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RESEARCH ARTICLE

International tourism, social distribution, and environmental Kuznets curve: evidence from a panel of G-7 countries

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Abstract

The study examined the long-run and causal relationship between international tourism receipts (ITR), social distribution, FDI inflows, and carbon (CO2) emissions to verify the different alternative and plausible hypotheses, i.e., environmental Kuznets curve (EKC) hypothesis, "pollution haven" hypothesis (PHH), and "resource efficiency" (REF) hypothesis, in a panel of Group of Seven (G-7) countries for the period of 1995–2015. The study employed panel random effect (RE) regression and panel causality test for robust inferences. The results show that ITR and FDI inflows increase CO2 emissions to verify PHH while government education expenditures (GEE) decrease CO2 emissions to substantiate the REF hypothesis across countries. The results validate the inverted U-shaped EKC relationship between CO2 emissions and economic growth (EG) with the turning point of US$30,900. In addition, GEE increase ITR while healthcare expenditures (HEXP) decrease ITR, which partially supported the REF hypothesis in a panel of countries. The impact of income inequality (INEQ) on ITR is positive at current time period while at later stages INEQ declines ITR that supported an inverted U-shaped relationship between them. The causality estimates confirm the bidirectional relationship between ITR and EG, while there is unidirectional casualty running from (i) ITR, EG, FDI inflows, and GEE to CO2 emissions, (ii) FDI inflows to ITR, (iii) GEE to EG, (iv) EG to social expenditures, (v) income inequality to health expenditures, (vi) social expenditures (SEXP) to ITR, and (vii) INEQ to ITR. There is no causal relationship found between ITR and EG during the study time period. The findings endorse the need for efficient resource spending, sustainable tourism (STR), and rational income distribution to improve environmental sustainability agenda in a panel of G-7 countries.

Keywords Carbon emissions · Tourism receipts · Social expenditures · Income inequality · GDP per capita · Environmental Kuznets curve · Panel estimates · G-7 countries

Introduction

The relationship between EG and CO2 emissions is a widely discussed area in the environmental economics that lay out the foundation of EKC hypothesis, which has a different stylish rise and fall in the given curve in the wide economic setting under the number of socio-economic and environmental factors (Dinda 2004, Stern 2004, Bagliani et al. 2008, Nassani et al. 2017, Stern 2018, Rasli et al. 2018, etc). The inclusion of international tourism (ITOUR) as a part of economic activity in the EKC hypothesis gives a new flavor of discussion that reached the conclusive findings to formulate sustainable tourism (STR) policies across the globe (Bella 2018, Qureshi et al. 2017, 2019, Zaman et al. 2016, 2017, etc). The economic impact report of the World Travel and Tourism Council (2016) highlighted the total contribution of travel and tourism, which is about US$7.2 trillion (approximately 9.8%) of world

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GDP. This sector created nearly 1:11 jobs in the world that shows the dynamism in this sector to sustain livelihoods of the many vulnerable people that are dependent on this sector. It is projected that G-20 countries will outperform until 2026, as China, Germany, the USA, and the UK will remain at higher place and they would be the top four market players by 2026 in terms of outbound spending. According to the OECD (2014) report, the SEXP to GDP ratio is devoted to more than one quarter of their GDP in France, Germany, Italy, the UK, and the USA, while HEXP and GEE are the key priority areas for G-7 countries to optimize their resources in a better and manageable way to support countries' economic growth (Verhoeven et al. 2007).

The G-7 countries are the top-ranked advanced countries that have a larger GDP profile and maintained the leading export countries in the world. The USA retains 3rd place in the Global Competitiveness Index (GCI) after Switzerland and Singapore. The major strength of the country is the innovation capacity, larger market size, and sound financial setup. Germany holds the 4th place due to its labor force participation rate and financial wellness. Japan secured 6th place by its research and development activities. The UK is at 10th place and the major strength of the country is devoted to public-private partnerships, an efficient judicial system, educated and skilled labor force, and technological up gradation. Canada is at 13th place and managing larger social spending on primary education and health. France is at 22nd place due to its macroeconomic stability, quality infrastructure, higher spending on education, and flexible tax base system. Italy secured 43rd place due to structural reforms and capacity building that fueled by easy monetary policy and increased domestic demand, which foster companies' innovation to improve productivity (World Economic Forum 2016). According to the reports of Euromonitor International (2014) and Brilliant Maps (2015), there is around 4.7 million tourists who visited two important destinations of Canada, i.e., Toronto and Vancouver, while Paris and Nice destinations of France received around 12 million tourists in 2015. The top destinations of Italy, i.e., Rome, Florence, and Venice, received 13.7 million tourists that visited these destinations. Tokyo in Japan (3.7 million tourists), London in the UK (15.5 million tourists), and different destinations in the USA, including New York city, Les Vegas, Miami, Los Angeles, Orlando, San Francisco, Honolulu, and Washington D.C., received 39.9 million tourists in the year 2015. The importance of these destinations in G-7 countries gives attention to the policy makers to sustain and build tourism infrastructure for broad-based growth in the region. The climate change is the top priority of the G-7 policy agenda, which comes up with the sustainable policy instruments to mitigate GHG emissions. The loss of biodiversity, deforestation, and environmental crime are the key problematic areas that need flair of environmental policies for sustaining broad-based growth.

