Saudi Arabia's sustainable tourism development model: New empirical insights

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1. Introduction

The Gulf Business Report (2016) shows that Saudi's vision by 2030 is to double the inbound tourism (I_TOUR), which reached almost 1.5 million international tourists in 2020. This vision is interlinked with establishing an Islamic museum that would generate more than 18 per cent revenue in the next 14 years. Further, the Kingdom of Saudi Arabia (KSA) made a set of policy agendas to attract 30 million Haj and Umrah pilgrims by completing Jeddah's new airport, the expansion of Taif's airport, the Haramain trains, and Mecca metro bus. These futuristic programs will support the country's tourism expansion projects, and create thousands and thousands of jobs in this sector. The WTTC (2019) report shows that the travel and tourism industry contributed 9 per cent of Saudi's economy in the last year. The country's travel competitiveness shows that KSA's tourism sector generated approximately 8.5 per cent total employment, contributed about US$65.2bn to the economy, and generated 85 per cent income from leisure visitors, 15 per cent from business travellers, roughly 55 per cent spending from domestic travellers, and 45 per cent from international visitors. The expansion of tourism sector plays a vital role to achieve the KSA's vision of 2030 by developing sustainable economic strategies for broad-based growth. The earlier studies mainly worked on country-specific and panel-based estimations to evaluate tourism-emissions nexus (see, Meng *et al*. 2016; Robaina-Alves *et al*. 2016; Zaman *et al*. 2016, 2017; Qureshi *et al*. 2017). While there is a major issue relating to the significant loss of degree of freedom, arising from the number of lags introduced in empirical modelling, leading to the potential bias in the estimation procedure (see, Hasan *et al*. 2017; Qureshi *et al*. 2019; Malik *et al*. 2016; Zaman 2015; Shouket *et al*. 2019). The more significant problem arises in dynamic econometric modelling, for instance, in the ARDL model,

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which includes the number of lags in the regressors while not including lead variables in order to minimise the degree of freedom and examine the variable's relationship in an inter-temporal setting. This provides some good economic rationale to use the model for the next 10 to 20 years.

The following is a review of earlier studies in sustainable tourism (SUS_TOUR). In one study, Lee and Brahmasrene (2013) utilised a European panel to analyse tourism-growth-emissions modelling from 1988 to 2009. The results show that I_TOUR and inbound FDI increases EG, while CO2 emissions are influenced by high EG that needs green instruments in order to support eco-friendly tourism and growth activities in a country. Sun (2016) proposed a framework to decompose tourism emissions footprints to check the efficiency of I_TOUR infrastructure, technology, and CO2 emissions. The results show that tourism emissions are directly proportional to tourism demand, which is the underlying cause of damaging natural flora that could be limited by achieving technological efficiencies. Ozturk *et al.* (2016) examined the tourism sector's ecological footprints in a large panel of countries and verified the EKC hypothesis, which further confirmed the negative relationship (NEG_REL) between ecological factors and growth determinants. The study concludes in favour of SUS_TOUR policies that support to mitigate ecological factors to limit carbon emissions across the countries. Ozturk (2016) further considered a panel of 34 heterogeneous countries to examine the relationship between I_TOUR, energy consumption (EC), and EG for 2005–2013. The results found that health expenditures improve I_TOUR infrastructure while CO2 emissions exert a positive relationship with I_TOUR. The results conclude that renewable energy consumption (REC) played a pivotal role in line with SUS_TOUR indicators across countries. Tang and Ozturk (2017) explored the causal relationships between I_TOUR, investment, and EG in the Egyptian economy for the period of 1982–2011 and supported the TLG hypothesis. The study concluded that I_TOUR expansion is imperative for increasing the country's EG to generate sufficient revenues through tourism investment. Işik *et al.* (2017) investigated the causal relationships between I_TOUR, EC, and EG in the top 10 tourism-induced countries and found the following causality is running from: i) EC to EG in Spain; ii) EG to EC in China, Turkey, and Germany; iii) I_TOUR to EG in China, Germany, Turkey, and the USA; and iv) EG to I_TOUR in Spain and the UK. The diversification of the causality relationship is assumed to be more consistent with economic policies to derive tourism expansion across countries.

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Paramati *et al.* (2017) considered a panel of selected European countries and found that I_TOUR increases CO2 emissions, further translated into TLE in the eastern EU. The results further support the GLT hypothesis in the panel of western EU countries. The results conclude that I_TOUR escalates a country's EG; however, while devising SUS_TOUR policies, it is imperative to mitigate CO2 emissions across countries. Tang *et al.* (2016) considered a case study of the Indian economy by using a dynamic causality relationship between I_TOUR, ED, and EG for 1971–2012. The results verified the EC-led EG hypothesis in a country, which concludes that EC needs a sustainable energy mix to promote the country's sustainable development agenda (SDA). At the same time, tourism expansion increases the country's EG, which needs to be revisited by economic policies to promote its I_TOUR infrastructure. Azam *et al.* (2018) examined the role of I_TOUR on three ASEAN countries' environments from 1990 through 2014. They found that Thailand and Singapore economies exert positive benefits of I_TOUR on those countries' natural environments to support the SUS_TOUR agenda while the Malaysian economy mainly suffered from high pollution due to massive I_TOUR. Thus, the SDA is compromised in Malaysia, which needs the following steps to mitigate CO2 emissions, including developing green tourism infrastructure, sustainable consumption and production, tight environmental policies, knowledge diffusion about environmental hazards at destination points, and tourists counselling and conserving natural heritage. These policies would mainly support the country's SUS_TOUR agenda, which is imperative for long-term growth. Ali *et al.* (2018) included financial development (FD) indicator, total reserves, REC, TOP, and sanitation in the I_TOUR modelling in a panel of 19 Asian countries from 1995 to 2015. They found that a country's total reserves vastly increase by increasing I_TOUR infrastructure, followed by sanitation, FD, REC, and TOP in countries with different incomes. The study confirmed the need to promote I_TOUR infrastructure and other growth determinants, which support the country's total reserves to amplify the country's EG. Raza *et al.* (2017) considered a case study of the United States to analyse the tourism-environment nexus for 1996–2015 and found that I_TOUR negatively impacts the country's ESA and further supported the TLE hypothesis in the short-, medium-, and long-run. The results confirmed the importance of I_TOUR infrastructure in a country's EG, while the policies to mitigate CO2 emissions are imperative to get a positive benefit acquired from I_TOUR that is pivotal for moving towards green development. Nepal *et al.* (2019) analysed the long-run relationship between I_TOUR, EC, and Nepal's EG and found that the SUS_TOUR agenda is affected by using the conventional source of energy factors that are demanded in the destination points, while the country's EG is considered the main factor that attracts tourists to spend their leisure time visiting cultural heritage sites. However, the massive visitation in a country damaged the ESA due to inadequate resources to conserve the natural environment that could mitigate CO2 emissions in a country. The countries required sustainable policy instruments to reduce environmental concerns that attract more tourists for visitation at healthier spots. Bhuiyan *et al.* (2018) considered a heterogeneous panel of countries to analyse some macroeconomic factors that directly and indirectly affect a country's ESA in the form of massive depletion of environmental resources. The results confirmed that bank-specific factors, I_TOUR infrastructure, industrialisation, and EC are the main determinants that affect ESA, which need fair economic policies to reduce carbon abatement cost and conserve natural resources across countries.

