

Structural Breaks, Tourism and Co2 Emissions: The case of Turkey

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ABSTRACT

Turkey is a growing economy with high CO₂ emissions and preferred tourist destinations in the world. Therefore, the study deals with the tourism-CO₂ emissions link over the period 1983-2017 in case of Turkey by integrating renewable energy consumption to the CO₂ emissions specification as an additional variable. The stationarity analysis of the variables is examined by Ng-Perron and Vogelsang-Perron tests. The ARDL and Hatemi-J cointegration approaches are employed to determine the existence of cointegration among the variables under structural breaks while the causality analysis is carried out through the VECM procedure. There exists cointegration among the variables under structural breaks. There also exists evidence in favour of EKC hypothesis. The DOLS, FMOLS and CCR results reveal that tourism and renewable energy consumption decrease CO₂ emissions in the long run. Additionally, a long-run bi-directional causality between tourism, renewable energy, and CO₂ emissions exists. The empirical results obtained from the study can provide several policy suggestions to reduce environmental pollution for Turkish economy.

Keywords: Structural breaks, tourism, CO₂ emissions, cointegration, causality, Turkey

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1. INTRODUCTION

Tourism is a main industry playing a vital role in the global economy. In 2018, the number of international tourist arrival was 1.4 million in the world. It is expected that this number will reach 1.8 million by 2030. In this year, tourism industry generated 10.4% of world GDP and 310 million jobs. Export earnings created by tourism reached to USD 1.7 trillion. At the same time, the growth in tourism exports was nearly 4% (WTTC, 2019). Tourism and air transport industry is one of the greatest contributors to CO₂ emissions. Transport-related CO₂ emissions from tourism represented 5% of global emissions and 22% of all transport emissions in 2016. These emissions are expected to rise from 1,597 million tonnes to

1,998 million tonnes between 2016 and 2030 (UNWTO, 2020). In recent years, it is seen that the literature has started to investigate the link between tourism and CO₂ emissions using different econometric methods for different countries (Bella, 2018; Khattak and Wang, 2018; Khan et al., 2019; Kumail et al., 2020).

This study examines the link between tourism and CO₂ emissions in Turkey for the period 1983-2017. The study includes economic growth and renewable energy consumption in CO₂ emissions specification as other explanatory variables. Turkish economy is selected to examine the tourism-CO₂ emissions link for several reasons. Turkey is an important country which has the most unique natural and cultural beauties. Therefore, Turkey has the most preferred tourist destinations in the world. Foreign travelers arrived in Turkey increased from 13 million to 46 million between 2002 and 2018 (UNWTO, 2020; TSI, 2020). On the other hand, Turkey is a country with high CO₂ emissions among OECD countries. Energy-related CO₂ emissions was 385 million tonnes in 2018. Turkey's CO₂ emissions are projected to continue to rise until 2030. Transport and tourism industry was found to release about 21% of total CO₂ emissions in Turkey (Climate Transparency, 2020). Therefore, examining the link between tourism and CO₂ emissions for Turkey will be very important for reviewing environmental policies.

As seen in Table 1, there exist very few studies considering both Turkish economy and structural breaks. In this study, the Ng-Perron test and Vogelsang-Perron approach with one structural break are employed for stationarity analysis. So, it is possible to prevent from the spurious regression problem. We use the ARDL approach under the structural break to carry out the cointegration analysis. We also use the Hatemi-J cointegration method with two regime shifts. We apply the ARDL, DOLS, FMOLS and CCR models to estimate the long-run coefficients. So, it is possible to provide robust long-run empirical findings. We also apply the VECM approach for causality analysis. The empirical findings obtained from the present study may provide important policy implications for Turkish economy.

This study can be organized as follows: The literature is dealt with in Section 2. The data and methodology are provided in Section 3. Section 4 includes the empirical results. Section 5 presents the main conclusions and policy suggestions.

2. LITERATURE

Tourism economics is an important branch of the economy that investigate social and economic effects of tourism sector on economy. This literature has intensified on the effect of tourism industry on welfare (King et al., 1993; Urtasun and Gutierrez, 2006), economic growth (Kammas and Salehi-Esfahani, 1992; Archer, 1995; Katircioglu, 2009; Holzner, 2011), employment (Dexter, 1995; Szivas and Riley, 1999; Liu and Wall, 2006), and trade (Santana-Gallego et al., 2016; Çalışkan et al., 2019). Although these researchers investigate several aspects of tourism, they do not deal with the link between tourism and environmental pollution. In recent years, the tourism-led environmental degradation approach has been discussed by Paramati et al. (2018), Ahmad et al. (2019), and Russo et al. (2020).

Tourism is accepted as a strategic industry which has both environmental benefits and costs (Kumail et al., 2020). Gössling (2000) discusses that tourism can cause CO₂ emissions in developing countries.

Tourism can positively affect environmental degradation because it is largely dependent on high energy-consuming activities such as transport, airport, cooking, cleaning, heating and cooling. So, it is found that tourism is not a low-carbon sector. On the other hand, tourism can generate positive effects on the environment. Tourism can increase the awareness of environmental problems because it is closely linked with nature and environment. It can contribute to the protection of biological diversity and natural resources. In addition, cleaner production methods may be important instruments for planning tourism activities. So, it is possible to decrease their environmental effects (UNEP, 1998).

Many studies have carried out time series analyses (see Table 1). Solarin (2014) may be first study to deal with the tourism-CO₂ emissions link for Malaysia from the period of 1972 to 2010. The findings reveal that tourism positively affects CO₂ emissions and tourism causes CO₂ emissions. Using the ARDL model and VECM causality approach, Katircioglu et al. (2014) for Cyprus show a positive link between the variables over the period of 1970-2009. This result is consistent with the findings of Sharif et al. (2017), who analyze the Pakistan economy from 1972 to 2013 employing the ARDL, DOLS and FMOLS estimation techniques. In addition, the study shows that tourism causes CO₂ emissions. Applying an ARDL approach, Işık et al. (2017) for Greece reveal a positive relation between the variables and uni-directional causal linkage from CO₂ emissions to tourism through the VECM causality method. Bella (2018) for France does not intensify on the estimation of the long-run parameters. But the study investigates the causal linkages between the variables over the period of 1995-2014. The results confirm that CO₂ emissions cause tourism. Azam et al. (2018) find that tourism positively affects CO₂ emissions in Malaysia during the period of 1990-2014. Sghaier et al. (2019) for Tunisia, Egypt and Morocco apply the ARDL procedure over the period of 1980-2014. It is determined that tourism rises CO₂ emissions. Ahmad et al. (2019) examine Indonesia, Philippines and Vietnam during the period of 1995-2014. The FMOLS analysis suggests a positive linkage between the variables in Indonesia and Philippines while there exists a negative link between the variables in Vietnam. Liu et al. (2019) and Kumail et al. (2020) use several time series techniques for Pakistan. The first shows that there exists no a long-run effect while the latter indicates a positive relationship between the variables.

