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Article

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Do Tourism and Renewable Energy Influence CO_2 Emissions in Tourism-Dependent Countries?

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ABSTRACT

The global community gathered in 2015 in paris to join efforts in order to mitigate the impact of global warming by decreasing carbon emissions. As tourism is viewed as one of the essential causes of global warming, policymakers are searching for tools to decrease the carbon footprint of the tourism sector by introducing energy efficiency strategies. This study aims to contribute to the energy-emissions debate by accounting for the presence of the tourism sector. In particular, we offer novel evidence on the effect of renewable energy on CO_2 emissions in a sample of 50 most tourism-oriented countries over the period from 2000 to 2015. Using a two-step GMM estimator, we find that a one percent increase in renewable energy consumption leads to a one percent decrease in CO_2 emissions. We also confirm the presence of the Environmental Kuznets Curve phenomena in tourism-oriented countries. Based on the empirical findings, the study suggests that the policymakers of the top tourist-oriented countries initiate more renewable energy-based activities to achieve sustainable economic development.

Keywords: CO_2 Emissions, Tourism, Renewable Energy, Tourism-dependent Countries, GMM
JEL Classifications: Q53, L83, Q20

1. INTRODUCTION

Global warming is a serious threat affecting every nation (Hao et al., 2021). Human activities and greenhouse gas emissions are the major drivers of climate change, as stated by the intergovernmental panel on climate change (IPCC) in their fourth global climate assessment (Jiang et al., 2019). One of the most highlighted objectives of the paris agreement to bring world temperature to 1.5°C between 2020 and 2025 via the mitigation of greenhouse gas emissions. Yet by 2021's end, emissions had risen more. As a result, a 27th conference of the parties (COP27) meeting considered it necessary to hasten responses to climate change and focus emphasis on the reduction of carbon emissions. United Nations (UN) forecast that global temperature will be 3° above the pre-industrial era, which is much above the target of 1.5° (UN, 2015). The paris conference stresses that nations must adopt environmentally friendly strategies and decrease their carbon footprint without harming economic growth. However, tourism has been viewed as a factor in economic development (De Siano and Canale, 2022).

The importance of the tourist industry became clear after a global economic crisis brought on by the COVID-19 pandemic. The travel and tourism industry share contributed 10.3% to the world GDP in 2019. Tourism-related exports reached 1.7 trillion US dollars in 2018. This accounts for 29% of all services exported globally and 7% of all exports of both goods and services (UNWTO, 2019). Tourism's environmental impact is often overlooked compared to its societal and economic effects (Zha et al., 2020). For example, the study of Koçak et al. (2020) is evident that the tourism sector may increase carbon emissions. According to a study by Lenzen et al. (2018), the worldwide carbon impact of tourism grew from 3.9 to 4.5 $GtCO_2$ between 2009 and 2013, four times the previous estimate and equivalent to almost 8% of global greenhouse gas emissions. Energy consumption, particularly using non-renewable energy resources, is also one of the primary considerations determining ecological footprint (Kirikkaleli et al., 2022 and Yousaf et al., 2022). Indeed, tourism-induced activities demand energy from non-renewable sources such as oil, gas, and coal. At the same time, studies find that fossil fuel energy consumption is one of the core drivers of climate change (Adebayo, 2022). However, the relationship between tourism and energy consumption has two different channels, the energy consumption in lodging services and energy use in the tourism-related transportation industry are used to actualize energy consumption in the industry. Policymakers must prioritize the effective use of energy in the transportation and lodging sectors. Global tourism has grown due to recent expansions in international collaboration and transportation services. With these changes, the energy sector's dependence on tourism has increased. For instance, the desire to see more destinations faster has increased the reliance of tourism-related transportation on non-renewable energy.

Using fossil fuel energy results in greenhouse gas emissions, which harm the environment (Ali et al., 2022; Raza et al., 2022). The idea of "green tourism" has started to be debated as an effect of using renewable energy in the tourism industry. The following are the primary rationale for using renewable energy in the tourist industry. Firstly, energy efficiency is crucial for the tourist industry to be sustainable and competitive. Secondly, environmentally friendly tourism destinations are often preferred by visitors. The most recent study by Ben Jebli et al. (2019) found that 34% of tourists are ready to spend extra to stay in eco-friendly hotels, and 38% of visitors prefer to stay in such accommodations. Several studies have dedicated much of their time and energy to researching urbanization and carbon emissions. The study by Khan et al. (2019) found that CO_2 emissions are caused by urbanization in South Korea. According to research by Al-Mulali et al. (2012), which analyzed seven global areas, urbanization directly affects CO_2 emissions in 84% of all nations. The effects of urbanization on carbon emissions in Chinese urban buildings were studied by Huo et al. (2020). The urban population and urban development area adversely impact carbon emissions from the urban building. In conclusion, the current research on urbanization and carbon emissions is rising. This relationship provides governments with a foundation to base policies to reduce carbon emissions.

Therefore, this study aims to contribute to the energy-emissions debate by accounting for the presence of the tourism sector by many folds. First, in particular, we offer novel evidence on the impact of renewable energy on CO_2 emissions in the fifty most tourism-oriented countries over the period of 2000-2015. Second, the present study empirically examines the impact of economic development, energy intensity, urbanization, and trade openness on environmental degradation. Third, this study contributes theoretically by laying the groundwork for future studies that might more effectively combine tourism and carbon policy. Fourth, to check the validity of the Environmental Kuznets Hypothesis for the above-mentioned countries set. Finally, in the methodological part, this study contributes to the literature by employing two-step generalized method of moments (GMM). Thus, the findings of this research may provide helpful insights for moving forward. Specifically, this research recommends how to investigate in the future.