Zhang and Zhang (2018) favoured the imposition of carbon taxes to achieve EG through the development of I_TOUR by mitigating tourism's associated emissions in China. The study further suggested some managerial implications to establish low carbon tourism destinations that help achieve economic welfare. Kadir *et al.* (2019) evaluated two different growth hypotheses related to I_TOUR, CO2 emissions, and EG by selecting a panel of 30 heterogeneous countries between 1996 and 2014. They found that in the growth model, I_TOUR and CO2 emissions amplify the country's EG, while in the CO2 emissions model, I_TOUR and conventional EC are considered the main predictors to escalate CO2 emissions across countries. Thus, the countries need to mitigate CO2 emissions by establishing I_TOUR infrastructure and REC mix, which helps achieve the global SUS_TOUR agenda. Jebli *et al.* (2019) selected a panel of 22 countries to evaluate the I_TOUR, REC, and CO2 emissions nexus for a period of 1995–2010 and confirmed the following causality relationship between the stated variables: 1) REC to CO2 emissions and TOP; 2) I_TOUR to TOP and FDI inflows; and 3) EG to I_TOUR and REC. The study emphasised the need to use REC to mitigate CO2 emissions, while I_TOUR supports the country's EG to generate sufficient revenues that further attract inbound FDI across countries. Balli *et al.* (2019) found that causality runs from I_TOUR to EG in three Mediterranean countries, and bidirectional causality is exhibited in the I_TOUR and EG nexus in the two Mediterranean countries. Bojanic and Warnick (2020) analysed a country's environmental performance under I_TOUR indicators by using a global panel of countries from 1995 through 2016 and found that countries that rely on I_TOUR and considered tourism as an engine of EG spend more on I_TOUR infrastructure, which ultimately attracts I_TOUR to increase visitation in a healthy and safe environment; thus it ultimately decreases GHG emissions.

The study extended the ARDL modelling into the leads model by transforming the partial adjustment and adaptive expectations model. The partial adjustment model shows that the closer the partial coefficient value to unity, the faster the leads model's adjustment. In contrast, if the coefficient value becomes zero, then the optimal level adjustment removed the lagged values and emphasised that the optimal level adjustment leads instantaneously. On the other hand, we assume that economic agents make an error in their expectations, and this time, they believe that the constant proportion of the most recent error is due to the absence of lead terms that adjusted it with some theta (φ) adjustment parameter. Hence, two outcomes were revealed. First, if φ is close to zero, then the error expectations are the lead adjustment, while φ is close to unity, expectations removed the lagged adjustment. Thus, there is a strong basis to incorporate leads in the ARDL estimator. The country's vision for 2030 for I_TOUR expansion served as a good case study that allowed both the initial and predictive factors in a single equation to analyse the country's future progress towards attaining set targets.

The above significant debate confirmed the viability of I_TOUR in the country's EG; however, it may influence the country's ESA in the form of high mass CO2 emissions due to the transformation shift from the conventional industrialisation sector in order to compete for the globalisation era. The study's main objective is to extend the ARDL-Bounds testing approach in the ARDL-LEAD modelling framework that was mostly ignored in the past. The study derives the ARDL-LEAD model by partial adjustment model and adaptive expectation model and leads time factor in the given ARDL specification to explore the dynamic linkages between I_TOUR, EG, CO2 emissions, and TOP in the context of KSA economy. Thus, ARDL-LEAD modelling would support the country's data to analyse the relationship between the stated factors in the inter-temporal setting. The study further examined the given relationships by using an innovation accounting matrix. Finally, the Granger causality relationship is obtained at the current and forecast levels between the variables. This study, we believe, gives a new empirical thought to the statisticians and econometricians to develop specific new codes for ARDL modelling to incorporate leads time factor that certainly has a greater power compared to conventional ARDL modelling.

2. Data source, theoretical framework, and methodology

The following variables are being used in this empirical exercise. Carbon intensity (denoted by CO2) is measured in kg per kg of oil equivalent energy use, GDP per capita (denoted by GDPPC) is measured in constant 2010 US$, international tourists' arrival (denoted by INBOUND) is measured as the number of tourists arrived, and trade openness (denoted by TOP) is measured in a percentage of GDP. The data is converted into 12-month time periods by using a low to high-frequency approach, i.e., 1995M01–2018M12. The data is collected from the World Bank (2019). The study extended the ARDL estimator to lead variables that give new insights into a previously rarely looked up relationship in the research arena.

We consider the simple distributed lag model and extended into the leads model:

$$\begin{aligned} Y_t &= \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \beta_3 X_{t-3} \\ &\quad + \cdots . + \beta_p X_{t-p} + \gamma_1 X_{t+1} + \gamma_2 X_{t+2} \\ &\quad + \gamma_3 X_{t+3} + \cdots . + \beta_q X_{t+q} + \varepsilon_t \end{aligned} \tag{1}$$

Where Y_t is the regress and and X_t is the regressor.

Equation (1) shows that Y_t depends upon the current value of X_t, past (lagged) values of X_t, and future (leads) values of X_t.