The importance of buyer-supplier relationship in improving social performance is largely based upon the supplier that gives their services in order to satisfy the buyer needs (see, Awan (2019); Awan et al. 2019). Stynes (1998) described three important channels through which tourism effects economic activities, i.e., direct effect, indirect effect, and induced effect. The direct effect of tourism reflects the sales and profit of the companies that are directly engaged with tourism activities including increase visitation of the foreign tourist that increase their overnight stays in hotels that ultimately increase the hotel's sales and profit, while this additional income further assists to pay hotels' incremental tax bill that helpful to step forward to contribute in the economic development. The indirect effect is the byproduct of the direct effect on tourism, as increase inbound tourism will generate job opportunities in the tourist destination points and it is the good source of foreign reserve earnings, which improve the livelihoods of the marginalized peoples of the country. The induced effect of tourism is related to the household earnings that are received by selling their services and then utilized their earnings in purchasing household food items, spending on education, health, housing, and transportation. Mbaiwa (2003) argued that the destruction of tourism ecology leads to increase air pollution, which needs sustainable policy options to restore tourist destination. Gao et al. (2019) confirmed the tourism-induced EKC hypothesis across different Mediterranean countries with some casual inferences, i.e., Northern region confirmed the feedback hypothesis between TD and EG while Southern region exhibit the tourism-led growth (TLG) hypothesis, which show sound policy inferences for building tourism infrastructure in the respective countries profile. Balli et al. (2019) further emphasized the role of sustainable tourism in mitigating carbon emissions across countries. This confined role of tourism is associated with dynamic causal interlinkages, which support either the feedback hypothesis and/or TLG (or GLT) hypothesis in countries profile. Saint Akadiri et al. (2019) included globalization in the ITOUR and EG modeling and confirmed the mediating role of globalization in support of EKC hypothesis, which is vital for achieving country's sustainable development goals. Liu et al. (2019) supported the sustainable tourism (ST) agenda that is helpful to lessen carbon emissions, while continued EG and energy demand (ED) are supposed to the main antecedents that largely escalates carbon emissions at countrywide. Thus, the sustainable environmental policies are imperative to limit negative externalities, which can be supported by ST agenda globally. Shaheen et al. (2019) suggested the need to improve ITOUR infrastructure through continued EG and energy demand, which is helpful to escalate ITOUR receipts that are further re-invested in the improving of environmental quality and TD across countries.

On the basis of significant discussion on the stated topic, the study formulate the following research objectives, i.e.:

1. To examine the role of social expenditures in promotion of international tourism demand.
2. To evaluate tourism-induced EKC hypothesis and pollution haven hypothesis, and
3. To analyzed the causal relationship between international tourism, social expenditures, and carbon emissions across countries.

These objectives have been set out on the basis of extensive debate on sustainable tourism agenda that is vital for achieving environmental sustainability at a global scale.

Literature review

This section is divided into the following sub-sections that are based upon the dynamic interlinkages among international tourism, social expenditures, and carbon emissions in a panel of selected countries.

Tourism and economic growth

The relationship between tourism demand (TD) and EG is not a new phenomenon, as previously there are a number of studies that examined this nexus and confirmed four alternatives and plausible hypothesis, i.e.:

1. Tourism-led growth (TLG) hypothesis supported by Primayesa et al. (2019) for Indonesian economy; Eyuboglu and Eyuboglu (2019) confirmed the TLG hypothesis in some emerging economies; Balli et al. (2019) supported this causal inferences in the context of Spain, Egypt, and Italy; Yazdi (2019) supported TLG hypothesis in the Iranian context; Zuo and Huang (2018) supported the hypothesis by using a provincial data of China; Gunduz and Hatemi-J (2005) confirmed in the context of Turkey; Solarin (2018) confirmed the same hypothesis for Mauritius; Lean and Tang (2010) confirmed in Malaysia; Brida et al. (2010) confirmed in Uruguay; Tang and Abosedra (2014) confirmed in Lebanon; Solarain (2016) confirmed in Mauritius; Zaman et al. (2017) confirmed in Transition economies, etc. This hypothesis implies that TD boosts EG, which can be verified through the one-way linkage (unidirectional causality) running from TD to EG but not vice versa.
2. Growth-led tourism (GLT) hypothesis supported by Dibeh et al. (2019) in Syrian context; Isik et al. (2018) in the context of Spain; Oh (2005) confirmed in the context of Korea; Lee (2008) confirmed in Singapore; Tang (2011) confirmed in some disaggregated markets of Malaysia; Aslan (2014) confirmed in some countries of the Mediterranean region; Zaman et al. (2016) confirmed in a diversified panel of countries, etc. This hypothesis implies that EG promotes TD, which can be substantiating through the causality estimate (unidirectional causality) that is running from EG to TD but not vice versa.
3. Feedback hypothesis supported by Neuts (2019) in a panel of 89 German cities; Mitra (2019) confirmed the hypothesis by using a large panel of 158 countries; Kim et al. (2006) confirmed in the context of Taiwan; Demiröz and Ongan (2005) confirmed in Turkey; Tugcu (2014) confirmed in the context of Europe and Asia, etc. This hypothesis implies that both the TD and EG are mutually dependent with each other and it would be validated through the bi-directional causality between them, and
4. Neutrality hypothesis supported by Kim et al. (2006) in the context of Taiwan; Ozturk and Ali (2009) confirmed in Turkey; Arslanturk et al. (2011) confirmed in Turkey; Alhowaish (2016) confirmed in Oman, etc. This hypothesis implies that both the variables are independent and have no causal relationships between them.

After the discussion of the above-cited studies in causality framework, the present study hypothesize that

> H1: The relationship between TD and EG is likely to support either TLG hypothesis, or GLT hypothesis, or feedback hypothesis or neutrality hypothesis in a panel of G-7 countries.

This relationship is confirmed by using a panel causality framework both in the short- and long-run.

Tourism demand and social expenditures

The relationship between TD and SEXP has been evaluated by a number of previous studies, i.e., Wong (1996) highlighted the need of SEXP in order to function the local government actions towards the management of police force, financial administration, and financial development while ITOUR work like a catalyst to support these local development expenditures to promote countries' economic growth. Katircioğlu (2010) confirmed the positive impact of TD and GEE on Northern Cyprus economic growth and supported the tourism-driven and education-driven EG hypothesis in the country. Deskins and Seevers (2011) argued that state expenditures for the promotion of ITOUR are highly sensitive in the USA, while the policy to strengthen the net base of the state expenditures on TD required highly intensive tourism coverage to promote country's EG. Loh (2014) confirmed that healthy tourism is the mounting concern in global health–related travels that affects the country's balance of payment. Aslan (2015) confined the role of GEE to promote ITOUR that is helpful to sustain Turkish EG. Kumar et al. (2012) emphasized the need of a strong health care base that provides healthcare facilities to the

