of the research reveal the impact of tourism developments on both energy consumption and CO_2 emissions in Turkey. Following similar models and methods with Solarin (2014), Sghaier, Guizani, Ben Jabeur, and Nurunnabi (2018) examined the effect of tourism arrivals on CO_2 emissions in Tunisia, Egypt, and Morocco over the period of 1980–2014. According to their findings, there is no significant relationship between tourism arrivals and CO_2 emissions in Morocco. On the other hand, tourist arrivals have a decreasing effect on CO_2 emissions in Egypt but have a boosting effect in Tunisia. De Vita, Katircioglu, Altinay, Fethi, and Mercan (2015) investigated the effect of tourist arrivals on CO_2 emissions in Turkey by using a cointegration approach with structural breaks suggested by Maki (2012), and they concluded that tourist arrivals make a significant contribution to the increase in CO_2 emissions. Zhang and Gao (2016) analyzed the relationship between international tourism receipts, energy consumption, economic growth and CO_2 emissions in 30 provinces of China in the period of 1995–2011. They applied panel cointegration, panel FMOLS, and panel causality analyses and found that tourism has a decreasing effect on CO_2 emissions in Western and Eastern China, while it has no significant effect in Central China. Naradda Gamage, Hewa Kuruppuge, and Haq (2017) investigated the relationship between tourism receipts, energy consumption, and CO_2 emissions in Sri Lanka for the period of 1974–2013 by JJ cointegration (Johansen and Juselius, 1990) and DOLS methods. Their results indicate that tourism receipts have a reducing effect on CO_2 emissions. Azam, Mahmudul Alam, and Haroon Hafeez (2018) explored the impact of tourist arrivals on CO_2 emissions in Malaysia, Thailand, and Singapore over the period of 1990–2014. They performed a cointegration test with a structural break suggested by Gregory-Hansen (1996). According to their estimations, tourist arrivals reduce CO_2 emissions in Singapore and Thailand, while CO_2 emissions increase in parallel with tourist arrivals in Malaysia. Sharif et al. (2017) examined the relations between tourism arrivals, foreign direct investments (FDI), and CO_2 emissions in Pakistan for the period 1972–2013 by following cointegration methods with structural breaks and found that tourist arrivals have a strong boosting effect on CO_2 emissions. Işik, Kasımatı, and Ongan (2017) investigated the relationship between trade, financial development, tourism expenditures, and CO_2 emissions in Greece for the period of 1974–2014 by using the ARDL approach. Empirical findings indicate that the tourism sector increases CO_2 emissions. Raza et al. (2017) explored the effect of tourist arrivals on CO_2 emission in the USA by employing a wavelet transform method with monthly data for the period of 1996–2015. Wavelet coherence findings reveal that tourist arrivals have an increasing effect on CO_2 emissions. Finally, Nepal et al. (2019) analyzed the effect of tourist arrivals on CO_2 emissions in Nepal for the period of 1975–2014. Their results demonstrate that tourism is a significant contributor to CO_2 emissions.

2.2. Multi-country studies on tourism-CO_2 emissions nexus

Multi-country studies generally perform panel data techniques as an investigation methodology. Estimation findings of panel data techniques are assumed to be valid for all countries in the panel analyses. Therefore, multi-country researches on the relationship between tourism and CO_2 emissions are of importance for designing common or homogeneous tourism policies. Lee and Brahmasrene (2013) estimated the relationship between tourism receipts, FDI, economic growth and CO_2 emissions in the European Union countries for the period of 1988–2009 by panel cointegration and fixed effects (FE) methods. Their findings show that tourism receipts have a reducing effect on CO_2 emissions. Following the same model and methods conducted by Lee and Brahmasrene (2013), Zaman, Shahbaz, Loganathan, and Raza (2016) analyzed the effect of international tourism transportation expenditures on CO_2 emissions in the transition countries during the period 1995–2013. The results of panel data analyses confirm that international tourism transportation expenditures have an increasing effect on CO_2 emissions. Dogan, Seker, and Bulbul (2017) investigated the relationships between energy consumption, GDP, trade, tourism, and CO_2 emissions in OECD countries for the period 1995–2016 by using a panel data analysis method, which takes into account the cross-sectional dependence. The results of the analysis show that tourism developments have an increasing effect on carbon emissions. Paramati, Shahbaz, and Alam (2017) explored the effect of tourism receipts on CO_2 emissions in Western and Eastern European countries for the period of 1995–2013 by using panel cointegration, FMOLS, and panel causality methods. According to their findings, tourism developments have an increasing effect on CO_2 emissions in Eastern Europe, while they have a reducing effect in Western Europe. Akadiri et al. (2018) examined the relationship between tourist arrivals and CO_2 emissions in the 16 small island developing countries for the period of 1995–2014 through panel bootstrap causality test. Their findings confirm that there is a bidirectional relationship between tourist arrivals and CO_2 emissions.

Some multi-country studies which examined the relationship between tourism and CO_2 emissions in the literature are as follows: Dogan and Aslan (2017) investigated the effect of energy consumption, GDP, tourist arrivals on carbon emissions in the EU countries in the period 1995–2011 using panel data method that considers the cross-sectional dependence. The analysis outputs confirm that tourism developments have a reducing effect on carbon emissions. Zaman et al. (2016) explored the relationship between tourism-economic growth and CO_2 emissions for developed and developing countries in the period of 2005–2013. Their findings indicate that tourism contributes to increasing CO_2 emissions. Shakouri et al. (2017) surveyed the impact of tourism arrivals and economic growth on CO_2 emissions in Asia-Pacific countries for the period 1995–2013 through panel cointegration and causality analyses. The study found that tourist arrivals have a one-way increasing effect on CO_2 emissions. Sherafatian-Jahromi, Othman, Law, and Ismail (2017) investigated the relationship between tourist arrivals, economic growth, energy consumption and CO_2 emissions for the Southeast Asian countries of 1979–2010 period through panel cointegration and mean group estimator and they concluded that there is a nonlinear relationship between tourism and CO_2 emissions.

Finally, few studies in the literature evaluated the relationship between tourism and CO_2 emissions within the framework of the STIRPAT model. León, Arana, and Hernández Alemán (2014) sounded the impact of population, tourist arrivals, economic growth, and energy efficiency on CO_2 emissions in developed and underdeveloped countries for the period of 1998–2006. Their findings indicate that population, economic growth, and tourist arrivals have an increasing effect on CO_2 emissions. It is also emphasized that the contribution of tourism to CO_2 increases is higher in developed countries than in developing ones. Paramati, Alam, and Chen (2017) questioned the relationship between tourism receipts, economic growth and CO_2 emissions in developed and underdeveloped countries for the period of 1995–2012. Their findings reveal that tourism receipts have an increasing effect on CO_2 emissions. Contrary to the findings of León et al. (2014), the increasing effect of tourism on CO_2 emissions is higher in underdeveloped countries than developed ones. Paramati et al. (2018) estimated the effect of tourism investments on CO_2 emissions in EU countries for the period 1990–2013. Their findings show that tourism investments make a significant contribution to reducing CO_2 emissions.