Equation (1) is being written as:

$$Y_t = \alpha + \sum_{i=0}^{p} \beta_i X_{t-i} + \sum_{i=0}^{p} \gamma_i X_{t+i} + \varepsilon_t$$

By using Koyck transformation, we substitute $\beta_i = \beta_0 \lambda^i$ and $\gamma_i = \gamma_0 \lambda^i$, i.e.,

$$\begin{aligned} Y_t &= \alpha + \beta_0 \lambda^0 X_t + \beta_0 \lambda^1 X_{t-1} + \beta_0 \lambda^2 X_{t-2} \\ &\quad + \beta_0 \lambda^3 X_{t-3} + \cdots . + \gamma_0 \lambda^1 X_{t+1} + \gamma_0 \lambda^2 X_{t+2} \\ &\quad + \gamma_0 \lambda^3 X_{t+3} + \cdots . + \varepsilon_t \end{aligned} \tag{2}$$

Taking the first lagged value of both sides of the equation (2), we get

$$Y_{t-1} = \alpha + \beta_0\lambda^0 X_{t-1} + \beta_0\lambda^1 X_{t-2} + \beta_0\lambda^2 X_{t-3} + \beta_0\lambda^3 X_{t-4} + \cdots . + \gamma_0\lambda^1 X_t + \gamma_0\lambda^2 X_{t+1} + \gamma_0\lambda^3 X_{t+2} + \cdots . + \varepsilon_t \quad (3)$$

Multiplying by λ on both sides of the equation (3), i.e.,

$$\lambda Y_{t-1} = \lambda\alpha + \beta_0\lambda^1 X_{t-1} + \beta_0\lambda^2 X_{t-2} + \beta_0\lambda^3 X_{t-3} + \beta_0\lambda^4 X_{t-4} + \cdots . + \gamma_0\lambda^2 X_t + \gamma_0\lambda^3 X_{t+1} + \gamma_0\lambda^4 X_{t+2} + \cdots . + \varepsilon_t \quad (4)$$

Subtract equation (4) from equation (2), to get

$$Y_t - \lambda Y_{t-1} = (\alpha - \lambda\alpha) + \beta_0\lambda^0 X_t - \beta_0\lambda^1 X_{t-1} + \beta_0\lambda^1 X_{t-1} - \beta_0\lambda^2 X_{t-2} + \beta_0\lambda^2 X_{t-2} - \beta_0\lambda^3 X_{t-3} + \beta_0\lambda^3 X_{t-3} - \beta_0\lambda^4 X_{t-4} + \cdots . + \gamma_0\lambda^1 X_{t+1} - \gamma_0\lambda^2 X_t + \gamma_0\lambda^2 X_{t+2} - \gamma_0\lambda^3 X_{t+1} + \gamma_0\lambda^3 X_{t+3} - \gamma_0\lambda^4 X_{t+2} + \cdots . + \varepsilon_t - \lambda\varepsilon_{t-1} \quad (5)$$

$$Y_t - \lambda Y_{t-1} = \alpha(1-\lambda) + \beta_0\lambda^0 X_t + \gamma_0\lambda^1 X_{t+1} - \gamma_0\lambda^2(X_t - X_{t+2}) - \gamma_0\lambda^3(X_{t+1} - \gamma_0\lambda^3 X_{t+3}) - \gamma_0\lambda^4(X_{t+2} - X_{t+4}) + \cdots . + v_t \quad (6)$$

$$Y_t - \lambda Y_{t-1} = \alpha(1-\lambda) + \beta_0\lambda^0 X_t + \gamma_0\lambda^1 X_{t+1} - \gamma_0\lambda^2(X_t - X_{t+2}) - \gamma_0\lambda^3(X_{t+1} - \gamma_0\lambda^3 X_{t+3}) - \gamma_0\lambda^4(X_{t+2} - X_{t+4}) + \cdots . + v_t \quad (7)$$

$$Y_t = \alpha(1-\lambda) + \beta_0\lambda^0 X_t + \gamma_0\lambda^1 X_{t+1} - \gamma_0\lambda^2(X_t - X_{t+2}) - \gamma_0\lambda^3(X_{t+1} - \gamma_0\lambda^3 X_{t+3}) - \gamma_0\lambda^4 (X_{t+2} - X_{t+4}) + \cdots . + \lambda Y_{t-1} + v_t \quad (8)$$

Equation (8) shows that Y_t depends not only on leads and lagged values of explanatory variables but also on the lagged dependent variable in a set of regressors. Equation (8) served the autoregressive foundation; thus, the study moves forward towards a “partial adjustment” model, i.e.,

$$Y_t - Y_{t-1} = \lambda(Y^* - Y_{t-1)} \quad (9)$$

While

$$Y^* = \beta_1 + \beta_2 X_t + \gamma_1 X_{t+1} - \gamma_2(X_t - X_{t+2}) - \gamma_3(X_{t+1} - \gamma_0\lambda^3 X_{t+3}) - \gamma_4(X_{t+2} - X_{t+4}) + v_t \quad (10)$$

Substituting Y^* in equation (9), i.e.,

$$Y_t = Y_{t-1} + \lambda[(\beta_1 + \beta_2 X_t + \gamma_1 X_{t+1} - \gamma_2(X_t - X_{t+2}) - \gamma_3\left(X_{t+1} - \gamma_0\lambda^3 X_{t+3}\right) - \gamma_4(X_{t+2} - X_{t+4}) + \lambda Y_{t-1} + v_t \quad (11)$$

$$Y_t = (Y_{t-1} - \lambda Y_{t-1}) + \beta_1\lambda + \beta_2\lambda X_t + \gamma_1\lambda X_{t+1} - \gamma_2\lambda(X_t - X_{t+2}) - \gamma_3\lambda\left(X_{t+1} - \gamma_0\lambda^3 X_{t+3}\right) - \gamma_4\lambda(X_{t+2} - X_{t+4}) + v_t \quad (12)$$

$$Y_t = \beta_1\lambda + (1-\lambda)Y_{t-1} + \beta_2\lambda X_t + \gamma_1\lambda X_{t+1} - \gamma_2\lambda(X_t - X_{t+2}) - \gamma_3\lambda\left(X_{t+1} - \gamma_0\lambda^3 X_{t+3}\right) - \gamma_4\lambda(X_{t+2} - X_{t+4}) + v_t \quad (13)$$

From equation (13), we get the following important points:

1) The long-run reaction could be found from $\beta 1$;
2) The short-run reaction could be found from $\beta 2\lambda$; and
3) The formula for $\beta 1$ is $\beta 1 = \beta 2\lambda/1–(1–\lambda)$.