The tourism-CO₂ emissions relationship is mentioned in many panel data studies. Applying several panel data techniques such as Pedroni cointegration test, FMOLS estimation method and VECM causality approach, Al-Mulali et al. (2015) find a positive link between the variables for 48 countries from 1985 to 2009. They also find that CO₂ emissions cause tourism. Using a similar methodology, Zhang and Gao (2016) suggest that tourism decreases CO₂ emissions in China over the period of 1995-2011. Their causality finding is in line with the findings of Al-Mulali et al. (2015). Lee and Brahmasrene (2016) for SSA countries show that CO₂ emissions are determined by tourism during the period of 1988-2010. Shakouri et al. (2017) deal with Asia-Pacific countries from the period of 1995 to 2013. The panel GMM estimation findings reveal that tourism decreases CO₂ emissions. Additionally, the findings suggest that tourism causes CO₂ emissions. Analyzing EU countries for the years from 1991 to 2013, Paramati et al. (2017) report that tourism promotes CO₂ emissions. In addition, there exists no causal linkage between the variables. Intensifying on OECD countries during 1995-2010,

Dogan et al. (2017) demonstrate that tourism rises CO2 emissions. They indicate that tourism causes CO2 emissions. This result is confirmed by the findings of Dogan and Aslan (2017), Khan et al. (2019), Zhang and Liu (2019), and Shi et al. (2019). Dogan and Aslan (2017) for EU countries and Jebli and Hadhri (2018) for 10 countries report that tourism negatively affects CO2 emissions.

For the Turkish economy, several studies such as Katircioglu (2014), Yorucu (2015), de Vita et al (2015), Akadiri et al. (2019) and Eyuboglu and Uzar (2019) have integrated tourism into CO2 emissions model.

Katircioglu (2014) is the first study investigating the tourism-CO2 emissions link for Turkey. Applying an ARDL procedure, the study indicates a positive relation between the series. However, the causality between the variables is not examined. Using the ARDL approach and VECM procedure during the period of 1960-2010, Yorucu (2015) reveals that tourism negatively affects and causes CO2 emissions in the long run. Conducting a time series analysis covering the period of 1960-2009, De Vita et al. (2015) include tourism in the EKC analysis. They show that the series are cointegrated under structural breaks. They do not deal with the causality between the variables. Akadiri et al. (2019) examine the determinants of environmental sustainability through the ARDL and VECM procedures during the period 1970-2014. The findings suggest that tourism is positively related to CO2 emissions and tourism causes CO2 emissions. Applying the cointegration tests of Bayer-Hanck, Fourier ADL and ARDL, Eyuboglu and Uzar (2019) test the link among tourism, growth, energy, and environmental degradation in the period 1960-2014. Their results reveal that tourism increases and causes CO2 emissions in the long run.

Table 1 : Selected Researches

<i>Author</i>	<i>Country</i>	<i>Period</i>	<i>Method</i>	<i>Long-run impact</i>	<i>Long-run causality</i>
<i>Panel A: Time-series studies</i>					
Kumail et al. (2020)	Pakistan	1990-2017	ARDL, Bayer-Hanck, Granger	(+)	TOUR ↔ CO2
Liu et al. (2019)	Pakistan	1980-2016	ARDL, Granger	No	No
Akadiri et al. (2019)	Turkey	1970-2014	ARDL, VECM	(+)	TOUR ↔ CO2
Ahmad et al. (2019)	Indonesia, Philippines and Vietnam	1995-2014	Gregory-Hansen, FMOLS,	(+) (Indonesia, Philippines) (-) (Vietnam)	Not investigated
Eyuboglu and Uzar (2019)	Turkey	1960-2014	Bayer-Hanck, Fourier ADL, ARDL, VECM	(+)	TOUR ↔ CO2
Sghaier et al. (2019)	Tunisia, Egypt and Morocco	1980-2014	ARDL	(+)	Not investigated
Azam et al. (2018)	Malaysia, Singapore and Thailand	1990-2014	Gregory-Hansen, FMOLS	(+) (Malaysia) (-) (Singapore and Thailand)	Not investigated
Bella (2018)	France	1995-2014	Johansen, VECM	Not investigated	CO2 → TOUR
Işık et al. (2017)	Greece	1970-2014	ARDL, VECM	(+)	CO2 → TOUR