3. Model, data, and methodology

This study follows the *STIRPAT* model to estimate the effect of tourism developments on CO_2 emissions. Ehrlich and Holdren (1971) emphasized that environmental impacts (I) are associated with the population (*P*), affluence (*A*), and technology (*T*) in their ecological model called *IPAT*. In order to demonstrate the effects of factors on the environment in this model, one of the factors is allowed to change while the other two are kept constant. In this way, the effect of all variables on the environment is estimated proportionally. York, Rosa, and Dietz (2003) developed the stochastic model by reformulating the *IPAT* model. In this way, they introduced a model that could estimate the non-proportional impact of population, welfare, and technology on the environment. This revised model is called *STIRPAT* (stochastic impacts by regression on population, affluence, and technology). Eq. (1) describes the model.

$$I_{it} = aP_{it}^{b}A_{it}^{c}T_{it}^{d}u_{it} \tag{1}$$

Following Lin, Wang, Marinova, Zhao, and Hong (2017), logarithmic structure of the *STIRPAT* model is rewritten as is in eq. (2):

$$lnI_{it} = a_i + blnP_{it} + clnA_{it} + dlnT_{it} + u_{it} \tag{2}$$

where *b, c,* and *d* show the parameters of the population (*P*), affluence (*A*) and technology (*T*) included in eq. (2) to eliminate the proportional effect on the *IPAT* model. α,u, *i,* and *t* indicate the constant, error term, countries and time dimension, respectively. Following Li and Lin (2015), Liddle (2014) and Zhang et al. (2017), the *STIRPAT* model becomes as in eq. (3) in case tourism, as an indicator of affluence, is included in it and the model with a tourism variable can be established.

$$lnCO_{2it} = \alpha_i + b(lnurban_{it}) + c_1(lnGDP_{it}) + c_2(lntourism_{it}) + d(lnEI_{it}) + u_{it} \tag{3}$$

$lnCO_2$, *lnurban*, *lnGDP*, *lntourism,* and *lnEI* in eq. (3) stand for per capita CO_2 emissions, urbanization rate, tourism developments, and energy intensity, respectively. Tourism drives carbon emissions by causing increased demand for transport, particularly due to the intensity of travel services. Besides, tourism developments contribute to carbon emissions by increasing food consumption and shopping activities (Lenzen et al., 2018). The literature represents tourism developments with two indicators to test the possible effects of tourism developments on CO_2 emissions. The first group considers the number of tourist arrivals (Akadiri et al., 2018; Nepal et al., 2019; Sghaier et al., 2018; Solarin, 2014). The second group employs tourism receipts as an indicator of tourism developments (Lee and Brahmasrene, 2013; Naradda Gamage et al., 2017; Zhang and Gao, 2016). Also, the World Tourism Organization (UNWTO) focuses on these two indicators to size tourism developments and underlines that it is important to consider both international tourist arrivals and international tourism receipts. Following these considerations, we represent tourism developments through two indicators: tourist arrivals (lnarrivals) and tourism receipts (lnreceipts).

The data used in the analysis covers the period of 1995–2014 and belongs to the 10 most visited countries[1], which are shown in Table 1 by statistics on tourist arrivals and tourism receipts. Annual data set for each indicator employed in model 2 and model 3 is obtained from the World Bank's data platform. The data period was ended by 2014 due to the availability of data set for CO_2 emissions. The most recent CO_2 emission data obtained from the World Bank are up to 2014. The data for each variable in eq. (3) was transformed into logarithmic form to obtain standardized coefficients that can also be commented as elasticity (Kanjilal and Ghosh, 2018). Table 2 depicts the explanations of the data used in the analyses.

In order to estimate the *STIRPAT* model constructed in eq. (3), the study follows the panel data techniques which take cross-sectional dependence into account. Pesaran (2006) proved that panel data analyses show substantial bias and size distortions when cross-sectional dependence is ignored. For this reason, cross-sectional dependence is firstly checked before proceeding to perform preliminary tests for parameter estimations. We employ the Lagrange multiplier (*LM*) test proposed by Breusch and Pagan (1980), CD_{LM} and *CD* tests proposed by Pesaran (2004), and the bias-adjusted LM (LM_{adj}) test proposed by Pesaran, Ullah, and Yamagata (2008) to determine whether the dependence exists or not. These tests investigate the null hypothesis of “there is no cross-sectional dependence” against the alternative hypothesis implying the existence of cross-sectional dependence.

In the next step, panel unit root, panel cointegration, and cointegration estimators are conducted to determine long-run relationship in the model in eq. (3). It should be firstly checked whether series is stationary or not since the non-stationary series reveals the problem of spurious regression. Pesaran (2007) proposes a cross-sectionally

[1] According to the list published by UNWTO in the last 10 years, the positions of the top 10 countries have not changed although there are small changes in their gradations within top 10 (see https://www.e-unwto.org/doi/pdf/10.18111/9789284416899 and https://www.e-unwto.org/doi/pdf/10.18111/9789284419876).

Table 2
Definitions of variables and data sources.

Variable	Definition	Proxy	Source
lnCO₂	CO_2 emissions per capita (Metric tons)	Environment	World Bank
lnurban	Urban population (Percent %)	Population	World Bank
lnGDP	GDP per capita (constant 2010/US Dollar)	Affluence	World Bank
lnarrivals	Number of tourist arrivals	Affluence	World Bank
lnreceipts	International tourism receipts (% of total exports)	Affluence	World Bank
lnEI	Energy intensity level of primary energy (MJ/ $2011 PPP GDP)	Technology (Energy intensity refers to the amount of energy per output. The reduction in energy intensity indicates technological development.)	World Bank

augmented ADF (CADF) unit root test that takes the cross-sectional dependence into account to observe stationary behaviors of variables. Using the arithmetic mean of individual CADF statistics calculated for each country in the panel, cross-sectional IPS (CIPS) statistic is obtained. The null hypothesis of the CIPS test implies that the series has unit root.

As a result of unit root analysis, series may be stationary at the level *[I(0)]* or at the first difference [*I(1)*]. If the series has a stationary process at the level, coefficients are estimated by the traditional OLS method. On the other hand, if the series has unit root, the existence of the cointegration relationship (long-run co-movement) should be verified before the coefficient estimations (Hatemi-J, 2008). Westerlund (2008) proposes a Durbin-Hausman procedure to check possible cointegration relationships in panel data analyses. This approach considers the cross-sectional dependence and produces two statistics. The first statistic of the Durbin-Hausman procedure (hereafter DH_p) investigates the long-run relationship under homogeneity assumption while the second (hereafter DH_g) determines this relationship in case of heterogeneity for panel sections. The null hypothesis for DH_p and DH_g tests implies "no cointegration."