The study further moved towards the “adaptive expectations” model and extended it by including the expectation of leads term in AR model, i.e., we assumed that an error could be expected in observing the actual value of explanatory variables; thus, the equation becomes:

$$X_t^e - X_{t-1}^e = \varphi(X_t - X_{t-1}^e) \quad (14)$$

Where φ is the adjustment coefficient.

We extended this expectation in leads values of explanatory variables, which shows uncertainty in the model, i.e.,

$$X_t^e + X_{t+1}^e = \varphi(X_t + X_{t+1}^e) \quad (15)$$

If $\varphi = 0$,

$$X_t^e = -X_{t+1}^e \quad (16)$$

If $\varphi = 1$,

$$X_t^e = X_t \quad (17)$$

Thus, equation (16) shows that the agent is uncertain about the future volatility, and no revision could be possible if the expectation is made, while in equation (17), the instantaneous adjustment is possible in the expectation.

Based on derivation, one could easily be adjusted leads and lagged variables in the ARDL modelling, i.e.,

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_2 \Delta X_{t-i} + \sum_{i=1}^{n} \beta_3 \Delta X_{t+i} + \theta_1 Y_{t-1} + \theta_2 X_{t-1} + \theta_3 X_{t+1} + u_t \quad (18)$$

Equation (18) is imposing linear restrictions through Wald F-statistics. The error correction term would be implied in equation (18) to assess the speed of adjustment coefficients towards reaching an equilibrium level.

The study used a reduced form of the EKC, which is based on the following non-linear specification, i.e.,

$$CO2 = \alpha (GDPPC)_t^{\beta_1} (SQGDPPC)_t^{\beta_2} (INBOUND)_t^{\beta_3} (TOP)_t^{\beta_4} e_t^{u_t} \quad (19)$$

Where "e" shows error term.

Equation (19) transforms the nonlinear model into linear model by taken natural logarithm of both sides of the equation to form:

$$\ln(CO2)_t = \ln(\alpha) + \beta_1 \ln(GDPPC)_t + \beta_2 \ln(SQGDPPC)_t + \beta_3 \ln(INBOUND)_t + \beta_4 \ln(TOP)_t + u_t \quad (20)$$

Where, ln shows natural logarithm and "t" shows time period.

Equation (20) shows that the country's EG will tend to show an EKC relationship with CO2 emissions with an expected coefficient of $\beta_1 > 0$ and $\beta_2 < 0$. I_TOUR is expected to positively (negative) impact on CO2 emissions to support I_TOUR associated CO2 emissions with a common coefficient sign of $\beta_3 > 0$. Finally, TOP is likely to negatively impact CO2 emissions with a coefficient sign of $\beta_4 > 0$.

This study is extending the conventional ARDL modelling into leads and lagged values based on adaptive expectation theory. Equation (20) shows the extended version of ARDL with lead variables. Equation (21) shows the modified form of the ARDL model with lead variables, i.e.,

$$\Delta(CO2)_t = \beta_0 + \sum_{i=i}^{n} \beta_1 \Delta(CO2)_{t-i} + \sum_{i=i}^{p} \beta_2 \Delta(GDPPC)_{t-i} + \sum_{i=i}^{q} \beta_3 \Delta(SQGDPPC)_{t-i} + \sum_{i=i}^{r} \beta_4 \Delta(INBOUND)_{t-i} + \sum_{i=i}^{s} \beta_5 \Delta(TOP)_{t-i} + \sum_{i=i}^{t} \delta_1 \Delta(GDPPC)_{t+i} + \sum_{i=i}^{u} \delta_2 \Delta(SQGDPPC)_{t+i} + \sum_{i=i}^{v} \delta_3 \Delta(INBOUND)_{t+i}$$

TABLE 1. Descriptive statistics of the variables

Statistics	*CO2*	*GDPPC*	*INBOUND*	*TOP*
Mean	2.836	19390.21	10508072	74.399
Maximum	3.304	21507.96	18260000	96.102
Minimum	2.259	16619.43	3325000	56.088
Std. Dev.	0.214	1312.909	5098524	11.391
Skewness	–0.277	0.063	0.049	0.257
Kurtosis	3.972	1.964	1.643	1.775
Observations	276	276	276	276

Note: CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

$$+\sum_{i=i}^{W}\delta_4\Delta(TOP)_{t+i}+\theta_1(CO2)_{t-1}+\theta_2(GDPPC)_{t-1}+\theta_3(SQGDPPC)_{t-1}+\theta_4(INBOUND)_{t-1}+\theta_5(TOP)_{t-1}+u_t \quad (21)$$

The following hypothesis would be evaluated through Wald F-statistics, i.e.,

H0: $\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0$
H1: $\theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0$

Narayan (2004) critical values were used that fall either in the upper I(1) bound values or lower I(0) bound values. Failure to fall in the upper bound values shows that the null hypothesis is correct and vice versa. The ECT will be introduced in equation (21) to see the adjustment coefficients' performance towards reaching the equilibrium.

Further, the study checked the following hypotheses by Granger causality test, i.e.,

1) Does I_TOUR Granger cause CO2 emissions (i.e., TLE hypothesis);
2) Does CO2 emissions Granger cause ITOUR (i.e., reverse hypothesis);
3) Both the variables Granger cause each other; and
4) No causality relationship between the two stated variables.

Finally, the study exercised the forecasting framework variables by the two most appropriate inter-temporal techniques – IRF and VDA – to evaluate the direction and magnitude of the variables towards the response variable. The following hypothesis is being assumed to be verified:

H1: *It is the likely that EG first increases CO2 emissions and then decreases emissions in a country;*
H2: *It is expected that I_TOUR will escalate CO2 emissions; and*
H3: *PHH is expected to substantiate due to ease of environmental regulations in a country.*

These hypotheses are empirically evaluated by using the cointegration technique in a given context.

3. Results and discussion

Table 1 statistics show that the average value of CO2 emissions, GDPPC, INBOUND, and TOP is 2.835 kg, US$19,390.21, 1,05,08,072 tourists, and 74.399 per cent of GDP, respectively.