foreign visitors in the USA. Atilgan et al. (2017) investigated the causal relationship between HEXP and Turkish EG by using a time series data from 1975 to 2013 and confirmed that HEXP have a positive association with country's EG that further supported the health-led tourism growth in a country. Uçak (2016) confirmed the health-led tourism income and social expenditures-led health tourism income in the case of Turkey. Nassani et al. (2018) concluded that socio-economic factors negatively influenced ITR; thus, it is important to design effective tourism management policies to reduce human suffering through providing job in this sector. The findings indicate the importance of health as a key determinant of tourism income and economic growth at countrywide. Cheah and Abdul-Rahim (2018) investigated the dynamism of healthcare tourism infrastructure to promote EG in 3 selected Asian countries and found the positive interlinkages among the stated variables across countries. The medical tourism is largely required for attracting international tourists to increase their safe and healthy visitation across Asian countries. Fahimi et al. (2018) showed the possible determinants of TD across different micro states for the period of 1995–2015 and found the TLG hypothesis, tourism-induced human capital, and human capital–led growth across countries. The results conclude that ITOUR is largely based upon high investment on human capabilities that required healthcare infrastructure and education expenditures for long-term growth.

In order to examine the relationship between TD and SEXP, thus, the study hypothesizes the following hypothesis, i.e.:

H2: Higher SEXP are likely to increase ITR.

The stated hypothesis estimated by panel regression and panel causality framework to support education-led tourism and health-led tourism hypothesis in a panel of G-7 countries.

Tourism and income inequality

The relationship between TD and tourism and income inequality (INEQ) is complex one, as higher TD either lead to an increase INEQ or may decrease INEQ due to increase TD, government social action plans, and country's economic profile. Lee and O'Leary (2008) confirmed the positive association between ITR and INEQ in the selected US metropolitan communities while employment and household income both have a negative relationship with INEQ. This result confirmed that greater household income and manufacturing employment tend to decline INEQ while tourism recreational earnings are the main predictors that escalate INEQ in country profile. Marcouiller and Xia (2008), however, argued that INEQ in tourism employment is sector-specific rather than a general phenomenon; therefore, it is imperative to strengthen the sectors that translate for pro-equality growth arguments. Kinyondo and Pelizzo (2015) showed that TD induced country's EG and employment while the TLG is less pronounced to reduce INEQ in Tanzania. The result emphasized the need of more equitable tourism that trickle down to the poor in the form of judicious income distribution. Alam and Paramati (2016) confirmed the Kuznets curve hypothesis in relation with ITOUR and INEQ in the context of developing countries and emphasized the need to improve judicious income distribution channel through effective tourism management in a region. Li et al. (2016) highlighted that the effective tourism management substantially decline the regional INEQ; however, the impact of domestic tourism is higher than the international tourism to reduce regional disparities among the member countries. Mahadevan et al. (2017) concluded that the trade-off between ITOUR, poverty, and INEQ is complex in nature, as poverty reduction is accompanied by rising INEQ that does not converge the tourism activities to sustain poverty reduction. Mahadevan Suardi (2019) concluded that ITOUR has a very little impact on redistribution of income; thus, it is important to design pro-equality growth and pro-poor tourism policies to improve equal distribution of income across countries. Lv (2019) confirmed the tourism-led regional inequality hypothesis and confined its finding that ITOUR substantially reduces regional inequality across a large panel of countries. The policy to support pro-poor tourism is deemed desirable by reduction in INEQ through effective labor market legislations. Higgins-Desbiolles (2018) argued that sustainable tourism is the need of the time that limits ecological and social conflicts that required environmental regulatory framework for sustaining global tourism. Pan et al. (2018) discussed the challenges through which ITOUR can affect the sustainability agenda, i.e., high energy demand, water consumption, and forest depletion; these factors negatively affect the global sustainable tourism agenda. Thus, it is highly desirable to formulate sustainable policies to conserve water-energy-food resources, which support tourism demand across countries. Font et al. (2019) suggested that R&D spending in the promotion of international tourism is highly associated with the carbon mitigation agenda that gives technology-embodied growth to attract foreign tourists across countries. The study hypothesize the following relationship, i.e.:

H3: INEQ is likely to increase ITR at initial level, while at later stage, INEQ declines TD.

Sustainable tourism

The ecological footprints of tourism are traces from the scholarly work of Gössling (2000) that include some aspects of energy demand in carbon-growth-tourism nexus and found

that tourism-induced fossil fuel has a highly negative impact on environment, which need to be cater from afforestation programs to mitigate GHG emissions. Becken (2004) surveyed from tourism experts about climate change and willingness for tree planting in the tourist destinations and found that more than 50% of the experts considered that tourism is highly affected by climate change, while it can be combat with tree plantation that is highly reported by tourists for safe and health visitation of the tourist destinations and support sustainable tourism (STR) agenda. Becken and Patterson (2006) found that STR policy instruments merely based upon the measurement of CO2 emissions stock nationwide, thus an integrated STR policy measures would be helpful to mitigate carbon stocks. Kuo and Chen (2009) discussed the quantification of carbon emissions stock through ITOUR, transportation, and accommodation. The results quantified that energy consumption per tourist trip used 1606 MJ, discharge 416 L of wastewater, and 1.95 g of solid waste. Lee and Brahmasrene (2013) examined the role of ITOUR in EG and CO2 emissions in a panel of European countries by using data series from 1988 to 2009. The results found that ITOUR and FDI inflows are both helpful to reduce CO2 emissions while continued EG largely increased carbon emissions across countries. The positive effect of ITOUR on EG is visible, thus the eco-friendly tourism policies are highly desirable to mitigate environmental externality across Europe. Katircioglu et al. (2014) focused on tourism-emissions model in the context of Cyprus and found that inbound tourism is highly inelastic and has a negative impact in relation with energy demand and carbon emissions. Thus, the need of renewable energy sources and STR policies is high to combat climate change effects on environment. Sun (2016) considered Taiwan economy as a case study in order to analyze the possible linkages between ITOUR and carbon footprint and found that tourism consumption largely increases total tourism emissions, which could be limited by eco-efficient technology. Ben Jebli and Hadhri (2018) examined the STR agenda across 10 tourism-induced countries and found a carbon-led economic growth, while the feedback relationship found between ITOUR, EG, and energy demand. The study conclude with the fact that ITOUR have a substantial negative impact on environmental quality, thus it needs energy efficient policies to mitigate carbon emissions. Nepal et al. (2019) concluded that inbound tourism is the crucial factor that increases carbon emissions in Nepal, while continued EG and energy demand increase and decrease inbound tourism respectively. The policy to sustained inbound tourism required more investment in the services sector that attracts international tourists to increase healthy and safe visitation. Eyuboglu and Uzar (2019) analyzed the dynamic interaction among inbound tourism, carbon emissions, and energy demand in the context of Turkey and found that inbound tourism, continued EG, and energy demand are the main predictors of carbon emissions, while tourism-led emissions hypothesis is confirmed in a given country. The long-term energy conservation strategy, STR, and growth-oriented policies would be beneficial to attract international tourists for healthy visitation. On the basis of substantial discussion, the study proposed the following hypothesis, i.e.:

H4: It is likelihood that inbound tourism increases carbon emissions, and
H5: There is expected to have an inverted U-shaped EKC hypothesis across a panel of countries.

These hypotheses need careful examination to assess STR reforms across countries.

The literature on civic sustainability and environmental challenges largely the need of the current generation that have to know how buyer and seller interaction may achieve the social sustainability and improve their performance in order to improve environmental quality (see, Camilleri and Camilleri 2020, Boca and Saraçlı 2019, Awan et al. 2018, Damiani and Losito 2019 etc).

Data source and methodological framework

The following of the variables are used for estimation, i.e., CO2 emissions, HEXP, GEE, INEQ, FDI inflows, EG, and inbound tourism. The TD is measured by ITR. The GINI index is taken from the World Bank estimates to measure INEQ that is ranging between 0% (no inequality) and 100% (large inequality) while CO2 emission is metric tons per capita, GEE (% of GDP), HEXP per capita in constant 2011 US$, GDPPC in constant 2011 US$, FDI inflows in % of GDP, and ITR as a percentage of total imports are taken from World Development Indicators published by the World Bank (2018). The preceding and subsequent values of the studied variables used to fill the missing series where required. The Group of Seven (G-7) countries, namely Canada, France, Germany, Italy, Japan, the UK, and the USA, are taken as a reference point by using time series data from 1995 to 2015. These countries are selected due to two main reasons, at first these countries have a significant policy plan to attract the foreign tourists in their countries tourists' destinations, as G-7 countries maintained top 20 tourists destinations in the world which generate substantial revenues from international tourists arrival. Secondly, the SEXP reforms in G-7 countries have a momentous growth, i.e., the maximum public spending on education is about 6.347% as percentage of GDP and the minimum public spending is about 3.426% with an average of 4.823% (see Table 1 for ready reference). HEXP per capita further escalates in G-7 countries with a minimum value of US$1349.750 and a maximum value of US$9402.537. INEQ falls in the range between minimum at 29.920 and maximum

at 41.750. The mean value of CO2 emissions and FDI inflows is about 10.791 metric tons per capita and 2.062% of GDP respectively. The GDPPC considerably increases during the study time period that indicates the sound economic performance in a region. ITR maintained an average value of 6.182% of total exports that support the economic development process by international tourism infrastructure across the countries. These are the key features that motivate this current study to analyze the relationship between CO2 emissions, TD, and SEXP in a panel of G-7 countries.

The following are sequential steps adopted in this study for empirical illustrations, i.e., unit root process, cointegration test, cross-sectional dependence tests, random effect model, and short- and long-run causality estimates.

Step 1: Summary of panel unit root tests

In Levin et al. (2002), Im et al. (2003), Fisher-ADF and PP tests are used to assess PUR tests for the ready reference. The following regression equation is used for PUR test, i.e.:

$$\Delta Y_{\mathrm{it}} = \alpha_i + \beta_i Y_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta Y_{i,t-j} + \mu_{\mathrm{it}}, \qquad \text{(i)}$$

where Y is the response variable, μ_{it} is an error term, i is the selected sample countries, and t is the time indexes used as a sample period. This single equation, although similar to the panel equation of regression, however, is different in terms of explanatory power of finite samples during the process of stationary process. Equation (1) is modified in terms of imposing restrictions on $\hat{\beta}_i$ by assuming constant across all cross-section identifiers, i.e., β(assuming constant β_s to all cross sections), and presented the panel based version of Eq. (i) which are as follows:

$$\Delta Y_{\mathrm{it}} = \alpha_i + \beta Y_{i,t-1} + \delta_i t + \sum_{j=1}^{k} \gamma_{ij} \Delta Y_{i,t-j} + \mu_{\mathrm{it}}, \qquad \text{(ii)}$$

The null hypothesis of $\beta_1 = \beta_2 = ... = \beta = 0$ is evaluated against its alternative hypothesis, i.e., $\beta_1 = \beta_2 = ... = \beta < 0$, to check the stationary process of the given variable series. Although the LLC test is considered more powerful unit root test, however, it is restricted against the identical cross-section identifiers in the given hypothesis; therefore, it is deemed desirable to address this crucial assumption and relaxed this assumption to allow β to move across the countries against the alternative hypothesis, i.e., $\beta_i < 0$, for some i. Similarly, Fisher-ADF and PP tests also accompanied with the same hypothesis with IPS with $\beta_i < 0$, for some i.

Step 2: Pedroni's panel cointegration test

Although there are different panel cointegration tests that defined the long-run relationships between the variables including Pedroni (1997, 1999), Kao (1999), and Fisher (combined Johansen), however, these tests has some limitations, i.e., Fisher test is not suitable for small sample size in multivariate systems, while Kao cointegration test is considered most suitable in bivariate modeling technique rather than multivariate. It is desirable that during regression, the residual should be non-stationary under no cointegration while reverse is held for cointegration with stationary residual. Pedroni (1997, 1999) test is substantially used in panel cointegration that allows for heterogeneity among selected panel countries, both in the dynamics and in long-run cointegrating vectors which facilitate to generate different "constants" with different slopes. Pedroni proposed the four panel statistics and three group mean statistics to derive asymptotic distributions. The point of attention is that the group-ADF statistic and panel-ADF statistic substantially performed well as compared with the group-rho and panel-variance statistics due to its asymptotic power distributions.