Having determined the cointegration relationship, the long-run parameters are estimated. For this purpose, this study performs the continuously updated fully modified (CUP-FM) and the continuously updated bias-corrected (CUP-BC) estimators, suggested by Bai and Kao (2006) and Bai et al. (2009). Firstly, Bai and Kao (2006) used eq. (4) by introducing common factors in matrix form to consider correlations between units.

$$h_{it} = c_i + \gamma' m_{it} + e_{it} \tag{4}$$

where h_{it} represents the dependent variable for *i.* unit at *t* period in the panel. *c* and γ stand for the constant term and coefficient matrix. m_{it} and e_{it} signifies explanatory variables matrix and error term respectively, divided into two parts as is in eq. (5) to include factor loadings (λ_i) and unobserved factors (f_t) in series.

$$m_{it} = m_{i,t-1} + u_{it},\ e_{it} = \lambda'_i f_t + \eta_{it,} \tag{5}$$

Secondly, Bai and Kao (2006) employed the fully modified ordinary least squares (FMOLS) estimator proposed by Phillips and Hansen (1990) in order to detect the presence of common factors through eq. (6).

$$\hat{\gamma}_{FMOLS} = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}(m_{it}-\overline{m}_i)(m_{it}-\overline{m}_i)'\right)^{-1} x \left(\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(m_{it}-\overline{m}_i)\hat{h}_{it}^{+} - T(\hat{\Delta}_{eu}+\hat{\Delta}_{uf}^{+}\hat{\lambda}_{i.})\right)\right) \tag{6}$$

Having γ coefficients estimated by eq. (6) in the first step, estimations are repeated using residuals of each previous phase till convergence is obtained. This repetitive process is labeled continuously updated fully modified (CUP-FM) estimator (Choi, 2015). The process in eq. (5) is later changed by Bai et al. (2009) following eq. (7).

$$h_{it} = c_i + \gamma' m_{it} + \lambda'_i f_t + e_{it}, \tag{7}$$

$$m_{it} = m_{i,\,t-1} + u_{it}, \quad f_t = f_{t-1} + \eta_t,$$

Additionally, Bai et al. (2009) corrected biases directly in estimations, and they developed bias-corrected estimator which is also continuously updated till convergence to be captured. This procedure is called continuously updated bias-corrected (CUP-BC) estimator. Bai et al. (2009) showed that the CUP-BC and CUP-FM are distinctly superior to conventional estimators for all cases by conducting Monte Carlo experiments. These estimators are consistent against exogenous variables and endogeneity problem, and they are robust in the existence of *I(1)* and *I(0)* factors as well as regressors (Bai et al., 2009).

In the final stage of the empirical analyses, this study also examines the possible bi-directional relationship between tourism developments and CO_2 emissions through causality analysis. To this end, causality analysis proposed by Dumitrescu and Hurlin (2012), taking the cross-sectional dependence into account, is carried out to reveal possible bidirectional causality between tourism developments and CO_2 emissions. The null hypothesis implies "no causal relationship between variables."

4. Estimation results and discussions

In order to perform all stages of analyses introduced in the previous section, Gauss 10 software and original codes written by their developers were used. Table 3 shows cross-sectional dependence test results. Results show that the null hypothesis is rejected at the 1% statistical significance level for all variables. These results mean that a shock occurs in one of the most visited countries may affect related variables of others. Therefore, it is necessary to consider the dependence between

Table 3
Cross-sectional dependence test results.

Variables	LM	CD_{LM}	LM_{adj}	CD
lnCO₂	495.72*** (0.000)	47.51*** (0.000)	47.24*** (0.000)	1.87*** (0.060)
lnGDP	587.72*** (0.00)	57.20*** (0.000)	56.94*** (0.000)	23.27*** (0.000)
lnurban	869.72*** (0.000)	86.93*** (0.000)	86.67*** (0.000)	29.48*** (0.000)
lnEI	553.19*** (0.000)	53.56*** (0.000)	53.30*** (0.000)	15.81*** (0.000)
lnarrivals	648.28*** (0.000)	63.59*** (0.000)	63.32*** (0.000)	25.29*** (0.000)
lnreceipts	339.04*** (0.000)	30.99*** (0.000)	30.73*** (0.000)	11.53*** (0.000)

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively. Prob-values are indicated in parentheses.

Table 4
Panel unit root test results.

	IPS		CIPS	
Variables	Level	First difference	Level	First difference
lnCO₂	1.14	−7.48***	−2.70	−3.58***
lnGDP	−0.05	−4.21***	−1.42	−2.99***
lnurban	−2.02**	−3.45***	−2.42	−3.97***
lnEI	−0.41	−3.17***	−1.81	−3.48***
lnarrivals	−0.32	−3.25***	−2.54	−3.12**
lnreceipts	−0.07	−5.33***	−1.39	−3.26***

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.
1%, 5%, and 10% critical values are −3.15, −2.88, −2.74, respectively for CADF test. Critical values are produced by Pesaran (2007).

countries by using the second generation of panel data methodologies to achieve robust findings.

Table 4 illustrates the results of the IPS unit root test proposed by Im, Pesaran, and Shin (2003, hereafter IPS) and the CIPS (cross-sectionally IPS) unit root test aforementioned before, which are the first and second-generation unit root tests respectively. According to the IPS test results, urbanization is stationary at the level while the others have unit root. The CIPS test results show that the null hypothesis is not rejected for all variables, meaning that all variables employed in eq. (3) have unit root. However, these variables become stationary when their first differences are taken. In this case, the cointegration relationship between the variables should be checked before the estimation of long-run coefficients that will reveal the effect of tourism developments on CO_2 emissions.

We constructed two models (Model I and Model II) to estimate eq. (3) since the current literature represents tourism developments with two indicators to test the possible effects of tourism developments on CO_2 emissions (Akadiri et al., 2018; Lee and Brahmasrene, 2013; Naradda Gamage et al., 2017; Nepal et al., 2019; Sghaier et al., 2018; Solarin, 2014; Zhang and Gao, 2016). Also, the World Tourism Organization (UNWTO) focuses on these two indicators to size tourism developments and underlines that it is important to consider both international tourist arrivals and international tourism receipts. The model I includes tourist arrivals to represent tourism developments and the Model II employs tourism receipts. Thus, we can obtain results for the effect of both tourism indicators on CO_2 emissions.

Table 5 depicts Westerlund (2008) cointegration test results. Results in Table 5 confirm that there is a long-run relationship between CO_2 emissions, urbanization, GDP per capita, tourism and energy intensity. Test statistics are statistically significant, and the null hypothesis of no cointegration can be rejected for both Model I and Model II.

Table 6 exhibits the estimation findings of long-run panel cointegration coefficients that can be commented as elasticity since logarithmic transformation was performed on each variable in the models (Kanjilal and Ghosh, 2018). Therefore, it means that 1% increase in any variable used in the model will lead the dependent variable to change by x%, where x refers to the negative or positive coefficient value of that variable. The estimation results are as follows: (a) CUP-FM and CUP-BC estimators show that *lnGDP* has a significant and enhancing effect on $lnCO_2$ emissions. That is CO_2 emissions increase as GDP per capita, as a representative of affluence, increases. (b) Urbanization has an enhancing effect on CO_2 emissions. (c) Results confirm that there is a negative relationship between energy intensity and CO_2 emissions. We consider energy intensity as an indicator of technology. Because the decrease in energy intensity is an output of efficiency (Bilgili, Koçak, Bulut, and Kuloğlu, 2017). According to expectations, technological development (decrease in energy intensity) has a reducing effect on carbon emissions. (d) We focus mainly on the findings of tourism-CO_2 emissions that CUP-FM and CUP-BC estimations consistently indicate that tourist arrivals increase CO_2 emissions. These findings coincide with the results obtained by Akadiri et al. (2018), De Vita et al. (2015), Nepal et al. (2019), Raza et al. (2017), Sharif et al. (2017) and Solarin (2014). Supporting the arguments of Dwyer et al. (2010), Gössling and Peeters (2015), and Gössling et al. (2015), transport services can be proposed as the main reason for the tourist arrivals to have an increasing effect on carbon emissions.