The variables trend further proceeds towards the correlation matrix to examine the magnitude and direction between the stated factors. Table 2 shows the correlation estimates for ready reference.

Table 2 shows that GDPPC has a weaker and insignificant correlation with the CO2 emissions, while INBOUND and TOP have a positive and high correlation of CO2 emissions with a correlation value of 0.142 and 0.358, respectively. Finally, TOP exerts a positive correlation with INBOUND while INBOUND tourism has a positive correlation with the country's EG. The given results partially confirmed the INBOUND associated CO2 emissions, TOP associated CO2 emissions, and INBOUND associated country's EG. Table 3 is used to assess unit root (UR) estimates in a given country data set.

The results show that CO2 emissions exhibit the level stationary series at level data with "constant" and "constant with drift", thus its confirmed I(0) variable. The GDPPC and INBOUND exhibit the differenced stationary series at a "constant" trend. However, it is seen that both the given vari-

TABLE 2. Correlation matrix

Variables	*CO2*	*GDPPC*	*INBOUND*	*TOP*
CO2	1			
GDPPC	–0.026	1		
INBOUND	0.142**	0.868*	1	
TOP	0.358*	0.306*	0.409*	1

Note: * and ** represents 1% and 5% level of significance. CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

TABLE 3. ADF Estimates

	Level		*First Difference*	
Variables	*C*	*C+T*	*C*	*C+T*
CO2	–3.325**	–3.362***	–3.310**	–3.302***
GDPPC	–1.491	–3.216***	–3.510*	–3.512**
INBOUND	–1.362	–4.081*	–3.586*	–3.600**
TOP	–1.920	–1.780	–2.864**	–2.946

Note: *, **, and *** indicates 1%, 5%, and 10% level of significance. "C" shows constant, "C+T" shows constant with trend, CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

TABLE 4. ADF estimates with break Test

	Level		*First Difference*	
Variables	*C+T*	*Break Dates*	*C+T*	*Break Dates*
CO2	–4.911**	2013	–7.929*	2005
GDPPC	–9.838*	2009	–5.198**	2010
INBOUND	–4.715***	2017	–5.320**	2017
TOP	–2.600	2003	–4.965**	2008

Note: *, **, and *** indicates 1%, 5%, and 10% level of significance. "C+T" shows constant with trend, CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

ables are level stationary series at "constant with drift"; thus, we confined our result and concluded that both the variables are I(0). Finally, the TOP is differenced stationary at a "constant" term. Thus, we confined that the trade factor is I(1) variable. The results give an excellent rationalisation to proceed with ARDL and lead modelling due to the combination of I(0) and I(1) variables. However, before we proceed with the cointegration test, we check the lag length criteria to used variables at certain lags and lead values. Further, the breakpoint unit root test checks for structural adjustment of the stated variables during the stated period. Table 4 shows the UR estimates with break dates.

The results show different break dates in the unit root estimation and confirmed that CO2, GDPPC, and INBOUND are level stationary variables, while TOP exhibits the differenced stationary variable. Four break dates have been found – 2003, 2009, 2013, and 2017 – which show substantial variations in the particular variables' data series. Further, at the first difference, the break dates are 2005, 2008, 2010, and 2017, which is significantly shown at 1 per cent and 5 per cent. Table 5 shows the lag length criteria, and the same criteria are used for the lead variables selection in the account of uniformity in the length selection.

The results show that all the five selected lag length criteria confirmed that the lags (and leads) length would be optimum at second lags (and leads) length; thus, it is viable to use the given length in the ARDL leads the process. Table -A in the appendix shows the Johansen Cointegration estimates, while Table 6 shows the ARDL cointegration estimates.

The results show that CO2 model and TOP model, both confirmed the significant relationship

TABLE 5. Lag length selection criteria

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	–7575.198	NA	4.31e + 19	56.561	56.614	56.582
1	–4284.467	6458.675	1.05e + 09	32.122	32.390	32.230
2	–3322.900	1858.551*	904383.2*	25.066*	25.548*	25.260*
3	–3321.867	1.965	1011463	25.178	25.874	25.457
4	–3320.715	2.157	1130412	25.288	26.200	25.654

Note: * indicates lag order selected by the criterion.

TABLE 6. Results of the ARDL Cointegration Test

Models	*ARDL Lag length*	*Wald F-statistics*	*Diagnostic Tests*		
			J.B Test	*Heteroskedasticity*	*Serial correlation*
CO2 = f(GDPPC, INBOUND, TOP)	2, 2, 1, 1	7.391*	1.294	0.673	1.186
GDPPC = f(CO2, INBOUND, TOP)	1, 0, 0, 0	0.898	3.877	1.020	0.319
INBOUND = f(CO2, GDPPC, TOP)	1, 0, 3, 0	0.918	0.779	1.533	4.383*
TOP = f(CO2, GDPPC, INBOUND)	3, 1, 3, 3	6.302*	0.226	0.461	5.706**

Level of Significance	*Lower Bounds I(0)*	*Upper Bounds I(1)*
1%	4.29	5.61
5%	3.23	4.35
10%	2.72	3.77

Note: * and ** shows 1% and 5% significance level. CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

between their variables, as the overall value of Wald F-statistics for CO2 model is 7.391, $p<0.000$, while for TOP model, the Wald F-statistics value is 6.302, $p<0.000$. Both values are significant at 1 per cent level. The remaining models, INBOUND and GDPPC, do not confirm the significant association with their regressors, as Wald F-statistics are 0.898 and 0.918, respectively. Table -B in the appendix shows the break test model as a dummy in ARDL and found that GDPPC and INBOUND decreases and increases CO2 emissions in the long run (LRUN), respectively, while the dummy break model is not significantly affecting CO2 emissions both in the short run (SRUN) and LRUN. Table 7 shows the ARDL-LEAD model. The results show that, in the SRUN, GDPPC confirmed the hump-shaped relationship with CO2 emissions. The difference of the results was found with lead values of GDPPC that confirmed the EKC relationship with CO2 emissions in the SRUN. The LRUN results support the SRUN leads model and confirmed the U-shaped relationship of GDPPC and CO2 emissions in a country. The volatility in the SRUN lag and LRUN results for the income-emissions model presumed that the country's structural adjustment towards sustainable development and KSA's vision for 2030 is exemplified by conditions that pursue industrialisation, innovation, and infrastructure development. Thus, it leads to the environmental destruction that substantially needs to be subsidised by cleaner production technologies and tight environmental policies. The results are supported by several previous studies that confirmed the income-emissions relationship in the KSA's economy. For instance, Mat Soma and Al-Shqiarat (2013) analysed the possible effect of tourism seasonality in the beautiful Al-Bahah Province in Saudi Arabia. They found that government support is highly needed to attract more tourists in the southern part of a country, supporting new product development accordingly. Alkhathlan and Javid (2013) suggested that the country has to switch from an oil to an electricity consumption model to an oil to a gas consumption model, which is less