Step 3: Panel cross-sectional dependence tests

The study used the diverse panel cross-section dependence (CSD) tests for robust analysis. The CSD tests can easily be computed during the panel least squares regression. The major motivation of Breusch and Pagan (1980) test based upon the assumption of zero cross-sectional error correlations been evaluated against it alternative hypothesis that can be shown by pairwise cross-sectional correlations, i.e.:

Table 1 Descriptive statistics

Statistics	GDPPC	GEE	GINI	HEXP	ITR	CO2	FDI
Mean	37,794.980	4.823	34.049	3527.390	6.183	10.791	2.062
Maximum	52,549.010	6.348	41.750	9402.537	12	20.178	12.717
Minimum	28,513.330	3.426	29.920	1349.750	1.140	4.573	− 0.725
Std. dev.	5212.247	0.706	3.280	1690.151	3.020	4.537	2.143
Skewness	1.038	− 0.295	0.991	1.650	− 0.036	0.739	2.272
Kurtosis	3.623	2.374	3.180	5.823	1.752	2.181	9.514

$$\rho_{ij} = \rho_{ji} = \frac{\sum_{t=T_{ij}}^{\overline{T}_{ij}} e_{it} e_{jt}}{\sqrt{\sum_{t=T_{ij}}^{\overline{T}_{ij}} e^2_{it}} \sqrt{\sum_{t=T_{ij}}^{\overline{T}_{ij}} e^2_{jt}}} \quad \text{(iii)}$$

where ρ is the pairwise correlation coefficient with lower and upper bound limits, i is the cross section and j is the time period, and e is the error term. Pesaran (2004) in a similar fashion evaluated the null hypothesis under the pairwise correlation coefficient, i.e.:

$$CD = \sqrt{\frac{2}{N(N-1)} \sum_{i=1}^{N} \sum_{j=i+1}^{N} \sqrt{T_{ij}\rho_{ij}}} \quad \text{(iv)}$$

These tests allow for estimates CSD if the cross-sectional identifiers are in given order that remains absolute over time.

Step 4: Panel fixed effect model versus panel RE model with Hausman test of model specification

Panel regression equations are supportive to estimate country-specific-time-invariant shocks to reduce unobserved heterogeneity. We started with the panel fixed effect (FE) model by including cross-section identifiers, and time period under dependent and independent variables, i.e.:

$$y_{it} = \lambda x_{it} + \mu_{it} \quad \text{(v)}$$

where is the coefficient of a set of regressors with i and t.

The FE model extends Eq. (v) with μ, i.e., unobserved shocks that vary across country units, but constant over time, while ε_{it} represents both the time and cross-section unit identifiers that move together in least square regression, i.e.,

$$y_{it} = \lambda x_{it} + \nu_i + \varepsilon_{it} \quad \text{(vi)}$$

where $\mu_{it} = \nu_i + \varepsilon_{it}$. We further replaced ν_i with constant α_s and rewritten Eq. (vi) for more simplicity, i.e.:

$$y_{it} = \lambda x_{it} + \alpha_1 + \alpha_2 + \ldots\ldots + \alpha_N + \varepsilon_{it} \quad \text{(vii)}$$

With FE regression model based upon two estimators, including dummy variable estimator and FE estimator, both the estimators consistently estimate the country-specific shocks in cross-section identifiers.

Similarly, the RE regression model also based upon the cross section and time periods, and FE parameters, i.e., ν_i, is replaced with two components, i.e., α_0 (deterministic component) + ω_i (random component). The RE model can be rewritten equivalently as:

$$y_{it} = \alpha_0(1-w) + \lambda x_{it} + \varepsilon_{it} \quad \text{(viii)}$$

This estimation technique incorporated time-invariant shocks from the given model. Hausman test is the well-establish test that confirmed the model specification between the FE and RE models, as Hausman test estimated whether ν_i is correlated with the set of explanatory variables, i.e.:

H_0: unobserved factor is not correlated with the regressors (random-effects model appropriately)
H_1: unobserved factor is correlated with the regressors (fixed-effects model is appropriately)

The Hausman test statistics is based upon the chi-square distribution with k (slope parameters) degrees of freedom. The significant chi-square value confirmed the alternative hypothesis while insignificant chi-square value supports the null hypothesis.

Step 5: Panel causality tests

The study used two different sets of panel causality estimates, first by imposing restrictions on the coefficient estimates in panel RE regression model by Wald F statistics and find the long-run causality estimates, while by using a vector error correction model where the variables set by the difference operator is used and evaluated the causality pattern by chi-square statistics for short-run causality between the variables. The short- and long-run causality estimates are helpful to understand the causality directions between the variables for conclusive findings. Table 2 shows the list of variables for ready reference.