(e) Estimation results reveal that tourism receipts have a negative impact on CO_2 emissions. These results show that tourism receipts, as an indicator of affluence, contribute to reducing CO_2 emissions. Our findings on tourism gains support the results estimated by Lee and Brahmasrene (2013), Naradda Gamage et al. (2017), Paramati, Sudharshan, et al. (2017), and Zhang and Gao (2016). Remarkably, while the overall economic growth process has an increasing effect on carbon emissions, tourism receipts have a positive impact on the environment by reducing CO_2 emissions. The possible cause of this result is that the tourism, as an important sub-sector of the service sector, is comparatively less energy-consuming sector or cleaner than the agricultural and industrial sectors (Begum, Sohag, Mastura, Abdullah, and Jaafar, 2014; Bilgili, Koçak, Bulut, and Kuşkaya, 2017; Shahbaz, Loganathan, Muzaffar, Ahmed, and Ali Jabran, 2016). For example, the current contribution of agricultural and industrial sectors to global CO_2 emissions is 21% and 24% (IPCC, 2014). The contribution of the tourism sector is much lower than the others, and it is around 4.6% (Scott et al., 2008). According to the carbon footprint calculations of Lenzen et al. (2018), global tourism accounts for about 8% of global greenhouse gas emissions.

Finally, this study carried out the causality test to reveal possible bidirectional causality relationships between tourism developments and CO_2 emissions. Table 7 presents the causality test results. One may validate that there is a bidirectional causality relationship between tourism developments (tourist arrivals and tourism receipts) and CO_2 emissions. In other words, tourism developments have an impact on CO_2 emissions, while changes in CO_2 emissions effect tourism developments. These findings that support the interrelationship between tourism and CO_2 emissions coincide with the results obtained by Amelung et al. (2007), Hamilton et al. (2005), Hoogendoorn and Fitchett (2018) and Scott et al. (2012). Causality test results also reveal that there is a bidirectional relationship between energy intensity and CO_2 emissions, while unidirectional relationship exists between GDP per capita and urbanization and CO_2 emissions.

5. Conclusions

The relationship between tourism and climate change has been an

Table 5
Westerlund (2008) cointegration test.

	DH_g		DH_p	
	Constant	Constant & trend	Constant	Constant & trend
Model I	−1.99** (0.020)	−2.27*** (0.010)	−1,68** (0.040)	−1.89** (0.020)
Model II	−1.91** (0.020)	−1.41* (0.070)	−1.45* (0.070)	−1.66** (0.040)

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively. Prob-values are indicated in parentheses.

Table 6
Estimation of the long-run coefficients (Dependent variable: $lnCO_2$).

	CUP-FM		CUP-BC	
	Model I	Model II	Model I	Model II
lnGDP	0.535*** (0.000)	0.773*** (0.000)	0.508*** (0.000)	0.882*** (0.000)
lnurban	0.036** (0.050)	0.055** (0.000)	0.031* (0.070)	0.067*** (0.000)
lnEI	−0.075*** (0.000)	−0.483*** (0.000)	−0.087*** (0.000)	−0.550*** (0.000)
lnarrivals	0.112*** (0.000)	–	0.119*** (0.000)	–
lnreceipts	–	−0.197*** (0.000)	–	−0.091*** (0.000)

Note: ***, **, and * denote significance levels at 1%, 5%, and 10%, respectively.
prob-values are indicated in parentheses.

important area of interest in recent years. In this context, this paper examines tourism and CO_2 emissions nexus for the most visited countries across the globe with annual data from 1995 to 2014 based on the *STIRPAT* model. The data for each indicator employed in estimated models is obtained from the World Bank's data platform. Different from the prevalent literature, advanced panel data estimation techniques (CUP-FM and CUP-BC), which take the cross-sectional dependence into account, are employed. Estimation results are summarized in three points: (i) Tourist arrivals have an increasing effect on CO_2 emissions. (ii) Conversely, tourism receipts have a reducing effect on CO_2 emissions. (iii) Finally, this effect is not unidirectional, and tourism developments are also responding to changes in CO_2 emissions, meaning that there is a bidirectional causality relationship between tourism and CO_2 emissions.

Theoretical underpinnings of the results that are why tourist arrivals contribute to increasing CO2 emissions and tourism receipts contribute to decrease CO2 emissions, may rely on two points: (i) One of the important factors affecting the natural environment in the world is international tourism transportations (Holden, 2016; Lenzen et al., 2018; Zaman et al., 2017). Developments in the tourism sector correspondingly increase the arrivals and departures of tourists and drive more transport services (Dogan et al., 2017; Sharif et al., 2017). Transportation is the most important producer of CO_2 emissions since the basic fuel needs of transportation vehicles used in air, road, railroad, and water transportation are met from fossil energy sources (Sharma and Ghoshal, 2015). According to Rico et al. (2019), the great share of tourism-related CO_2 emissions (nearly 95%) belongs to transport services, and the aviation sector is responsible for these emissions to a large extent. The increase in the number of tourists also increases the variety of infrastructure services such as accommodation, hotels, restaurants, airports, ports, roads, railways and telecommunications. Infrastructure and tourist destination creation processes contribute significantly to increase CO_2 emissions (Lee and Brahmasrene, 2013). Therefore, the findings of this study regarding the increasing effect of tourism arrivals on CO_2 emissions can be explained by these channels in accordance with the theoretical expectations. (ii) It is a clear fact that the tourism sector, as a sub-sector of the service sector, is relatively cleaner than industrial and agricultural sectors (Bilgili, Koçak, and Bulut, 2016; Simmons, 2013). From this perspective, it is emphasized that the service sector that is cleaner than the industrial one contributes to improving environmental quality (Grossman and Krueger, 1991, 1995). Therefore, the tourism sector may increase environmental quality, or it produces less pollution than other dirty ones. Also, it should be stated that receipts are not directly related to CO_2 emissions contrary to arrivals leading to increase transportations and fuel demand. Moreover, tourism receipts of countries with high tourist arrivals may not be high enough. For instance, France has the highest tourism arrivals in 2017 while the USA has the highest tourism receipts in the same year (UNWTO, 2018). Thailand is the 10th country in terms of arrivals but it is the 4th in the receipt rankings of 2017 (UNWTO, 2018). Therefore, empirical outputs of this study can be explained by this viewpoint to support why tourism receipts reduce CO_2 emissions.

The results achieved in this study are expected to contribute to the design of sustainable tourism policies. Considering the empirical findings and the current literature, the most visited countries may encourage to use of the use of alternative fuels and hybrid engines in both air and other transport services. In this respect, low-cost air travel can be regarded as an alternative solution as it creates hypermobile travel models (Raza et al., 2017). Also, transport rules which are well defined in tourism regions may be adopted to reduce the environmental damages caused by tourism and additional funds can be created for the development of carbon-neutral transport systems in their public budgets.

The accommodation that also includes heating, air conditioning services of the facilities, the maintenance of bars, restaurants, and pools has a considerable share of CO2 emissions (Lenzen et al., 2018; Rico et al., 2019). It is important to note that the accommodation industry has very accessible options to reduce fossil energy by transforming energy sources into solar and wind energy technologies (Azam et al., 2018). Governments may lead the sector for clean energy transformation through subsidies and/or additional taxes in mostly visited tourist destinations. The hospitality sector can exhibit a more sustainable growth performance through the implementation of these strategies.

Paramati et al. (2018) emphasize that the aim of sustainable tourism investments is to reduce the negative effects of tourism on the environment and that tourism investments increase the quality of the

Table 7
Causality test.