Sharif et al. (2017)	Pakistan	1972-2013	Johansen, Gregory-Hansen, ARDL, DOLS, FMOLS	(+)	TOUR → CO2
Yorucu (2015)	Turkey	1960-2010	ARDL, VECM	(-)	TOUR → CO2
De Vita et al. (2015)	Turkey	1960-2009	Maki, DOLS	(+)	Not investigated
Katircioglu et al. (2014)	Cyprus	1970-2009	ARDL, VECM	(+)	TOUR → CO2
Katircioglu (2014)	Turkey	1960-2014	ARDL, VAR	(+)	Not investigated
Solarin (2014)	Malaysia	1972-2010	ARDL, DOLS, VECM	(+)	TOUR → CO2
Panel B: Panel data studies					
Koçak et al. (2020)	10 countries	1995-2014	Westerlund, CUP-FM, CUP-BC, Dumitrescu-Hurlin	(+) (-)	TOUR ↔ CO2
Shi et al. (2019)	147 countries	1995-2015	Pedroni, FMOLS, VECM	No	TOUR → CO2
Zhang and Liu (2019)	NSEA-10 countries	1995-2014	FMOLS, AMG	(+)	TOUR → CO2
Khan et al. (2019)	34 countries	1995-2017	Westerlund, DOLS, AMG, Dumitrescu-Hurlin	(+) (-)	TOUR → CO2
Khattak and Wang (2018)	BRICS	1995-2014	Westerlund, DSUR, Dumitrescu-Hurlin	(+)	TOUR ↔ CO2
Jebli and Hadhri (2018)	10 countries	1995-2013	Pedroni, FMOLS, DOLS, VECM	(-)	TOUR ↔ CO2
Dogan and Aslan (2017)	EU	1995-2011	FMOLS, DOLS, Emirmahmutoglu-Kose	(-)	TOUR → CO2
Dogan et al. (2017)	OECD	1995-2010	Westerlund-Edgerton, DOLS, Dumitrescu-Hurlin	(+)	TOUR → CO2
Paramati et al. (2017)	EU	1991-2013	Westerlund, FMOLS, Dumitrescu-Hurlin	(+)	No
Shakouri et al. (2017)	Asia-Pacific countries	1995-2013	GMM, Granger	(-)	TOUR → CO2
Lee and Brahmasrene (2016)	SSA	1988-2010	Johansen, Panel random effect	(+)	Not investigated
Zhang and Gao (2016)	China	1995-2011	Pedroni, FMOLS, VECM	(-)	TOUR → CO2

3. EMPIRICAL MODEL AND DATA

This paper conducts a time-series analysis to investigate the link between tourism and environmental pollution in Turkey. Following Bella (2018), we use the log-linear regression specification because its results are more robust. This model can be expressed as follows:

$$\ln CO_{2t} = \delta_0 + \delta_1 \ln GDP_t + \delta_2 \ln GDP_t^2 + \delta_3 \ln TOUR_t + \mu_t \quad (1)$$

The main property of this specification is that it permits us to examine the relationship between tourism and CO2 emissions by considering the environmental Kuznets curve (EKC) hypothesis. This hypothesis

asserts that the link between real income and CO2 emissions is an inverted-U shaped. In addition to real income and tourism, Bekhet and Othman (2018) and Zhang and Liu (2019) consider the renewable energy-CO2 emissions link. By integrating renewable energy as an independent variable to the CO2 emissions specification, we also use the following model to examine the tourism-environmental pollution relationship:

$$\ln CO_{2t} = \delta_0 + \delta_1 \ln GDP_t + \delta_2 \ln GDP_t^2 + \delta_3 \ln TOUR_t + \delta_4 \ln REN_t + \mu_t \quad (2)$$

where CO2 is per capita CO2 emissions (metric tons) (Işık et al., 2017; Cetin et al., 2018a), GDP is per capita real income (constant 2010 US \$) (Koçak et al., 2020), GDP2 is the square of per capita real income, REN is renewable energy consumption (hydroelectricity, million tons of oil equivalent) (Solarin et al., 2017; Pata, 2018), and TOUR is the number of tourist arrivals (Nepal et al., 2019). The μ is the residual term. The data set used in the study encompasses the period of 1983-2017. The period is started by 1983 owing to the availability of data set for the number of tourist arrivals. We use the logarithmic forms of all the variables to comment as elasticity. δ_1 , δ_3 and δ_4 are the long-run parameters for per capita CO2 emissions with per capita real income, tourism and renewable energy consumption, respectively. Based on the EKC hypothesis, the signs of δ_1 and δ_2 are expected to be positive and negative, respectively (Azam et al., 2018; Cetin et al., 2018b). Tourism sector can negatively affects environmental degradation, therefore the expected sign for δ_3 is negative (Alam and Paramati, 2017). Lastly, the sign of δ_4 is expected to be negative because renewable energy is negatively related to environmental pollution (Sinha and Shahbaz, 2018). The data for per capita CO2 emissions, per capita real income, tourist arrivals and hydroelectricity consumption are collected from the databases of the OECD (2020), World Bank (2020), Turkish Statistical Institute (2020) and BP (2020), respectively. The descriptive statistics of the series are indicated in Table 2. Fig. 1, shows the trends of the series for the period 1983-2017.

Table2: Summary Statistics

Statistics	$\ln CO_2$	$\ln GDP$	$\ln GDP^2$	$\ln TOUR$	$\ln REN$
Mean	1.065	9.051	82.005	9.277	1.993
Median	1.064	9.010	81.184	9.252	2.078
Std. dev.	0.268	0.289	5.267	0.939	0.484
Min.	0.530	8.577	73.571	7.317	0.942
Max.	1.547	9.607	92.302	10.514	2.722
Skewness	-0.198	0.307	0.352	-0.405	-0.682
Kurtosis	2.113	2.055	2.078	2.128	2.813
Jarque-Bera	1.375	1.852	1.964	2.066	2.768
Prob.	0.502	0.396	0.374	0.355	0.250
Sum	37.286	316.791	2870.184	324.706	69.775
Sum sq. dev.	2.450	2.850	943.264	29.991	7.991
Obs.	35	35	35	35	35