The study used the following two non-linear regression equations in order to estimate (i) the relationship between SEXP, INEQ, and ITR to assess REF hypothesis (see, Nassani et al. 2018, Awan et al. 2019, Incera and Fernández 2015, etc) and (ii) the relationship between ITR, CO2 emissions, and FDI inflows to assess EKC and PHH (Blancas et al. 2015, Qureshi et al. 2017, Paramati et al. 2017, Ozturk et al. 2016 etc) in a panel of G-7 countries, i.e.:

Model -1: International tourism and social distribution

$$\ln(ITR)_{it} = \varphi_0 + \varphi_1 \ln(GEE)_{it} + \varphi_2 \ln(HEXP)_{it} + \varphi_3 \ln(GINI)_{it} + \varphi_4 SQGINI + \varphi_5 \ln(GDPPC) + \nu_t + \varepsilon_{it} \quad (1)$$

Table 2 List of variables

Variables	Symbol	Measurements	Hypothesis testing
Carbon emissions	CO2	Metric tons per capita	Sustainable tourism (STR)
International tourism receipts	ITR	% of total exports	
Education expenditures	GEE	% of GDP	Resource efficiency (REF) hypothesis
Health expenditures	HEXP	Constant 2011 US$	
GINI index	GINI	World Bank estimates	Income inequality Kuznets curve
Square of GINI index	SQGINI		
GDP per capita	GDPPC	Constant 2011 US$	EKC hypothesis
GDP per capita square	SQGDPPC		
FDI inflows	FDI	% of GDP	PHH

Source: World Bank (2018)

Model -2: International tourism and carbon emissions

$$(CO2)_{it} = \varphi_0 + \varphi_1(ITR)_{it} + \varphi_2(GDPPC)_{it} + \varphi_3(SQGDPPC)_{it} + \varphi_4(GEE)_{it} + \varphi_5 \ln(FDI) + \nu_t + \varepsilon_{it} \quad (2)$$

where ITR indicates international tourism receipts, CO2 indicates carbon emissions, GEE indicates public spending on education, HEXP indicates health expenditures per capita, GINI indicates the GINI coefficient, GDPPC indicates per capita GDP, FDI indicates FDI Inflows, i indicates the panel of G-7 countries, t indicates the time period from 1995 to 2015, ln indicates natural logarithm, ν_{it} indicates random effect regression, and ε_{it} indicates error term at i and t.

Equation (1) shows that ITR is the function of GEE, HEXP, INEQ, and GDPPC in a panel of G-7 countries. The study hypothesized that public spending on GEE and HEXP will be a positive relationship with the ITR, as higher SEXP is likely to increase ITR to support the REF hypothesis in a region. The expected relationship between INEQ (square of INEQ) and ITR is positive (negative), as at initial level of economic development, higher INEQ leads to increase ITR, while in the later stages, INEQ reduces ITR that confirmed the inverted U-shaped relationship between the variables. Finally, the study hypothesizes the positive relationship between ITR and GDPPC, as higher GDPPC is expected to increase ITR to support the "trickle down" hypothesis in order to improve the livelihood of the poor by increasing gains from tourism in a panel of countries. Equation (2) shows that carbon emissions is the function of ITR, EG, FDI inflows, and GEE expected that ITR increases CO2 emissions, while there will be an inverted U-shaped relationship between EG and CO2 emissions to verify EKC hypothesis. GEE is expected to be influenced positively to decrease CO2 emissions while FDI inflows are likely to increase CO2

Table 3 Summary of PUR estimates

Methods	GDPPC	GEE	GINI	HEXP	ITR	CO2	FDI
Level statistics							
LLC	− 3.749*	− 1.471	0.015	− 2.348*	1.655***	3.641	− 2.816*
IPS	− 0.610	− 0.725	0.584	1.468	0.335	4.004	− 3.482*
ADF-Fisher	16.746	18.342	14.958	8.213	9.900	6.353	20.951[a]
PP-Fisher	22.252***	19.504	22.551***	3.955	8.181	5.637	40.603*
First difference statistics							
LLC	− 5.523*	− 7.080*	− 3.727*	0.183	− 5.140*	− 1.593***	− 4.532*
IPS	− 4.112*	− 5.704*	− 4.241*	− 0.868	− 5.775*	− 4.293*	− 5.549*
ADF-Fisher	42.564*	58.003*	40.960*	15.254	59.602*	44.187*	56.207*
PP-Fisher	82.445*	190.625*	70.289*	34.852*	108.465*	123.284*	125.738*

A single asterisk and double asterisk indicate 1% and 10% significance levels. LLC denotes Levin, Lin and Chu; IPS denotes Im, Pesaran, and Shin panel unit root test

[a] Exogenous variable is at "None"

Table 4 Results of Pedroni's residual cointegration test

	Statistics for model-1	Statistics for model-2	Weighted statistics for model-1	Weighted statistics for model-2
Panel tests				
v-statistic	− 0.292	− 1.150	− 0.101	− 1.052
rho-statistic	1.645	2.063	1.379	1.937
PP-statistic	0.039	1.274	− 0.489	1.088
ADF-statistic	0.693	1.671	0.4396	1.890
Group tests				
rho-statistic	2.018	2.988		
PP-statistic	− 0.828	1.762		
ADF-statistic	0.619	2.636		

emissions to support PHH. Thus, there is a need to devise eco-tourism policies to mitigate carbon emissions across countries.

Results

Table 3 presents the summary of panel unit root (PUR) estimates and found that GDPPC is stationary at a level in the LLC and Fisher-PP PUR tests while IPS and Fisher-ADF PUR tests shows that GDPPC is difference stationary. The GEE confirmed the non-stationary series at level while stationary at first difference. INEQ is the difference stationary except in Fisher-PP PUR test that is significant at the level. HEXP per capita and ITR both show the stationary level series according to the LLC PUR test, however, in the remaining PURs, i.e., IPS, Fisher-ADF, and the PP PUR, does not significant at the level. HEXP is the difference stationary in Fisher-PP PUR test, while ITR is the difference stationary in IPS, Fisher-ADF, and Fisher-PP PUR. The carbon emissions are the difference stationary while FDI inflows are level stationary at LLC, IPS, and PP tests. The order of integration is varied in different panel unit root (PUR) tests; therefore, we may categorize that at least in any one of the PUR tests confirmed that the given variables are difference stationary and may have connected in the long-run.

The study estimated cointegration relationship by Pedroni's residual test and presented the results in Table 4. The results show that "within-dimension" and "between-dimension" coefficient estimates do not confirm the common autoregressive and individual autoregressive processes in panel statistics and group statistics, as all of the four panel statistics including panel v, rho, Phillips-Perron, and ADF statistics do not fall in the critical region of 5% level, similarly with the weighted statistics of these four panel statistics, while group tests including group-rho, PP, and ADF statistics further do not fall in the acceptance region of 5% probability value. Therefore, we may conclude that the model-1 and model-2 do not have a cointegration relationship between the variables, as we expected due to mix order of integration of the same variable in different panel unit root methods.