Null hypothesis	Wald-stat.	*p*-value	Decision
lnarrivals does not cause $lnCO_2$	6.529	0.00	*lnarrivals* ↔ $lnCO_2$ (bidirectional causality)
$lnCO_2$ does not cause *lnarrivals*	4.694	0.05	
lnreceipts does not cause $lnCO_2$	5.216	0.00	*lnreceipts* ↔$lnCO_2$ (bidirectional causality)
$lnCO_2$ does not cause *lnreceipts*	2.985	0.03	
lnGDP does not cause $lnCO_2$	5.779	0.00	*lnGDP* → $lnCO_2$ (unidirectional causality)
$lnCO_2$ does not cause *lnGDP*	2.749	0.49	
lnurban does not cause $lnCO_2$	10.971	0.00	*lnurban* → $lnCO_2$ (unidirectional causality)
$lnCO_2$ does not cause *lnurban*	2.640	0.74	
lnEI does not cause $lnCO_2$	5.267	0.00	*lnEI* ↔ $lnCO_2$ (bidirectional causality)
$lnCO_2$ does not cause *lnEI*	5.026	0.00	

environment. Countries may contribute to the development of the tourism sector and minimize environmental pollution by following similar policies. The development of the tourism sector within the scope of investment-oriented tourism will encourage investors to build roads, plan recycling programs in touristic facilities, and support energy and infrastructure projects (Zaman et al., 2016). Given that the tourism sector is also affected by climate change, directing a certain proportion of state budgets to green infrastructure development can both support the development of the tourism sector and reduce the environmental impacts of urbanization, transportation, and industry (Nepal et al., 2019).

In order to reduce CO_2 emissions, it is also necessary to draw attention to the development of the financial sector. Policies that focus on developing a financial system such as openness and liberalization can provide more R&D funding for development in energy technologies (Koçak and Ulucak, 2019; Sharif et al., 2017; Solarin, 2014). Special attention should be paid to the marketing and supporting of low-carbon tourism at the industry level. So, the tourism sector should design and develop low carbon tourism products. In this process, R&D investments in the tourism sector should continuously improve energy efficiency and emission reduction capacity (Zhang and Gao, 2016).

Countries can further support the carbon-neutral policies of the UNWTO (2007) and follow similar policies at the national level. In this context, (i) carbon emission can be reduced by alternative and clean means of transportation. (ii) A carbon footprint can be calculated for travels through one of the carbon offset organizations. (iii) Carbon emissions can be balanced by purchasing certified carbon credits or by encouraging projects such as tree planting, renewable energy, energy-saving and environmental education. As a result, all these efforts will contribute significantly to the development of the tourism sector, while eliminating the negative environmental impacts of the sector.

Finally, apart from the general recommendations, specific recommendations are presented considering the differences between the top 10 countries. Among the most visited countries, six are developed countries (France, USA, Spain, Italy, UK, and Germany), and four are developing countries (China, Mexico, Turkey, and Thailand). It is clear that there are significant differences between developed and developing countries in terms of economic, institutional, technological, infrastructure, human capital, and environmental awareness (Chan, Darko, Olanipekun, and Ameyaw, 2018; Lund-Thomsen, Lindgreen, and Vanhamme, 2016). Therefore, developed and developing countries may implement different alternative policies to reduce CO2 emissions caused by the tourism sector. Developed countries can improve the use of clean fuel technologies such as ethanol and biodiesel instead of fossil fuels by providing incentives for tourism transport services, low-interest loans and tax reductions (Alaswad, Baroutaji, Achour, Carton, and Al Makky, 2016; Bilgili, Koçak, Bulut, and Kuloğlu, 2017; Steenberghen and López, 2008). They may also transfer clean technologies and information and support the use and development of these technologies. Especially, R&D investments in energy storage, renewable energy, and energy efficiency can reduce production costs and CO_2 emissions of these technologies (Koçak and Ulucak, 2019). Developing countries, on the other hand, in order to reduce the environmental damage of tourism sector may (i) prioritize policies that support to increase environmental awareness in the public for sustainable tourism (Antimova, Nawijn, and Peeters, 2012; Mihalic, 2016), (ii) follow policies that will form the institutional environment necessary for the development of clean production processes and technologies (Bhattacharya, Awaworyi Churchill, and Paramati, 2017; Ibrahim and Law, 2016), (iii) support the development of tourism infrastructure and other infrastructure services in an environmentalist manner (Gladstone, Curley, and Shokri, 2013; Shimizu and Okamoto, 2019). (iv) Developing countries can contribute to the use and development of clean technologies by encouraging foreign capital investments to transfer clean technologies and technical knowledge from developed countries (Koçak and Şarkgüneşi, 2018).

References

Akadiri, S. S., Lasisi, T. T., Uzuner, G., & Akadiri, A. C. (2018). Examining the causal impacts of tourism, globalization, economic growth and carbon emissions in tourism island territories: Bootstrap panel granger causality analysis. *Current Issues in Tourism,* 1–15. https://doi.org/10.1080/13683500.2018.1539067.

Alaswad, A., Baroutaji, A., Achour, H., Carton, J., & Al Makky, A. (2016). Developments in fuel cell technologies in the transport sector. *International Journal of Hydrogen Energy, 41*(37), 16499–16508. https://doi.org/10.1016/J.IJHYDENE.2016.03.164.

Al-Mulali, U., Fereidouni, H. G., & Mohammed, A. H. (2015). The effect of tourism arrival on CO 2 emissions from transportation sector. *Anatolia, 26*(2), 230–243. https://doi.org/10.1080/13032917.2014.934701.

Amelung, B., Nicholls, S., & Viner, D. (2007). Implications of global climate change for tourism flows and seasonality. *Journal of Travel Research, 45*, 285–296. https://doi.org/10.1177/0047287506295937.

Anderson, T. R., Hawkins, E., & Jones, P. D. (2016). CO2, the greenhouse effect and global warming: From the pioneering work of Arrhenius and Callendar to today's earth system models. *Endeavour, 40*(3), 178–187. https://doi.org/10.1016/J.ENDEAVOUR.2016.07.002.

Antimova, R., Nawijn, J., & Peeters, P. (2012). The awareness/attitude-gap in sustainable tourism: A theoretical perspective. *Tourism Review, 67*(3), 7–16. https://doi.org/10.1108/16605371211259795.

Atzori, R., Fyall, A., & Miller, G. (2018). *Tourist responses to climate change: Potential impacts and adaptation in Florida's coastal destinations.* https://doi.org/10.1016/j.tourman.2018.05.005.

Azam, M., Mahmudul Alam, M., & Haroon Hafeez, M. (2018). Effect of tourism on environmental pollution: Further evidence from Malaysia, Singapore and Thailand. *Journal of Cleaner Production, 190*, 330–338. https://doi.org/10.1016/j.jclepro.2018.04.168.

Bach, W., & Gössling, S. (1996). Geographische Rundschau. *Geographische Rundschau; 48. Vol. 48. Geographische Rundschau; 48* (pp. 54–59). G. Westermann 1996.

Bai, J., & Kao, C. (2006). Chapter 1 on the estimation and inference of a panel cointegration model with cross-sectional dependence. *Contributions to Economic Analysis, 274*, 3–30. https://doi.org/10.1016/S0573-8555(06)74001-9.

Bai, J., Kao, C., & Ng, S. (2009). Panel cointegration with global stochastic trends. *Journal of Econometrics, 149*(1), 82–99. https://doi.org/10.1016/j.jeconom.2008.10.012.

Begum, R. A., Sohag, K., Mastura, S., Abdullah, S., & Jaafar, M. (2014). CO 2 emissions, energy consumption, economic and population growth in Malaysia. *Renewable and Sustainable Energy Reviews, 41*, 594–601. https://doi.org/10.1016/j.rser.2014.07.205.