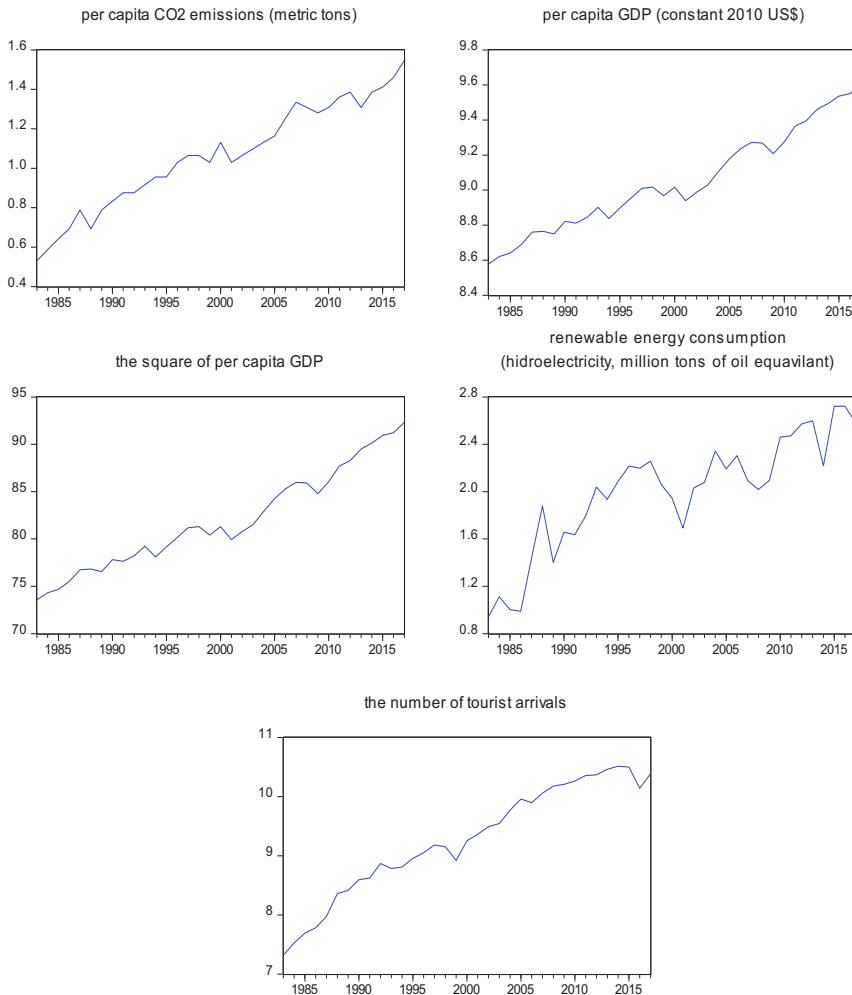


Figure 1. Trends of the variables (1983-2017)

4. ECONOMETRIC METHODOLOGY

In order to estimate the specifications constructed in eqs. (1) and (2), the study applies the time series techniques. In the first step, the stationarity analysis of series is examined through the Ng-Perron and Vogelsang-Perron unit root tests. Ng and Perron (2001) propose several tests called as $MZ\alpha$, MZt , MSB and MPT . When compared with the other classical unit root tests, this test presents more reliable findings related to the series (Shahbaz and Lean, 2012). However, the results may be not robust and unbiased because all the classical unit root tests do not include structural break in their analyses (Shahbaz et al., 2014). So, the stationarity properties are also checked by the Vogelsang-Perron unit root test. Vogelsang and Perron (1998) develop two models including one structural break. First, the additive outlier value (AO) model postulates that structural changes show suddenly, and it allows a change in the slope of the trend specification. Second, the innovation outlier value (IO) model presumes

that the change occurs gradually and it allows only a change in the constant of the trend specification. We use the AO model for unit root analysis.

In the second step, the cointegration between the variables are examined by ARDL bounds test and Hatemi-J cointegration technique. This approach is preferred to the conventional techniques proposed by Johansen (1988) and Engle and Granger (1987) due to the following reasons. The ARDL approach incorporates the variables to the analysis in their levels. The ARDL procedure permits the series to be integrated at I(0) or I(1). This test is very appropriate for small samples. Moreover, the long and short-run dynamics can be analysed through the dynamic unrestricted error correction model (UECM) (Pesaran et al., 2001). The UECMs derived from the ARDL model can be specified as follows:

$$\Delta \ln CO_{2t} = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta \ln CO_{2t-i} + \sum_{i=0}^q \alpha_{2i} \Delta \ln GDP_{t-i} + \sum_{i=0}^q \alpha_{3i} \Delta \ln GDP^2_{t-i} + \sum_{i=0}^q \alpha_{4i} \Delta \ln TOUR_{t-i} + \beta_1 \ln CO_{2t-1} + \beta_2 \ln GDP_{t-1} + \beta_3 \ln GDP^2_{t-1} + \beta_4 \ln TOUR_{t-1} + \beta_5 D_{1998} + u_t \quad (3)$$

$$\Delta \ln CO_{2t} = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta \ln CO_{2t-i} + \sum_{i=0}^q \alpha_{2i} \Delta \ln GDP_{t-i} + \sum_{i=0}^q \alpha_{3i} \Delta \ln GDP^2_{t-i} + \sum_{i=0}^q \alpha_{4i} \Delta \ln TOUR_{t-i} + \sum_{i=0}^q \alpha_{5i} \Delta \ln REN_{t-i} + \beta_1 \ln CO_{2t-1} + \beta_2 \ln GDP_{t-1} + \beta_3 \ln GDP^2_{t-1} + \beta_4 \ln TOUR_{t-1} + \beta_5 \ln REN_{t-1} + \beta_6 D_{1998} + u_t \quad (4)$$

where Δ , α_0 , u_t and p denote the first different operator, drift component, white noise error term and maximum lag length, respectively. In the ARDL procedure, the AIC or SIC criteria are preferred for appropriate lag length. The SIC is employed in this study. In above models, $\alpha_0 - \alpha_5$ indicate the error correction dynamics, while $\beta_1 - \beta_5$ depict the long-run dynamics between the series. The null hypothesis is $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$, while the alternative is $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$. Pesaran et al. (2001) compare the upper and lower critical bounds (UCB and LCB) with the calculated F-statistic. The null hypothesis is rejected when the computed F-statistic is larger than the UCB. This suggests a cointegration among the variables. The null hypothesis is not rejected when the calculated F-statistic is smaller than the LCB. This shows no cointegration among the variables.

The serial correlation, normality and heteroscedasticity tests are used to explore the validity of ARDL model. In addition, the stability of the long-run parameters is tested through the CUSUM and CUSUMsq tests suggested by Brown et al. (1975).