TABLE 7. Autoregressive distributed lag and lead (ARDL-LEAD) model estimates in the robust least square M-specification

Dependent Variable: $\Delta ln(CO2)_t$				
Variables	*Coefficient*	*Std. Error*	*z-Statistic*	*Prob.*
Constant	–0.003032	0.000890	–3.408528	0.0007
Short-run Lag Elasticities				
$\Delta ln(CO2)_{t-1}$	1.002227	0.001248	802.9017	0.0000
$\Delta ln(CO2)_{t-2}$	–0.000632	0.001239	–0.510176	0.6099
$\Delta ln\ GDPPC)_{t-1}$	–0.024304	0.071298	–0.340879	0.7332
$\Delta ln(GDPPC)_{t-2}$	0.122425	0.071907	1.702544	0.0887
$\Delta ln(SQGDPPC)_{t-1}$	0.010989	0.035340	0.310961	0.7558
$\Delta ln(SQGDPPC)_{t-2}$	–0.062184	0.035827	–1.735672	0.0826
$\Delta ln(INBOUND)_{t-1}$	–0.004437	0.000564	–7.869604	0.0000
$\Delta ln(INBOUND)_{t-2}$	–1.22E-05	0.000493	–0.024829	0.9802
$\Delta ln(TOP)_{t-1}$	–0.002905	0.001498	–1.939125	0.0525
$\Delta ln(TOP)_{t-2}$	–3.04E-05	0.001297	–0.023428	0.9813
Short-run Lead Elasticities				
$\Delta ln(GDPPC)_{t+1}$	–0.122007	0.073904	–1.650888	0.0988
$\Delta ln(GDPPC)_{t+2}$	–0.158880	0.073237	–2.169383	0.0301
$\Delta ln(SQGDPPC)_{t+1}$	0.060734	0.036667	1.656363	0.0976
$\Delta ln(SQGDPPC)_{t+2}$	0.078699	0.036390	2.162629	0.0306
$\Delta ln(INBOUND)_{t+1}$	0.000270	0.000546	0.495517	0.6202
$\Delta ln(INBOUND)_{t+2}$	2.62E-05	0.000470	0.055858	0.9555
$\Delta ln(TOP)_{t+1}$	–0.000587	0.001449	–0.405049	0.6854
$\Delta ln(TOP)_{t+2}$	0.000708	0.001227	0.576882	0.5640
Long-run Elasticities				
$ln(CO2)_{t-1}$	7.29E-05	5.31E – 05	1.373301	0.1697
$ln(GDPPC)_{t-1}$	–0.251961	0.032942	–7.648706	0.0000
$ln(SQGDPPC)_{t-1}$	0.126062	0.016509	7.635850	0.0000
$ln(INBOUND)_{t-1}$	9.71E-06	1.12E – 05	0.865801	0.3866
$ln(TOP)_{t-1}$	0.000271	2.18E – 05	12.40397	0.0000
Robust Statistics				
R^2	0.787254	Adjusted R^2	0.767443	
Rw-squared	0.999973	Adjust Rw-squared	0.999973	
AIC	351.9334	SC	460.0143	

Note: t-1 and t-2 show first and second-degree lag values, while t+1 and t+2 show first and second-degree lead values. ln shows a natural logarithm. CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

sensitive to CO2 emissions. Ozcan (2013) confirmed a different relationship between EG and CO2 emissions modelling across Middle Eastern countries (MEC) and found an EKC relationship for three MEC and found a U-shaped relationship for five MEC. The study concludes that EC and EG are both the chief factors that negatively influenced ESA across countries. Salahuddin *et al*. (2015) opined that GCC countries need sustainable policies to mitigate CO2 emissions by green financing instruments that would broadly support the country's EG and reduce CO2 emissions through financial innovation. Alshehry and Belloumi (2015) concluded that EC increases EG and CO2 emissions; thus, it is supposed to devise sustainable growth strategies towards which the country has to utilise different sources of REC that correspondingly limit CO2 emissions. Alshehry and Belloumi (2017) further point out that road transport EC is involved mainly in transport emissions that need to be repaired by sustainable transport engineering in a country. Kahia *et al*. (2019) emphasised the need to shift towards REC to mitigate CO2 emissions, while Toumi and Toui (2019) further support a REC mix that is imperative for KSA's economy to precede for green development agenda.

The other results show that INBOUND and TOP both positively impact CO2 emissions in the SRUN, whereas INBOUND is unable to significantly determine its relationship with the CO2 emissions in the LRUN. However, TOP adjusts its direction and shows a positive relationship with

TABLE 8. Hypothesis testing for short-run (Lags and Lead variables) and long-run relationships

Hypothesis Testing	*Equations Testing*	*Wald F-statistics*	*Probability value*	*Decision*
Short-run (Lags model)	c(4) = c(5) = c(6) = c(7) = c(8) = c(9) = c(10) = c(11) = 0	2.762*	0.006	Confirm
Short-run (Leads model)	c(12) = c(13) = c(14) = c(15) = c(16) = c(17) = c(18) = c(19) = 0	4.384*	0.000	Confirm
Long-run model	c(20) = c(21) = c(22) = c(23) = c(24) = 0	3.821*	0.002	Confirm
Error correction term	First lag of the residual	–2.017*	0.000	Confirm

Note: * shows 1% level of significance.