Bhattacharya, M., Awaworyi Churchill, S., & Paramati, S. R. (2017). The dynamic impact of renewable energy and institutions on economic output and CO2 emissions across regions. *Renewable Energy, 111*, 157–167. https://doi.org/10.1016/J.RENENE.2017.03.102.

Bilgili, F., Koçak, E., & Bulut, Ü. (2016). The dynamic impact of renewable energy consumption on CO_2 emissions: A revisited environmental Kuznets curve approach. *Renewable and Sustainable Energy Reviews, 54*. https://doi.org/10.1016/j.rser.2015.10.080.

Bilgili, F., Koçak, E., Bulut, Ü., & Kuloğlu, A. (2017). The impact of urbanization on energy intensity: Panel data evidence considering cross-sectional dependence and heterogeneity. *Energy, 133*, 242–256. https://doi.org/10.1016/J.ENERGY.2017.05.121.

Bilgili, F., Koçak, E., Bulut, Ü., & Kuşkaya, S. (2017). Can biomass energy be an efficient policy tool for sustainable development? *Renewable and Sustainable Energy Reviews, 71*. https://doi.org/10.1016/j.rser.2016.12.109.

Bilgili, F., Öztürk, İ., Koçak, E., Bulut, Ü., Pamuk, Y., Muğaloğlu, E., & Bağlıtaş, H. H. (2016). The influence of biomass energy consumption on CO2 emissions: A wavelet coherence approach. *Environmental Science and Pollution Research, 23*(19), 19043–19061. https://doi.org/10.1007/s11356-016-7094-2.

Blunden, J., Arndt, D. S., & Hartfield, G. (2018). State of the climate in 2017. *Bulletin of the American Meteorological Society, 99*(8), 143–173. https://doi.org/10.1175/2018BAMSStateoftheClimate.1.

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies, 47*(1), 239. https://doi.org/10.2307/2297111.

Cannonier, C., & Burke, M. G. (2018). The economic growth impact of tourism in small island developing states—Evidence from the Caribbean. *Tourism Economics.*. https://doi.org/10.1177/1354816618792792.

Cetin, M., Ecevit, E., & Yucel, A. G. (2018). The impact of economic growth, energy consumption, trade openness, and financial development on carbon emissions: Empirical evidence from Turkey. *Environmental Science and Pollution Research.*. https://doi.org/10.1007/s11356-018-3526-5.

Chan, A. P. C., Darko, A., Olanipekun, A. O., & Ameyaw, E. E. (2018). Critical barriers to green building technologies adoption in developing countries: The case of Ghana. *Journal of Cleaner Production, 172*, 1067–1079. https://doi.org/10.1016/J.JCLEPRO.2017.10.235.

Choi, I. (2015). Panel cointegration. In B. H. Baltagi (Ed.). *The Oxford Handbook of Panel Data* (pp. 46–75). New York, NY: Oxford University Press.

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. *Renewable and Sustainable Energy Reviews, 77*, 239–245. https://doi.org/10.1016/J.RSER.2017.03.111.

Dogan, E., Seker, F., & Bulbul, S. (2017). Investigating the impacts of energy consumption, real GDP, tourism and trade on CO $_2$ emissions by accounting for cross-sectional