In this study, the cointegration between the variables are also examined by Hatemi-J test. Hatemi-J (2008) extends the tests presented by Gregory and Hansen (1996) by allowing for two regime shifts. Hatemi-J (2008) employs the ADF test suggested by Engle and Granger (1987), Z_a and Z_t tests proposed by Phillips (1987) to test the null hypothesis of no cointegration. This cointegration procedure presents new critical values for three tests. According to the Monte Carlo simulations, these tests exhibit good power properties (Hatemi-J, 2008). The model with two regime shifts proposed by Hatemi-J (2008) is used in this study. The model can be specified as follows:

$$y_t = \alpha_0 + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \beta'_0 x_t + \beta'_1 D_{1t} x_t + \beta'_2 D_{2t} x_t + \mu_t \quad (5)$$

where D_{1t} and D_{2t} are the dummy variables denoting structural breaks. They can be expressed as follows:

$$D_{1t} = \begin{cases} 0 & \text{if } t \leq [n\tau_1] \\ 1 & \text{if } t > [n\tau_1] \end{cases} \quad \text{and} \quad D_{2t} = \begin{cases} 0 & \text{if } t \leq [n\tau_2] \\ 1 & \text{if } t > [n\tau_2] \end{cases} \quad (6)$$

where $\tau_1 \in (0, 1)$ and $\tau_2 \in (0, 1)$ refer to the unknown break points. The test statistics are the smallest values of these three tests across all values for τ_1 and τ_2 , with $\tau_1 \in T_1 = (0.15, 0.70)$ and $\tau_2 \in T_2 = (0.15 + \tau_1, 0.85)$. These test statistics are specified as follows:

$$ADF^* = \inf_{(\tau_1, \tau_2) \in T} ADF(\tau_1, \tau_2) \quad (7)$$

$$Z_t^* = \inf_{(\tau_1, \tau_2) \in T} Z_t(\tau_1, \tau_2) \quad (8)$$

$$Z_\alpha^* = \inf_{(\tau_1, \tau_2) \in T} Z_\alpha(\tau_1, \tau_2) \quad (9)$$

All three test statistics indicate a non-standard distribution. The null hypothesis of no cointegration is rejected when the calculated ADF^* , Z_t^* and Z_α^* statistics are larger than the critical values tabulated by Hatemi-J (2008).

In the third step, the long-run estimates are carried out by the ARDL model, dynamic OLS (DOLS), fully modified OLS (FMOLS) and canonical cointegration regression (CCR). In the ARDL approach, the long-run coefficients are examined through the OLS method. The DOLS, FMOLS and CCR procedures require the variables to be stationary at their first difference, while the ARDL approach allows the variables to be integrated at $I(0)$ or $I(1)$. In addition, the ARDL approach can easily solve the endogeneity problem in the variables because the model has a dynamic structure (Riti et al., 2017).

Stock and Watson (1993) put forward a very dynamic model integrating first differences of the regressors and leads and lags of the first differences into the initial specification. The DOLS procedure is a parametric approach which considers the serial correlation and endogeneity of the regressors. Kirikkaleli (2020) indicates that this method may provide efficient and unbiased estimates for small sample size. Phillips and Hansen (1990) provide a semiparametric version of the maximum likelihood methods. The FMOLS procedure suggests the fully modified Wald test which display χ^2 distribution. These statistics facilitate inference in $I(1)$ regression specifications. The CCR model developed by Park (1992) proposes a nonparametric procedure for a cointegrated model. This model is generated with the transformed data and very simple to implement.

Lastly, after estimating the long-run coefficient, we explore the causality among the variables using the VECM approach. Engle and Granger (1987) augment the classical Granger causality technique with an error-correction term (ECT_{t-1}). In this procedure, this term is integrated into the original VAR model as a new variable. When considering our extensive regression model, the VECM is specified as follows:

$$(1 - L) \begin{bmatrix} \ln CO_{2t} \\ \ln GDP_t \\ \ln TOUR_t \\ \ln REN_t \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix} + \sum_{i=1}^p (1 - L) \begin{bmatrix} c_{11i} c_{12i} c_{13i} c_{14i} \\ c_{21i} c_{22i} c_{23i} c_{24i} \\ c_{31i} c_{32i} c_{33i} c_{34i} \\ c_{41i} c_{42i} c_{43i} c_{44i} \end{bmatrix} \times \begin{bmatrix} \ln CO_{2t-1} \\ \ln GDP_{t-1} \\ \ln TOUR_{t-1} \\ \ln REN_{t-1} \end{bmatrix} + \begin{bmatrix} \beta \\ \theta \\ \delta \\ \gamma \end{bmatrix} ECT_{t-1} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \end{bmatrix} \quad (10)$$

where $(1-L)$ denotes the first-difference operator; β , θ , δ and γ are the coefficients of the ECT-1; u_1 , u_2 , u_3 and u_4 are normally distributed and serially uncorrelated residual terms. The long-run causal linkage between the series is described by a significance of the coefficient of ECTt-1 using t-statistic. The F-statistic is applied on the first differences of the series for the short-run causality. There exists a short-run causality among the series when the F-statistic is statistically significant.

5. RESULTS

The descriptive statistics revealed in Table 2 suggest that the mean is higher for tourism than for CO2 emissions. The median value of CO2 emissions is lower than the other series. The standard deviation is higher for tourism than for CO2 emissions and real GDP per capita. The Jarque-Bera test results indicate that all the series have a normal distribution over the period.

In the first step, we carry out the stationarity analysis for variables using the Ng-Perron and Vogelsang-Perron tests. Table 3 shows the Ng-Perron test results. The findings reveal that the series are stationary in their first difference. This implies that the series are integrated at $I(1)$. The Vogelsang-Perron test results presented in Table 4 are similar with the findings of Ng-Perron test. This means that they are $I(1)$ series. Table 4 provides detailed information on the structural breaks of the series. The structural break dates for CO2 emissions, real GDP per capita, the square of real GDP per capita, tourism and renewable energy consumption are 1998, 2007, 2002, 2010 and 1997, respectively.

Table 3 : Ng-Perron test

<i>Variables/Statistics</i>	<i>MZ_a</i>	<i>MZ_t</i>	<i>MSB</i>	<i>MPT</i>	<i>Result</i>
<i>Level</i>					
lnCO ₂	-12.128	-2.451	0.202	7.572	-
lnGDP	-8.198	-1.924	0.234	11.402	-
lnGDP ²	-7.416	-1.801	0.242	12.511	-
lnTOUR	-5.204	-1.376	0.264	16.577	-
lnREN	-11.647	-2.392	0.205	7.929	-
<i>First difference</i>					
Δ lnCO ₂	-14.780*	-2.662*	0.180*	6.485*	$I(1)$
Δ lnGDP	-16.270*	-2.844*	0.174*	5.649*	$I(1)$
Δ lnGDP ²	-16.296*	-2.845*	0.174*	5.646*	$I(1)$
Δ lnTOUR	-15.438*	-2.679*	0.173*	6.473*	$I(1)$
Δ lnREN	-15.245*	-2.748*	0.180*	6.047*	$I(1)$

Note: * shows significance at 10%.