The study moves forward to analyze the CSD between the variables in Table 5 and found different results, as LM test, which is proposed by Breusch-Pagan and Pesaran both confirmed the CSD between the variables in a given model-1 and model-2, as the desired statistics fall in the critical region of 5% level of acceptance, while CD test proposed by Pesaran does not accept the CSD among the variables in the model-1; however, it is significant in the model-2. These disjoint results do not move further to estimate conventional panel cointegration regression tests, and employed panel least square regression techniques for robust estimates.

Table 6 shows the estimates of panel RE model, as the Hausman test of model specification rejected the FE model due to no correlation that has been found between unobserved factor and explanatory variables, which is further depicted in the chi-square statistics that does not fall in the acceptance region of 5% level of significance.

Table 5 Results of CSD tests

Tests	Statistics	Probability value	Statistics	Probability value
Model-1			Model-2	
Breusch-Pagan LM	67.344	0.000	371.694	0.000
Pesaran scaled LM	6.070	0.000	53.033	0.000
Pesaran CD	0.469	0.638	19.249	0.000

Table 6 Estimates of panel RE for model-1 and estimates of panel RE for model-2

Variables	Coefficient values	Standard error	*t* statistics	Probability value
Estimates of panel RE for model-1				
Constant	− 20.920	9.966	− 2.099	0.037
ln (GEE)	0.579	0.209	2.760	0.006
ln (HEXP)	− 0.269	0.081	− 3.317	0.001
ln (GINI)	7.115	3.083	2.307	0.022
GINI^2	− 0.002	0.001	− 1.786	0.076
ln (GDPPC)	0.168	0.307	0.546	0.585
Estimates of panel RE for model-2				
Constant	5.185	3.547	1.461	0.146
ITR	0.229	0.077	2.959	0.003
GDPPC	0.000428	0.000163	2.630	0.009
SQGDPPC	− 6.93 − 09	2.08E − 09	− 3.338	0.001
EKC turning point = US$30,900				
FDI	0.093	0.033	2.817	0.005
GEE	− 0.436	0.187	− 2.324	0.021

Statistical tests: *F* statistics = 9.283, probability *F* statistics = 0.000, cross-section random–rho = 0.928, idiosyncratic random–rho = 0.071, Hausman test: chi-square statistic = 9.328, probability value chi-square = 0.096. Note: Dependent variable-ln (ITR)

Statistical tests**:** *F* statistics = 17.473, probability *F* statistics = 0.000, cross-section random–rho = 4.236, idiosyncratic random–rho = 0.677, Hausman test: chi-square statistic = 8.786, probability value chi-square = 0.117. Note: Dependent variable–CO2

The results show that there is a positive relationship between ITR and GEE, as higher GEE transformed in to greater tourism income that supports the REF hypothesis. This relationship is less elastic in nature, as greater change in public spending has a moderate change in tourism income that needs more policy intervention to boosts SEXP to be benefited by tourism income in all the three forms of tourism economic impact, i.e., direct effects (economic activity generated by increase in number of tourists), indirect effects (economic activity generated by tourism receipts), and induced effects (money flow from household to businesses and vice versa) (Stynes 1998). There is a negative relationship between HEXP and ITR, as higher HEXP reduce the economic impact of tourism; therefore, it is imperative to focus on medical tourism that would helpful to attract foreign tourists to increase visitation by healthy and safety standards (Puczko 2010). The relationship between INEQ and ITR confirmed an inverted U-shaped relationship between them, as higher INEQ supports to increase ITR, while after reaching at optimum level, it tends to decline ITR to increase INEQ across countries. The results are differing with Alam et al. (2016) that argued that squaring tourism revenue declines INEQ and supported the theory of inverted U-shaped relationship between the variables, while in this study, we used INEQ as a regressor and doubling the INEQ reduces the ITR, which implies that if INEQ doubles, it significantly reduces the tourism income in G-7 countries. The impact of per capita income on ITR is insignificant during the study time period; therefore, analyzing the causal relationships between tourism and SEXP provides more policy insights to describe the direction of the variables between them.

The results of model-2 show that there is a positive relationship between ITR and carbon emissions, which implies that higher the ITOUR, higher is the carbon emissions, which need STR policies to mitigate carbon emissions stock. The results confirmed the viability of eco-friendly tourism policies to decrease carbon abatement costs via increase in tourism revenue. The investment in the tourism infrastructure amplifies EG on the cost of carbon emissions, thus the safe and healthy visitation is the optimized solution for less-polluting tourists destinations across countries (Qureshi et al. 2017, Atzori et al. 2018, Van Dyk et al. 2019, etc). The results verify the inverted U-shaped relationship between country's GDPPC and CO2 emissions with the EKC turning point of US$30,900. The impact of FDI inflows on CO2 emissions is positive that confirmed the PHH across countries. There is a negative relationship between GEE and CO2 emissions, which imply that GEE is helpful to reduce CO2 emissions through sharing knowledge information in a panel of selected countries. Thus, there is a high need to devise strong environmental regulations in order to limit polluting industries for sustainable development (Zhang et al. 2019, Sarkodie and Strezov 2019, Sarkodie and Strezov 2018, Murthy and Gambhir 2018, Shen et al. 2019, etc). Table 7 shows the short- and long-run causal relationships between TD, CO2 emissions, and SEXP in a panel of G-7 countries.