dependence: A panel study of OECD countries. *Current Issues in Tourism, 20*(16), 1701–1719. https://doi.org/10.1080/13683500.2015.1119103.
Dogru, T., & Bulut, U. (2018). Is tourism an engine for economic recovery? Theory and empirical evidence. *Tourism Management, 67*, 425–434. https://doi.org/10.1016/j.tourman.2017.06.014.
Dogru, T., & Sirakaya-Turk, E. (2017). Engines of tourism's growth: An examination of efficacy of shift-share regression analysis in South Carolina. *Tourism Management, 58*, 205–214. https://doi.org/10.1016/j.tourman.2016.10.021.
Dogru, T., Sirakaya-Turk, E., & Crouch, G. I. (2017). Remodeling international tourism demand: Old theory and new evidence. *Tourism Management, 60*, 47–55. https://doi.org/10.1016/j.tourman.2016.11.010.
Dong, K., Sun, R., & Dong, X. (2018). CO2 emissions, natural gas and renewables, economic growth: Assessing the evidence from China. *Science of the Total Environment, 640–641*, 293–302. https://doi.org/10.1016/j.scitotenv.2018.05.322.
Dumitrescu, E.-I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling, 29*(4), 1450–1460. https://doi.org/10.1016/J.ECONMOD.2012.02.014.
Dwyer, L., Forsyth, P., Spurr, R., & Hoque, S. (2010). Estimating the carbon footprint of Australian tourism. *Journal of Sustainable Tourism, 18*(3), 355–376. https://doi.org/10.1080/09669580903513061.
Ehrlich, P. R., & Holdren, J. P. (1971). Impact of population growth on JSTOR. *Science, 171*(3), 1212–1217.
Escobar, J. C., Lora, E. S., Venturini, O. J., Yáñez, E. E., Castillo, E. F., & Almazan, O. (2009). Biofuels: Environment, technology and food security. *Renewable and Sustainable Energy Reviews, 13*(6–7), 1275–1287. https://doi.org/10.1016/J.RSER.2008.08.014.
Gladstone, W., Curley, B., & Shokri, M. R. (2013). Environmental impacts of tourism in the Gulf and the Red Sea. *Marine Pollution Bulletin, 72*(2), 375–388. https://doi.org/10.1016/J.MARPOLBUL.2012.09.017.
Gössling, S., & Peeters, P. (2015). Assessing tourism's global environmental impact 1900-2050. *Journal of Sustainable Tourism, 23*(5), 639–659. https://doi.org/10.1080/09669582.2015.1008500.
Gössling, S., Scott, D., & Hall, C. M. (2015). Inter-market variability in CO2 emission-intensities in tourism: Implications for destination marketing and carbon management. *Tourism Management, 46*, 203–212. https://doi.org/10.1016/j.tourman.2014.06.021.
Gregory, A. W., & Hansen, B. E. (1996). Residual-based tests for cointegration in models with regime shifts. *Journal of econometrics, 70*(1), 99–126. https://doi.org/10.1016/0304-4076(69)41685-7.
Grossman, G. M., & Krueger, A. B. (1991). *Environmental Impacts of a North American Free Trade Agreement. National Bureau of Economic Research Working Paper Series, No. 3914, 3914*, 1–57. https://doi.org/10.3386/w3914.
Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *The Quarterly Journal of Economics, 110*(2), 353–377. https://doi.org/10.2307/2118443.
Hamilton, J. M., Maddison, D. J., & Tol, R. S. J. (2005). Climate change and international tourism: A simulation study. *Global Environmental Change, 15*, 253–266. https://doi.org/10.1016/j.gloenvcha.2004.12.009.
Hatemi-J, A. (2008). Tests for cointegration with two unknown regime shifts with an application to financial market integration. *Empirical Economics, 35*, 497–505. https://doi.org/10.1007/s00181-007-0175-9.
Holden, A. (2016). *Environment and Tourism.* https://doi.org/10.4324/9781315767659.
Hoogendoorn, G., & Fitchett, J. M. (2018). Tourism and climate change: A review of threats and adaptation strategies for Africa. *Current Issues in Tourism, 21*(7), 742–759. https://doi.org/10.1080/13683500.2016.1188893.
Ibrahim, M. H., & Law, S. H. (2016). Institutional quality and CO_2 emission-trade relations: Evidence from sub-Saharan Africa. *South African Journal of Economics, 84*(2), 323–340. https://doi.org/10.1111/saje.12095.
Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7.
IPCC (2014). Climate change 2014: Synthesis report. *Contribution of Working Groups I, II, and III to the Fifth Assesment Report of the Intergovernmental Panel on the Climate Change*. Retrieved from https://www.ipcc.ch/report/ar5/syr/.
IPCC (2018). Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change. Retrieved from https://www.ipcc.ch/sr15/.
Işik, C., Kasımatı, E., & Ongan, S. (2017). Analyzing the causalities between economic growth, financial development, international trade, tourism expenditure and/on the CO2 emissions in Greece. *Energy Sources, Part B: Economics, Planning and Policy, 12*(7), 665–673. https://doi.org/10.1080/15567249.2016.1263251.
Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—With applications to the demand for money. *Oxford Bulletin of Economics and Statistics, 52*(2), 169–210. https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x.
Kanjilal, K., & Ghosh, S. (2018). Revisiting income and price elasticity of gasoline demand in India: New evidence from cointegration tests. *Empirical Economics, 55*(4), 1869–1888. https://doi.org/10.1007/s00181-017-1334-2.
Katircioglu, S. T. (2014). International tourism, energy consumption, and environmental pollution: The case of Turkey. *Renewable and Sustainable Energy Reviews, 36*, 180–187. https://doi.org/10.1016/J.RSER.2014.04.058.
Katircioglu, S. T., Feridun, M., & Kilinc, C. (2014). Estimating tourism-induced energy consumption and CO2 emissions: The case of Cyprus. *Renewable and Sustainable Energy Reviews, 29*, 634–640. https://doi.org/10.1016/J.RSER.2013.09.004.
Koçak, E., & Şarkgüneşi, A. (2018). The impact of foreign direct investment on CO2 emissions in Turkey: New evidence from cointegration and bootstrap causality analysis. *Environmental Science and Pollution Research, 25*(1), 790–804. https://doi.org/10.1007/s11356-017-0468-2.
Koçak, E., & Ulucak, Z.Ş. (2019). The effect of energy R&D expenditures on CO2 emission reduction: estimation of the STIRPAT model for OECD countries. *Environmental Science and Pollution Research,* 1–11. https://doi.org/10.1007/s11356-019-04712-2.
Lee, J. W., & Brahmasrene, T. (2013). Investigating the influence of tourism on economic growth and carbon emissions: Evidence from panel analysis of the European Union. *Tourism Management, 38*, 69–76. https://doi.org/10.1016/j.tourman.2013.02.016.
Lenzen, M., Sun, Y.-Y., Faturay, F., Ting, Y.-P., Geschke, A., & Malik, A. (2018). The carbon footprint of global tourism. *Nature Climate Change, 8*(6), 522–528. https://doi.org/10.1038/s41558-018-0141-x.
León, C. J., Arana, J. E., & Hernández Alemán, A. (2014). CO2 emissions and tourism in developed and less developed countries. *Applied Economics Letters, 21*(16), 1169–1173. https://doi.org/10.1080/13504851.2014.916376.
Li, K., & Lin, B. (2015). Impacts of urbanization and industrialization on energy consumption/CO_2 emissions: Does the level of development matter? *Renewable and Sustainable Energy Reviews, 52*, 1107–1122. https://doi.org/10.1016/j.rser.2015.07.185.
Liddle, B. (2014). Impact of population, age structure, and urbanization on carbon emissions/energy consumption: Evidence from macro-level, cross-country analyses. *Population and Environment, 35*(3), 286–304. https://doi.org/10.1007/s11111-013-0198-4.
Lin, S., Wang, S., Marinova, D., Zhao, D., & Hong, J. (2017). Impacts of urbanization and real economic development on CO2 emissions in non-high income countries: Empirical research based on the extended STIRPAT model. *Journal of Cleaner Production, 166*, 952–966. https://doi.org/10.1016/J.JCLEPRO.2017.08.107.
Lund-Thomsen, P., Lindgreen, A., & Vanhamme, J. (2016). Industrial clusters and corporate social responsibility in developing countries: What we know, what we do not know, and what we need to know. *Journal of Business Ethics, 133*(1), 9–24. https://doi.org/10.1007/s10551-014-2372-8.
Maki, D. (2012). Tests for cointegration allowing for an unknown number of breaks. *Economic Modelling, 29*(5), 2011–2015. https://doi.org/10.1016/J.ECONMOD.2012.04.022.
Martins, L. F., Gan, Y., & Ferreira-Lopes, A. (2017). An empirical analysis of the influence of macroeconomic determinants on world tourism demand. *Tourism Management, 61*, 248–260. https://doi.org/10.1016/j.tourman.2017.01.008.
Meo, M. S., Chowdhury, M. A. F., Shaikh, G. M., Ali, M., & Masood Sheikh, S. (2018). Asymmetric impact of oil prices, exchange rate, and inflation on tourism demand in Pakistan: New evidence from nonlinear ARDL. *Asia Pacific Journal of Tourism Research, 23*(4), 408–422. https://doi.org/10.1080/10941665.2018.1445652.
Mihalic, T. (2016). Sustainable-responsible tourism discourse – Towards 'responsustable' tourism. *Journal of Cleaner Production, 111*, 461–470. https://doi.org/10.1016/J.JCLEPRO.2014.12.062.
Mossler, M. V., Bostrom, A., Kelly, R. P., Crosman, K. M., & Moy, P. (2017). How does framing affect policy support for emissions mitigation? Testing the effects of ocean acidification and other carbon emissions frames. *Global Environmental Change, 45*, 63–78. https://doi.org/10.1016/J.GLOENVCHA.2017.04.002.
Naradda Gamage, S. K., Hewa Kuruppuge, R., & Haq, I.u. (2017). Energy consumption, tourism development, and environmental degradation in Sri Lanka. *Energy Sources, Part B: Economics, Planning and Policy, 12*(10), 910–916. https://doi.org/10.1080/15567249.2017.1324533.
Nasrollahi, Z., Hashemi, M.s., Bameri, S., & Mohamad Taghvaee, V. (2018). Environmental pollution, economic growth, population, industrialization, and technology in weak and strong sustainability: Using STIRPAT model. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-018-0237-5 (0123456789).
Nepal, R., Indra al Irsyad, M., & Nepal, S. K. (2019). Tourist arrivals, energy consumption and pollutant emissions in a developing economy–implications for sustainable tourism. *Tourism Management, 72*(December 2018), 145–154. https://doi.org/10.1016/j.tourman.2018.08.025.
Paramati, S. R., Alam, M. S., & Chen, C.-F. (2017). The effects of tourism on economic growth and CO_2 emissions: A comparison between developed and developing economies. *Journal of Travel Research, 56*(6), 712–724. https://doi.org/10.1177/0047287516667848.
Paramati, S. R., Alam, M. S., & Lau, C. K. M. (2018). The effect of tourism investment on tourism development and CO2 emissions: Empirical evidence from the EU nations. *Journal of Sustainable Tourism, 26*(9), 1587–1607. https://doi.org/10.1080/09669582.2018.1489398.
Paramati, S. R., Shahbaz, M., & Alam, M. S. (2017). Does tourism degrade environmental quality? A comparative study of Eastern and Western European Union. *Transportation Research Part D: Transport and Environment, 50*, 1–13. https://doi.org/10.1016/j.trd.2016.10.034.
Paramati, S. R., Sudharshan, R., Alam, M. S., & Chen, C. F. (2017). The effects of tourism on economic growth and CO2 emissions: A comparison between developed and developing economies. *Journal of Travel Research, 56*(6), 712–724. https://doi.org/10.1177/0047287516667848.
Park, Y., Meng, F., & Baloch, M. A. (2018). The effect of ICT, financial development, growth, and trade openness on CO2 emissions: An empirical analysis. *Environmental Science and Pollution Research,* 30708–30719. https://doi.org/10.1007/s11356-018-3108-6.
Pesaran, M. H., Ullah, A., & Yamagata, T. (2008). A bias-adjusted LM test of error cross-section independence. *The Econometrics Journal, 11*(1), 105–127. https://doi.org/10.1111/j.1368-423X.2007.00227.x.
Pesaran, M. H. (2004). *General Diagnostic Tests for Cross Section Dependence in Panel.* CESifo Working Paper No. 1233: Munich CESifo Group.
Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a