Table 4 : Vogelsang-Perron test

<i>Variables</i>	<i>t-statistic</i>	<i>Time break</i>	<i>Result</i>
<i>Level</i>			
lnCO ₂	-4.504	1998	-
lnGDP	-4.409	2007	-
lnGDP ²	-4.478	2002	-
lnTOUR	-3.780	2010	-
lnREN	-4.682	1997	-
<i>First difference</i>			
Δ lnCO ₂	-8.314***	2007	$I(1)$
Δ lnGDP	-6.751***	2007	$I(1)$
Δ lnGDP ²	-6.751***	2009	$I(1)$

$\Delta \ln \text{TOUR}$	-9.367***	1999	$I(1)$
$\Delta \ln \text{REN}$	-8.227***	1988	$I(1)$

Note: * shows significance at 1%.

We can apply the cointegration tests on Eqs. (1) and (2). All the stationarity findings enable us to use the ARDL bounds test and Hatemi-J cointegration technique for long-run analysis. Therefore, in the second step, we apply these tests for cointegration analysis. The selection of the optimal lag length is very important for cointegration and causality analyses. We determine the optimal lag length using the SIC. The findings illustrated in Table 5 show that the optimal lag length for all the models is estimated as one. So, we have ARDL(1,0,0,0) for case 1 and ARDL(1,0,0,0,0) for case 2.

The findings for cointegration are provided in Table 6. The cointegration analysis shows that the calculated F-statistics for ARDL bounds test are 9.66 and 10.03, respectively. The values surpass the upper critical bounds at 1% level of significance indicating that the null hypothesis of no cointegration among the variables is rejected for all the models. This means that the variables are cointegrated. The findings show that the computed ADF* statistics for Hatemi-J cointegration test are -7.66 and -9.23, respectively. The values exceed the upper critical bounds at different levels of significance. This indicates the cointegration among the series. The findings are compatible with the results of Z_t^* statistics. Moreover, the coefficients of $\text{ECT}(t-1)$ are found to be negative and statistically significant at 1% level meaning that the cointegration between the series are confirmed.

Table 5 : Lag Selection Criteria

Lag length	LR	FPE	AIC	SIC	HQ
Model 1					
1	206.215* ¹	1.81e-11*	-13.394*	-12.477*	-13.090*
2	15.437	2.65e-11	-13.065	-11.416	-12.518
3	10.624	4.72e-11	-12.624	-10.242	-11.834
Model 2					
1	216.078*	5.49e-13*	-14.062*	-12.688*	-13.607*
2	22.262	1.03e-12	-13.560	-11.041	-12.725
3	14.748	2.76e-12	-12.919	-9.255	-11.705

Note: * shows optimal lag length.

Table 6 : Cointegration Analysis

Panel A: Bounds F-test						
Estimated equation	$F(\ln\text{CO}_2/\ln\text{GDP}, \ln\text{GDP}^2, \ln\text{TOUR})$			$F(\ln\text{CO}_2/\ln\text{GDP}, \ln\text{GDP}^2, \ln\text{TOUR}, \ln\text{REN})$		
Optimal lag structure	[1,0,0,0]			[1,0,0,0,0]		
F-statistic	9.66***			10.03***		
Structural break	1998			1998		
ECT _(t-1)	-0.878***			-0.858***		
Cointegration	Yes			Yes		
Critical values for bounds test						
Significance level	Lower	bounds,	Upper	Lower	bounds,	Upper bounds,
	I(0)		bounds, I(1)	I(0)		I(1)
1%	5.17		6.36	4.40		5.72
5%	4.01		5.07	3.47		4.57
10%	3.47		4.45	3.03		4.06

Panel B: Hatemi-J cointegration test

Test statistics	Estimated value	Estimated value
ADF^*	-7.669**	-9.231***
Z_t^*	-8.828***	-11.778***
Z_{∞}^*	-49.957	-51.368
Cointegration	Yes	Yes

Note: The optimal lag length is selected based on SIC. *** and ** show significance at 1% and 5%, respectively.

After conducting the cointegration analysis, the long-run coefficients are estimated through the ARDL model. The ARDL model estimation results are presented in Table 7. We can start to guess by considering the model 1. The coefficients of real GDP per capita and the square of real GDP per capita are found to be positive and negative, respectively. They are statistically significant at 1% level. The results for Turkish economy prove the existence of EKC hypothesis suggesting that there exists an inverted U-shaped link between the variables. The findings coincide with the results of model 2. Our results are supported by Dong et al. (2018), who intensify on the effect of nuclear and renewable energy sources on CO₂ emissions in case of China. The study suggests that there exists a long-run evidence in favor of the EKC. The EKC results from the present study are also supported by Acaravci and Ozturk (2010) for European countries, Shahbaz et al. (2012) for Pakistan, Alam et al. (2016) for Brazil, China, India and Indonesia, Ali et al. (2017) for Malaysia, and Pata (2018) for Turkey. On the other hand, the EKC results are not in line with the results of Dogan et al. (2017), who indicate the presence of EKC hypothesis in OECD countries using the DOLS estimator.

Some studies consider the role of tourism in examining the EKC hypothesis. de Vita et al. (2015) for Turkey, Azam et al. (2018) for Malaysia, Bella (2018) for France, Sghaier et al. (2019) for Tunisia, Egypt and Morocco, Ahmad et al. (2019) for Indonesia and Vietnam, Zaman et al. (2016) for 34 countries, Sghaier et al. (2019) for Tunisia, Egypt and Morocco provide evidence in favour of the EKC hypothesis. Conversely, Azam et al. (2018) for Singapore and Thailand do not provide evidence that supports the validity of EKC hypothesis.