Table 7 Short- and long-run causality estimates

Long-run causality estimates	Wald *F* statistics	Short-run causality estimates	Chi-square statistics
ln (GDPPC) → ln (ITR)	0.298	Δln (GDPPC) → Δln (ITR)	6.324**
ln (GEE) → ln (ITR)	7.619*	Δln (ITR) → Δln (GDPPC)	5.114***
ln (GINI) → ln (ITR)	5.325**	Δln (GDPPC) → Δln (GEE)	16.254*
ln (HEXP) → ln (ITR)	11.005*	Δln (HEXP) → Δln (GEE)	7.200**
ITR → CO2	8.760*	Δln (GDPPC) → Δln (HEXP)	5.613***
GDPPC→CO2	6.919*	Δln (GINI) → Δln (HEXP)	5.576***
FDI → CO2	7.938*	CO2 → ITR	6.557**
GEE → CO2	5.403*	FDI → ITR	4.964***
		CO2 → GDPPC	11.654*
		GEE → GDPPC	4.950***
		CO2 → FDI	9.217*
		FDI → GEE	18.476*

A single asterisk, double asterisk, and triple asterisk indicate 1%, 5%, and 10% levels of significance. ln denotes natural logarithm, Δ indicates first difference, → indicates unidirectional causality

The results show that in the short-run, there is bidirectional causality between GDPPC and ITR, which implies that both the variables are the "joint goods" and both affect each other. This promotes the tourism-induced policies for sustained economic growth at least in the short-run. The causal relationship, however, evaporated in the long-run, where GDPPC and ITR both hold the "neutrality hypothesis," as expected because in the regression apparatus, both variables do not have any significant impact between them. The results differ with the findings of Hatemi-J et al. (2018), although their study evaluated panel asymmetric causality between TD and EG across the group of seven countries and supported in the majority of the cases of TLG hypothesis with some positive and negative growth shocks, however, the current study does not examine positive and negative growth shocks in the G-7 countries. There is unidirectional causality running from GDPPC to GEE and HEXP, which implies that GDPPC promotes GEE and HEXP and it speeds up the process of SEXP in a panel of countries. HEXP Granger cause GEE and support the health-led education spending, while INEQ Granger cause HEXP. In the long-run, GEE and HEXP both Granger cause ITR and support the SEXP-led TD in a region, similarly, INEQ promotes ITR but not vice versa. The short-run causality estimates further confirmed the emissions-led tourism, FDI-led tourism, carbon-led growth, education-led growth, carbon-led FDI, and FDI-led education hypothesis, while in the long-run, there is a unidirectional causality running from ITOUR to CO2 emissions, EG to CO2 emissions, FDI inflows to CO2 emissions, and GEE to CO2 emissions across countries. The causality estimates draw an attention to promote healthy and wealthy tourism by strong intervention of GEE, STR, HEXP, and rational income distribution policies across countries.

Conclusions

The eco-friendly tourism policies are the sustainable policy agenda to mitigate CO2 emission to overcome the global health concerns. The study empirically analyzed the relationship between ITR, CO2 emissions, SEXP, and INEQ in a panel of G-7 countries for a period of 1995–2015. The study employed different PUR tests and confirmed the mixture of order of integration in different unit root tests while Pedroni's cointegration test does not confirm the long-run relationship between the variables. For this purpose, the study used CSD tests and found the rejection of null hypothesis of no CSD among the member countries. After confirmation of Hausman test of model specification, panel RE regression is considered best model fit for the empirical estimation and found that SEXP including GEE and HEXP have a differential impact on ITR, as higher GEE lead to an increase ITR while HEXP decline the ITR and confined the role of resource optimization across countries. The results further confirm the positive association between INEQ and ITR while the square of INEQ declines the ITR that supports an EKC relationship between the variables. The results validate the inverted U-shaped EKC hypothesis with respect to CO2 emissions and further supported the PHH, as FDI inflows largely increases CO2 emissions in a country. The impact of increase GEE is helpful to decrease CO2 emissions across countries. The panel causality estimates confirmed the bidirectional causality between GDPPC and ITR while growth-led SEXP and INEQ-led HEXP are established in a short-run. In the long-run, SEXP and INEQ both Granger cause ITR that support SEXP-led ITR and INEQ-led ITR across countries. The results support the neutrality hypothesis between GDPPC and ITR in the long-run. Further, the short-run causality estimates validate the CO2-led tourism and FDI-led emissions while in

the long-run, growth-led emissions and education-led emissions hypothesis is verified in a panel of countries. These results enforced the need to devise STR policies to mitigate CO2 emissions, while an increase in the optimum resource allocation and formulate judicious income distribution policies would aid to increase tourism income in the region. The following short-, medium-, and long-term policy implications are proposed to take necessary actions for sustained tourism growth in G-7 countries i.e.:

- Short-term policy implications: The eco-friendly policies are highly desirable in order to limit carbon emissions and achieved United Nation environmental sustainability agenda to manage global average temperature less than 2 °C. The sustainable tourism policies may achieve the Paris Agreement (COP21) mission agenda to combat climate change with the development of green infrastructure. Tourism and social expenditures both equally considered as a strong driver to promote sustained economic growth. The challenges of rising poverty and income inequality may be reduced by increasing social spending on education and health. The policy makers should have to reinforce their energy on tackling human's vulnerability by increasing social expenditures and international tourism to promote sustained economic growth in a panel of countries.
- Medium-term policy implications: The rising income inequality reduced the tourism demand and income, which required more policy intervention to judiciously distribute income in the lower strata group and marginalized peoples. The pro-equality distribution of health, education, and income may support the livelihood of the poor peoples. Social expenditures–led tourism demand derives the conclusion that education and health expenditures substantially improve the tourism income at the expense of income inequality; therefore, it is advised to make a rational decision about income distribution among the poor and non-poor and to support pro-poor tourism policy in a region.
- Long-term policy implications: Growth-led tourism and tourism-led growth both have a different policy implications, as former indicates the policy reforms for tourism extension to sustained economic growth while later enforced the importance of growth expansionary policies to increase tourism demand. The feedback hypothesis further implies that both the variables are mutually dependent with each other. The long-term policies to integrate international tourism with growth factors could be able to reap maximum benefits of sustained economic growth. The G-7 countries required sustainable policy interventions in the tourism modeling framework by legislating the environmental laws, carbon pricing, and advancement in the development of smart tourist destinations through expanding social spending, while policy should be device to formulate judicious income distribution that would be helpful to increase the livelihood of the poor and support pro-poor tourism in a region. The future work plan will be more comprehensive and include the number of other possible determinants of international tourism and environmental quality in order to excel in the United Nation SDGs and COP21 agreement.

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