multifactor error structure. *Econometrica, 74*(4), 967–1012. https://doi.org/10.1111/j.1468-0262.2006.00692.x.
Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics, 22*(2), 265–312. https://doi.org/10.1002/jae.951.
Phillips, P. C. B., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. *The Review of Economic Studies, 57*(1), 99. https://doi.org/10.2307/2297545.
Raza, S. A., Sharif, A., Wong, W. K., & Karim, M. Z. A. (2017). Tourism development and environmental degradation in the United States: Evidence from wavelet-based analysis. *Current Issues in Tourism, 20*(16), 1768–1790. https://doi.org/10.1080/13683500.2016.1192587.
Rico, A., Martínez-Blanco, J., Montlleó, M., Rodríguez, G., Tavares, N., Arias, A., & Oliver-Solà, J. (2019). Carbon footprint of tourism in Barcelona. *Tourism Management, 70*, 491–504. https://doi.org/10.1016/J.TOURMAN.2018.09.012.
Scott, D., Gössling, S., & Hall, C. M. (2012). International tourism and climate change. *Wiley Interdisciplinary Reviews: Climate Change, 3*(3), 213–232. https://doi.org/10.1002/wcc.165.
Sghaier, A., Guizani, A., Ben Jabeur, S., & Nurunnabi, M. (2018). Tourism development, energy consumption and environmental quality in Tunisia, Egypt and Morocco: a trivariate analysis. *GeoJournal, Wttc 2017*, 1–17. https://doi.org/10.1007/s10708-018-9878-z.
Shahbaz, M., Loganathan, N., Muzaffar, A. T., Ahmed, K., & Ali Jabran, M. (2016). How urbanization affects CO2 emissions in Malaysia? The application of STIRPAT model. *Renewable and Sustainable Energy Reviews, 57*, 83–93. https://doi.org/10.1016/J.RSER.2015.12.096.
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.
Sharif, A., Afshan, S., & Nisha, N. (2017). Impact of tourism on CO2 emission: Evidence from Pakistan. *Asia Pacific Journal of Tourism Research, 22*(4), 408–421. https://doi.org/10.1080/10941665.2016.1273960.
Sharma, S., & Ghoshal, S. K. (2015). Hydrogen the future transportation fuel: From production to applications. *Renewable and Sustainable Energy Reviews, 43*, 1151–1158. https://doi.org/10.1016/J.RSER.2014.11.093.
Sherafatian-Jahromi, R., Othman, M. S., Law, S. H., & Ismail, N. W. (2017). Tourism and CO2 emissions nexus in Southeast Asia: New evidence from panel estimation. *Environment, Development and Sustainability, 19*(4), 1407–1423. https://doi.org/10.1007/s10668-016-9811-x.
Shimizu, T., & Okamoto, H. (2019). *Tourism Infrastructure, the Environment, and International Trade*.
Simmons, D. G. (2013). *Tourism and Ecosystem Services in New Zealand*.
Solarin, S. A. (2014). Tourist arrivals and macroeconomic determinants of CO_2 emissions in Malaysia. *Anatolia, 25*(2), 228–241. https://doi.org/10.1080/13032917.2013.868364.
Steenberghen, T., & López, E. (2008). Overcoming barriers to the implementation of alternative fuels for road transport in Europe. *Journal of Cleaner Production, 16*(5), 577–590. https://doi.org/10.1016/J.JCLEPRO.2006.12.001.
Ulucak, R., & Bilgili, F. (2018). A reinvestigation of EKC model by ecological footprint measurement for high, middle and low income countries. *Journal of Cleaner Production, 188*, 144–157. https://doi.org/10.1016/j.jclepro.2018.03.191.
UNWTO (2007). *Climate change and tourism: Responding to global chalenges.* http://sdt.unwto.org/sites/all/files/docpdf/summarydavose.pdf.
UNWTO (2018). *Tourism Highlights 2018 Edition International Tourism Trends 2017.* https://doi.org/10.18111/9789284419876.
de Vita, G., Katircioglu, S., Altinay, L., Fethi, S., & Mercan, M. (2015). Revisiting the environmental Kuznets curve hypothesis in a tourism development context. *Environmental Science and Pollution Research, 22*(21), 16652–16663. https://doi.org/10.1007/s11356-015-4861-4.
Westerlund, J. (2008). Panel cointegration tests of the Fisher effect. *Journal of Applied Econometrics, 23*(2), 193–233. https://doi.org/10.1002/jae.967.
York, R., Rosa, E. A., & Dietz, T. (2003). STIRPAT, IPAT and ImPACT: Analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics, 46*(3), 351–365. https://doi.org/10.1016/S0921-8009(03)00188-5.
Zaman, K., Moemen, M. A.e., & Islam, T. (2017). Dynamic linkages between tourism transportation expenditures, carbon dioxide emission, energy consumption and growth factors: Evidence from the transition economies. *Current Issues in Tourism, 20*(16), 1720–1735. https://doi.org/10.1080/13683500.2015.1135107.
Zaman, K., Shahbaz, M., Loganathan, N., & Raza, S. A. (2016). Tourism development, energy consumption and environmental Kuznets curve: Trivariate analysis in the panel of developed and developing countries. *Tourism Management, 54*, 275–283. https://doi.org/10.1016/j.tourman.2015.12.001.
Zhang, C., Wang, Y., Song, X., Kubota, J., He, Y., Tojo, J., & Zhu, X. (2017). An integrated specification for the nexus of water pollution and economic growth in China: Panel cointegration, long-run causality and environmental Kuznets curve. *Science of the Total Environment, 609*, 319–328. https://doi.org/10.1016/j.scitotenv.2017.07.107.
Zhang, L., & Gao, J. (2016). Exploring the effects of international tourism on China's economic growth, energy consumption and environmental pollution: Evidence from a regional panel analysis. *Renewable and Sustainable Energy Reviews, 53*, 225–234. https://doi.org/10.1016/j.rser.2015.08.040.
Zuo, B., & Huang, S.(. S.). (2018). Revisiting the tourism-led economic growth hypothesis: The case of China. *Journal of Travel Research, 57*(2), 151–163. https://doi.org/10.1177/0047287516686725.

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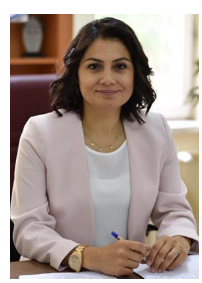

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