One major finding of this study is revealing the impact of tourism on CO₂ emissions. It is observed that the long-run elasticities for model 1 and 2 are -0.121 and -0.162, respectively (see Table 7). The results indicate a negative long-run relation between tourism and CO₂ emissions meaning that a 1% rise in tourism reduces CO₂ emissions by 0.121% and 0.162%, respectively. Therefore, we conclude that tourism improves environmental quality in the long run. The results coincide with the work of Ahmad et al. (2019), who find that tourism reduces CO₂ emissions in Vietnam using the FMOLS estimation approach. The results are not in line with the study of de Vita et al. (2015), who reveal that tourism positively affects CO₂ emissions in the long run applying the DOLS estimation method under structural breaks for Turkey. Our results are demonstrated by many studies (i.e., Zhang and Gao, 2016; Dogan and Aslan, 2017; Shakouri et al. 2017; Bella, 2018; Jebli and Hadhri, 2018). On the other hand, Solarin (2014) for Malaysia, Katircioglu (2014) for Turkey, Katircioglu et al. (2014) for Cyprus, Yorucu (2015) for Turkey, Liu et al. (2019) for Pakistan, and Eyuboglu and Uzar (2019) for Turkey show that tourism increases environmental degradation.

The long-run results for model 2 reveal that the coefficient of renewable energy consumption is negative and statistically significant at 5% level. The result shows that renewable energy consumption negatively affects CO₂ emissions. This implies that a 1% rise in renewable energy consumption reduces CO₂ emissions by 0.095%. The result is similar to the findings of Waheed et al. (2018), who suggest that renewable energy consumption has a negative effect on CO₂ emissions for Pakistan applying the ARDL,

DOLS and FMOLS techniques. The finding is not similar to the results of Belaid and Youssef (2017), who reveal a positive relationship between the variables for Algeria using the ARDL bounds test.

We use several diagnostic tests to investigate the reliability of the ARDL models. The findings presented at the bottom of Table 7 reveal that there exists no serial correlation and heteroscedasticity of residuals. Additionally, the residuals have a normal distribution and the models are well designed. Thus, all the findings confirm the robustness of the ARDL models. In addition, the results seen in Figs. 2 and 3 indicate that the long-run parameters are stable and can be employed for policy suggestions.

In order to check the robustness of the long-run results obtained from the ARDL model, we further employ several estimation techniques such as the FMOLS, DOLS and CCR. The results obtained from the DOLS, FMOLS and CCR estimates with structural breaks reveal the validity of EKC hypothesis for Turkish economy. The results also reveal that tourism and renewable energy consumption reduce CO2 emissions. This mean that tourism and renewable energy consumption improve environmental quality in Turkey. As a result, the ARDL estimates are in line with the results presented by DOLS, FMOLS and CCR estimation methods.

Table 7 : ARDL Estimates

Variables	Model 1	Model 2
Constant	-55.572***	-77.004***
LnGDP	13.733***	19.470***
lnGDP ²	-0.721***	-1.025***
LnTOUR	-0.121*	-0.162**
LnREN		-0.095**
Diagnostic tests		
R ²	0.983	0.986
Adj. R ²	0.979	0.982
F-statistic	268.884***	268.214***
Breusch-Godfrey LM test	2.674 (0.114)	1.780 (0.160)
ARCH LM test	0.351 (0.557)	0.082 (0.775)
J-B normality test	1.005 (0.605)	0.076 (0.962)
Ramsey RESET test	1.153 (0.258)	1.263 (0.216)

Note: The optimal lag length is selected based on SIC. Figures in parentheses are *t*-statistics. ***, ** and * show significance at 1%, 5% and 10%, respectively.

Table 8 : DOLS, FMOLS and CCR Estimates

Variables	DOLS		FMOLS		CCR	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Constant	-78.124***	-108.079***	-63.957***	-87.828***	-64.067***	-90.585***
lnGDP	16.988***	23.558***	13.874***	19.080***	13.893***	19.699***
lnGDP ²	-0.894***	-1.246***	-0.729***	-1.007***	-0.730***	-1.041***
lnTOUR	-0.173***	-0.227***	-0.109**	-0.150***	-0.111**	-0.160***
lnREN		-0.098**		-0.081***		-0.085**
Diagnostic tests						
R ²	0.985	0.988	0.983	0.985	0.983	0.985
Adj. R ²	0.980	0.983	0.980	0.982	0.980	0.982
OSE of regression	0.035	0.032	0.036	0.033	0.036	0.033
SSR	0.031	0.024	0.036	0.030	0.036	0.030

Note: The optimal lag length is selected based on SIC. ***, ** and * show significance at 1%, 5% and 10%, respectively.