CO2 emissions in a country. The results conclude that I_TOUR infrastructure should be more capable of impacting the LRUN and its needed long-run policy options to derive environmental sustainability countrywide. The policies to support green exports and import goods is pivotal for the country's ESA; thus, export and import substitution policies should be environmentally friendly. The results are linked with the earlier studies; for instance, Khizindar (2012) concluded that KSA's economy has progressed due to improving I_TOUR infrastructure, primarily by increasing Muslim pilgrims from all across the world that perform Hajj go to Holy Makkah. The country's residents are enjoying a high quality of life due to the arrival of I_TOUR and safe visitation. There is a need for sustainable I_TOUR marketing policies to cover environmental aspects of tourists' visitation in a country. Shqiarat and Altarawneh (2019) concluded that the development of I_TOUR infrastructure in Aldarrab province, Saudi Arabia, is imperative for improving tourism services in the country's south-west. Seddon (2000) argued that protecting protected areas and wildlife is imperative for KSA's economy to improve eco-tourism infrastructure. Thus, the local community involvement in the conservation of natural assets will be pivotal for sustainable development. Al-Tokhais and Thapa (2020) discussed the number of potential challenges faced by the KSA Government to preserve world heritage sites in a country, including resource constraints, difficulties in the implementation of heritage management policies, increases in pressure of I_TOUR, and urbanisation. Thus, these stated factors need legally sustainable policies to combat environmental challenges for resource conservation in a country. Zaman *et al*. (2017) found that economic activities, including I_TOUR visitation, give support to the country's EG; however, its intensified CO2 emissions need fair economic and trade policies to reduce climate vulnerabilities through sustainable goods transportation. Akadiri *et al*. (2019) confined the role of TOP and EC in the KSA's vision of environmental sustainability that needs green traded goods to revitalise economic policies by adopting RE sources to achieve ESA in a country.

After analysing the long-run parameter estimates, it is imperative to impose some linear restrictions on the ARDL-LEAD model to verify the SRUN and LRUN. Table 8 shows the SRUN and LRUN relationships through Wald F-statistics and error correction term (ECT), respectively.

The results show that SRUN lags and leads model are both statistically significant at 1 per cent level. We may not rely on the Narayan critical values, as these values are exclusively based upon lag values, baseless for handling the lead variables. Thus, we rely on given Wald F-statistics values for the given assessment. The results confirmed that the leads and lags values are statistically significant; thus, the leads and lags variables' viability in the given model is confirmed. Similarly, we imposed the linear restrictions on the LRUN coefficients and confirmed that the given model exhibits the LRUN relationship between the variables. The speed of adjustment coefficient is captured by ECT and found with a correct sign with a high coefficient value, which confirmed the high speed of adjustment to converge the equilibrium in the long run. After analysing the LRUN cointegrated relationship between the variables, the diagnostic tests must detect the model stability, heteroskedasticity issue, breakpoint test, and CUSUM stability test. Table 9 shows all prerequisite tests for ready reference.

The results show that the Ramsey RESET test supported the null hypothesis of model specification with the given t-statistics. Similarly, the ARCH test is used to check the possible heteroskedas-

TABLE 9. Diagnostic tests

Test Specification	*f or t-statistics*	*Probability value*	*Decision*
Ramsey RESET Test	0.969	0.330	Model is stable
ARCH Test	1.401	0.237	No heteroskedasticity issue
Chow Breakpoint Test 2005M01 & 2010M01	1.170	0.227	No breaks at specific breakpoints
CUSUM Test	$p<0.050$	5% significance level	Model is stable

TABLE 10. Wald Granger causality estimates

Variables	*χ^2 - Statistics*	*Probability Value*	*Decision*
GDPPC→CO2	6.160	0.046	GLE
INBOUND→CO2	7.263	0.026	TLE
INBOUND→GDPPC	5.645	0.059	TLG
Forecast Wald Granger Causality Estimates			
(INBOUND)F→(CO2)F	22.648	0.000	TLE
(CO2)F→(GDPPC)F	4.837	0.089	ELG
(TOPF)F→(GDPPC)F	5.509	0.063	TLG
(TOP)F→(INBOUND)F	9.836	0.007	Feedback relationship between I_TOUR and TOP
(INBOUND)F→(TOP)F	13.258	0.001	
(CO2)F→(TOP)F	16.358	0.000	Emissions led trade (ELT)

Note: "F" shows forecast variables. CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

ticity issues and confirmed that the given model is homoscedastic. The Chow breakpoint test was not detecting any breaks between 2005M01 and 2010M01. Finally, the CUSUM test confirmed that the model is stable.

Table 10 shows the Granger causality estimates both at the level data and for forecasted data. The Granger causality test shows the one-way linkages: 1) GDPPC to CO2 emissions; 2) INBOUND to CO2 emissions; and 3) INBOUND to GDPPC to substantiate TLG hypothesis in a country.

On the other hand, we estimated the Granger causality estimates for forecasted variables and found that forecasted INBOUND and CO2 emissions increases together to verify TLE in the future, while CO2 emissions increase the country's GDPPC and TOP over the time horizon. The forecast relationship between TOP and GDPPC will confirm the TLG hypothesis in a country. Finally, a forecast relationship between TOP and INBOUND supports the bidirectional causality hypothesis between the two variables. The rest of the variables will support the neutrality hypothesis, not shown in the given table. Finally, the study analysed IRF and VDA (see Table 11) and shows that GDPPC and TOP will positively contribute (negative impact) to increase CO2 emissions over a time horizon. In contrast, INBOUND is expected to negatively influence (positive impact) CO2 emissions in the account of carbon mitigation through SUS_TOUR policies over a time horizon.

The VDA shows that CO2 emissions have their innovation shocks that largely contributed to the total model, whereas TOP will significantly influence CO2 emissions, followed by the country's GDPPC and INBOUND. The results give fresh insight into the KSA's SUS_TOUR agenda that needs cleaner production technologies, RE mix, tight environmental policies, and eco-tourism support for green development.