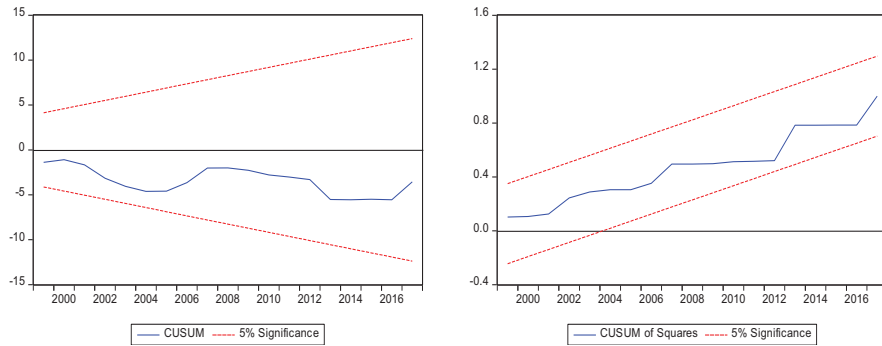


Figure 2. CUSUM and CUSUMsq tests for model 1

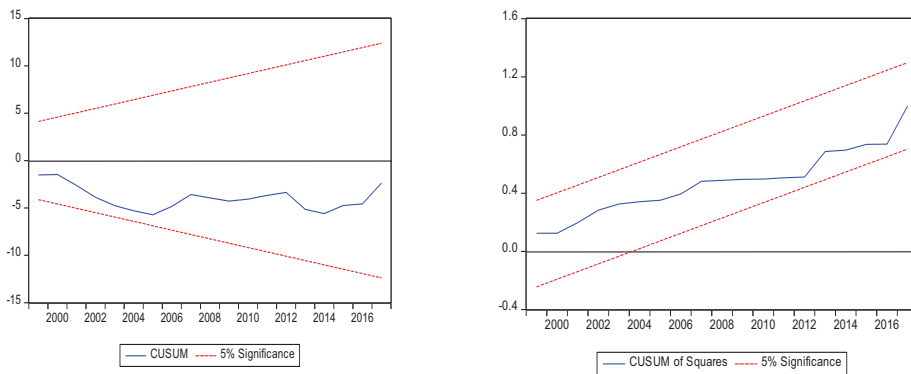


Figure 3. CUSUM and CUSUMsq tests for model 2

Table 9 and 10 report the causal linkages between the variables for model 1 and 2. The long-run results show that tourism and CO2 emissions cause each other. The result is coincide with the findings of Kumail et al. (2020), who intensify on Pakistan applying the Granger causality technique. Using the VECM Granger causality method, Akadiri et al. (2019) and Eyuboglu and Uzar (2019) present similar results for Turkey. Our result is not coincide with the findings of Liu et al. (2019), who indicate no causality between the variables. Our long-run results reveal a causal linkage from economic growth to CO2 emissions. The result is consistent with the findings of Liu et al. (2019), who suggest that in the long run economic growth causes CO2 emissions in Pakistan. Our result also shows that economic growth causes tourism in the long run.

The findings for model 2 indicate the existence of bi-directional causal linkage between renewable energy consumption and CO2 emissions in the long run. The result is coincide with the findings of Dogan and Seker (2016), who apply the Dumitrescu-Hurlin panel causality test for causality analysis in EU countries. The study concludes that the causal linkage between renewable energy consumption

and CO₂ emissions is bi-directional. Jebli and Hadhri (2018) for 10 countries, Khattak and Wang (2018) for BRICS countries, and Shaheen et al. (2019) for 10 countries report similar findings. Our result is not coincide with the findings of Bekhet and Othman (2018), who integrate renewable energy consumption into the EKC model for Malaysia. The study suggests that CO₂ emissions causes renewable energy consumption in the long run using the VECM Granger causality approach. Using Dumitrescu-Hurlin panel causality technique, Alam and Paramati (2017) for 10 countries and Paramati et al. (2018) for 28 EU countries reveal no causality between the variables. On the other hand, Shakouri et al. (2017) for Asia Pacific countries and Dogan et al. (2017) for OECD countries indicate that tourism causes CO₂ emissions using a similar methodology.

Table 9 : Causality analysis for model 1

<i>Dependent variable</i>	<i>Short-run</i>			<i>Long-run</i>
	$\Delta \ln CO_2$	$\Delta \ln GDP$	$\Delta \ln TOUR$	
$\Delta \ln CO_2$	-	1.860	2.658*	-2.547**
$\Delta \ln GDP$	3.710**	-	0.898	-0.566
$\Delta \ln TOUR$	0.005	3.337*	-	-2.406**

Note: ** and * show significance at 5% and 10%, respectively.

Table 10 : Causality analysis for model 2

<i>Dependent variable</i>	<i>Short-run</i>				<i>Long-run</i>
	$\Delta \ln CO_2$	$\Delta \ln GDP$	$\Delta \ln TOUR$	$\Delta \ln REN$	
$\Delta \ln CO_2$	-	2.567*	1.823	0.886	-2.367**
$\Delta \ln GDP$	5.123**	-	1.130	4.062**	-0.475
$\Delta \ln TOUR$	0.025	2.320	-	0.215	-2.034*
$\Delta \ln REN$	2.335	4.750**	0.300	-	-2.789**

Note: ** and * show significance at 5% and 10%, respectively.

6. DISCUSSION AND CONCLUSION

Turkey is an important country with high CO₂ emissions and preferred tourist destinations in the world. Besides, only a handful of studies investigate the impact of tourism on carbon emissions for Turkish economy. In these reasons, the study has intensified on the linkages between tourism and CO₂ emission over the period from 1983 to 2017 by including economic growth and renewable energy consumption in the CO₂ emissions specification. In the study, two regression specifications are constructed to investigate the link between the variables. We have applied the ARDL bounds test and Hatemi-J method for long-run analysis. We have also applied the ARDL, DOLS, FMOLS and CCR techniques for long-run estimates. Lastly, the VECM procedure is employed for causality analysis.

The findings indicate that the series are integrated at I(1). The findings also indicate the existence of cointegration under structural break. The long-run estimates provide an evidence in favour of EKC hypothesis for Turkey. Tourism negatively affects CO₂ emissions meaning that tourism decreases environmental degradation. We find that renewable energy consumption is negatively related to CO₂ emissions implying that renewable energy consumption decreases environmental pollution. We also find a bi-directional causality between explanatory variables and CO₂ emissions.

The findings suggest that the effect of tourism on the environmental degradation depends on several factors. The findings confirm that government can decrease environmental degradation by developing tourism and renewable energy sectors in Turkey. New economic program containing the period of 2019-2021 puts great emphasis on Turkish tourism sector.

The main aim of the program is to diversify tourism products and widen tourism season. However, Turkey should take a number of measurements in the context of environmentally friendly tourism strategy. First, local and national governments should apply several programs to ensure environmental protection and awareness. These encompass environmental protection workshops and training programs. Second, the Turkish government should provide several incentives such as reduced utility prices and tax rates. Third, the bureaucratic barriers encountered in tourism sector should be eliminated. Fourth, the natural and human resources in tourist destinations should be preserved for the present and future generations.

The findings also suggest that government can decrease environmental pollution by developing renewable energy sector. Renewable energy sources are closely related to Turkish tourism development. These sources decrease the dependence on non-renewable energy sources, therefore, improve environmental quality. They can provide energy efficiency and security. The use of renewable energy sources decreases costs and increase the competitiveness of tourist businesses. In addition, they create a positive image of an environmentally committed destination/business. So, promoting the use of renewable energy sources can develop tourism sector and reduce environmental pollution in Turkish economy.

The present study can guide the future papers. These studies can investigate the link between financial development and CO₂ emissions by taking into account different tourism indicators. So, it will be possible to obtain more robust empirical findings. Additionally, different countries can be analyzed to suggest comparative empirical results.

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