4. Conclusions and policy recommendations

The main objective is to derive the conventional ARDL model in its lags transformation to minimise inadvertent bias in parameter estimates due to the absence of futuristic trends of the variables in the SURN and LRUN. This study gives new empirical insights to investigate the relationship between I_TOUR and CO2 emissions in the context of KSA's economy for the period of 1995M01–

TABLE 11. IRF and VDA estimates

IRF for CO2

Periods	*CO2*	*GDPPC*	*INBOUND*	*TOP*
2021	0.012215	0.000102	–6.73E-05	0.000255
2022	0.017411	0.000265	–0.000171	0.000716
2023	0.021997	0.000454	–0.000286	0.001341
2024	0.025983	0.000636	–0.000387	0.002087
2025	0.029382	0.000785	–0.000456	0.002918
2026	0.032214	0.000881	–0.000478	0.003800
2027	0.034503	0.000907	–0.000438	0.004703
2028	0.036279	0.000849	–0.000329	0.005600
2029	0.037572	0.000699	–0.000144	0.006469

VDA for CO2

Period	*S.E.*	*CO2*	*GDPPC*	*INBOUND*	*TOP*
2021	0.013797	99.95805	0.005488	0.002377	0.034083
2022	0.022228	99.85974	0.016371	0.006861	0.117023
2023	0.031306	99.71650	0.029241	0.011787	0.242468
2024	0.040744	99.53683	0.041593	0.015987	0.405585
2025	0.050326	99.32761	0.051610	0.018704	0.602078
2026	0.059882	99.09436	0.058113	0.019572	0.827952
2027	0.069278	98.84141	0.060548	0.018625	1.079415
2028	0.078408	98.57190	0.058987	0.016301	1.352817
2029	0.087189	98.28782	0.054124	0.013454	1.644600

Note: CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

2018M12. The result supports the EKC hypothesis at lag variables, while a U-shaped relationship was found with lead variables in the income-emissions nexus in the SRUN. In the LRUN, the results supported the short-run lead estimates to confirm the U-shaped emissions-income nexus in a country. The short-run results further reveal that I_TOUR and TOP both substantially decrease CO2 emissions at lag values, while the results are insignificantly determined at the lead's value. In the LRUN, the results verified PHH, an account of trade liberalisation policies that hamper economic activities due to deep environmental concern in a country. The causality estimates show the following: 1) GDPPC to CO2 emissions; 2) INBOUND to CO2 emissions; 3) INBOUND to GDPPC; 4) CO2 emissions to GDPPC; 5) TOP to GDPPC; and 6) CO2 emissions to TOP. The estimates show the bidirectional causality between TOP and INBOUND at forecast estimates. The results of IRF confirmed the direct relationship of the country's EG and TOP with CO2 emissions, whereas the VDA estimates show that TOP will exert a greater magnitude in terms of influencing CO2 emissions, followed by the country's EG and I_TOUR. The results show sound inferences both of leads and lags values, which enables the creation of strong policies of SUS_TOUR in a country.

The following policy implications are being presented for the possible achievement of the country's sustainable tourism agenda that is imperative to progress the country's future vision 2030:

1) High-level optimisation techniques are needed to analyse the country's futuristic progression towards reaching the 2030 sustainable tourism agenda;
2) The lead factors may play a vital role in assessing the country's future vision, which was mostly invisible in the given optimisation techniques, especially in the ARDL modelling;
3) The adaptive expectations model confirmed that the agents are indifferent to utilise the leads term in their expectation model; thus, the adjustment coefficient shows a negative expectation with the leads factor, which is right in the sense of uncertainty that could prevail in the future;
4) The partial adjustment model could be further utilised for optimisation solving issues while using the leads term in the given model;
5) The country's sustainability issues arise due to trade liberalisation policies that needed tight

environmental regulations to limit dirty production in a country; and

6) The country's tourism infrastructure needs more corrective measures to decrease high abatement carbon costs through the imposition of carbon taxes, development of green infrastructure and destination points, hybrid vehicles, green fuels, preserve natural heritage sites, and high-speed information technologies.

The given six policies would be helpful to attract I_TOUR in the country's green destination points. Good empirical discussion and policy conclusions would support the country's ESA that is imperative for the country's sustained growth.

Data Availability Statement

The data is freely available at World Development Indicators published by the World Bank (2019) at https://databank.worldbank.org/source/world-development-indicators

Appendix

TABLE A. Johansen cointegration test

Trace Statistics (TS)				
No. of CE(s)	*Eigenvalue (EV)*	*TS*	*0.05 Critical Value (CV)*	*Prob. value (PV)*
¥≥0 *	0.820927	64.58669	63.87610	0.0435
¥≥1	0.511888	26.74757	42.91525	0.6956
¥≥2	0.279668	10.96895	25.87211	0.8770
¥≥3	0.156795	3.752007	12.51798	0.7777
EV Statistics				
No. of CE(s)	*EV*	*Max-EV Statistic*	*0.05 CV*	*PV*
¥≥0 *	0.820927	37.83911	32.11832	0.0090
¥≥1	0.511888	15.77862	25.82321	0.5644
¥≥2	0.279668	7.216943	19.38704	0.8855
¥≥3	0.156795	3.752007	12.51798	0.7777

Note: *One CE(s) at the 0.05 level

TABLE B. ARDL estimates with break dummy

Variables	*Coefficient*			
(COE)	*Std. Error (SE)*	*t-statistic*	*PV*	
Δln(CO2)$_{t-1}$	0.323847	0.170961	1.894273	0.0907
Δln(GDPPC)$_{t}$	–0.704240	0.409327	–1.720483	0.1195
Δln(GDPPC)$_{t-1}$	1.234285	0.412734	2.990512	0.0152
Δln(INBOUND)$_{t}$	0.221219	0.114188	1.937318	0.0847
Δln(INBOUND)$_{t-1}$	–0.210928	0.100153	–2.106063	0.0645
Δln(TOP)$_{t}$	0.077286	0.244039	0.316693	0.7587
Δln(TOP)$_{t-1}$	0.378477	0.264289	1.432058	0.1859
DUM	0.048388	0.040873	1.183850	0.2668
ECT$_{t-1}$	–0.911359	0.197349	–4.618015	0.0013
Long Run Coefficients				
Variables	*COE*	*SE*	*t-statistic*	*PV*
ln(GDPPC)$_{t}$	–1.049385	0.338813	–3.097239	0.0128
ln(INBOUND)$_{t}$	0.175741	0.046337	3.792705	0.0043
ln(TOP)$_{t}$	–0.208516	0.160400	–1.299978	0.2259
DUM	0.053094	0.048029	1.105457	0.2976
Constant	9.458620	3.030020	3.121636	0.0123

Note: DUM shows break dummy. CO2 shows carbon emissions, GDPPC shows GDP per capita, INBOUND shows international tourists' arrival, and TOP shows trade openness.

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