The organization of this paper is as follows. The next section provides a relevant Literature Review; Section 3 introduces the data and methodology; Section 4 presents empirical results and discussions. Section 5 offers the conclusion of the study, some policy ramifications, and suggestions for future studies.

2. LITERATURE REVIEW

The main drivers of environmental degradation are a well-debated topic and gained significant attraction from researchers over the past years. Scholars investigated numerous determinants of CO_2 emissions in a sample of different countries, and results vary from each other. In particular, trade openness, FDI, urbanization, non-renewable energy consumption, tourism, and population growth are highly cited factors that increase emissions. In contrast, the consumption of renewable energy and human capital reduces it.

The empirical findings of prior studies on the relationship between different variables and CO_2 emissions are inclusive. For instance, Li and Haneklaus (2022) analyzed that trade openness increases CO_2 emissions while advanced urbanization reduces them. Another study by Raihan and Tuspekova (2022) investigated the relationship between economic development, the travel industry, and environmental degradation, and the results revealed that urbanization and tourism increase CO_2 emissions. A recent study by Raihan (2023) and Raihan et al., (2022) analyzed the nexus between variables and found that a 1% increase in the use of renewable energy may decrease carbon emissions by 1.5%. Khan et al. (2022) discovered a direct association between energy consumption and urbanization, while adverse effects have been found between international trade and environmental degradation. Li and Ullah (2022) used a proxy of human capital and found a positive change in education can significantly decrease CO_2 emissions in the long run or vice versa. Based on this, policymakers should develop vital education on environmental protection. Similarly, Isiksal et al. (2022) stated in their research that higher environmental awareness through education reduces environmental pollution, especially in developing countries. Fresh evidence by Wang et al. (2023) explains that clean energy and natural resources preserve the quality of the environment both in short and long-run analyses. However, Sadiq et al. (2023a) and Sadiq et al. (2023b) indicated that globalization and economic growth degrade environmental sustainability. Furthermore, Tzeremes et al. (2023) found ICT to solve ecological challenges, whereas Sun et al. (2023) evidenced that ICT dramatically reduces CO_2 emissions in high-income countries.

Many quantitative approaches have been used in studies to find the associations between various factors and environmental degradation. For example. Wang and Wang (2021) applied different estimation techniques, resulting that trade having a U-shaped impact on carbon intensity in 104 countries. The ARDL-bound testing approach is widely used to explore the association between variables in a sample of different countries (Liu et al., 2022; Ridzuan et al., 2022; Nepal et al., 2021; Ali et al., 2023; Li et al., 2022). For the Asian economies, Tiwari et al. (2022) employed the novel techniques of panel quantile regression (PQR) which was constructed by Canay (2011). The study by Ge et al., (2022) used econometric panel techniques for China i.e., generalized least squares (GLS) and panel VAR estimators. Hongxing et al., (2021) analyzed heterogeneous evidence from African countries using cross-sectional dependency from 1990 to 2018. Among these techniques, FMOLS and DOLS are extensively applied to estimate the nexus by Adebayo et al. (2022), Karimi Alavijeh et al. (2023), Yuldashev et al. (2023); and Majeed et al. (2022) for the case of BRICS, EU, Asian and OECD economies, respectively. Moreover, Chenyun et al. (2022) examined BRI countries under the augmented mean group estimator with novel results. The westerlund panel co-integration test also gives promising results in several kinds of research (Kostakis and Arauzo-Carod, 2023; Satrovic and Adedoyin, 2023; Saud et al., 2023) based on MENA, SEE, and highly developed countries with different time frameworks. Similarly, the most recent study of Gu et al., (2023) employed MM-QR. Furthermore, traditional panel co-integration methods fail to account for the cross-sectional dependence error term, yielding inaccurate results. Hence, our study uses improved GMM estimation to conduct in-depth research and empirically analyze to draw the solutions.

While earlier studies have explored the impact of clean energy on environmental degradation across countries categorized by income group or geographical location, we specifically select countries with the highest levels of tourism receipts per capita. This allows us to explore whether renewable energy consumption can be important in climate change mitigation strategies for tourism-dependent countries. Reviewing the literature, however, we see surprisingly few studies on the connection between urbanization, trade, energy uses, and carbon emissions in the top 50 tourism-oriented countries. This research fulfills the gap by analyzing the presence of the environmental kuznets hypothesis in sampled states, and empirical findings are tested under two steps generalized methods of moments. To our best knowledge, the study results are highly reliable to implement by policymakers of tourism-oriented countries to keep a sustainable environment with the development of tourism correspondingly.

3. DATA AND METHODOLOGY

This study examines the role of tourism and renewable energy with other independent variables on environmental degradation. Here the dependent variable in our study is tCO_2 emissions per person. In our study, tCO_2 emissions per person range from 0.91 in Fiji to 67.01 in Qatar. To assess the effect of renewable energy on CO_2 emissions, we use two measures from the World Bank, including renewable electricity output and renewable energy consumption. The full description of the variables is given below in Table 1.

3.1. Theoretical Model

This study expanded the STRIPAT (Stochastic Regression Impacts of Population Affluence and Technology) model, which is considered a model of the drivers of environmental degradation. The model's primary form is stated as follows:

$$I_{i,t} = \alpha P_{i,t}^{b} A_{i,t}^{c} T_{i,t}^{d} \varepsilon_{i,t} \quad (1)$$

In its linear form, the model is expressed as:

$$I_{i,t} = \alpha + bP_{i,t} + cA_{i,t} + dT_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where, the data is collected for i^{th} country at year t, I denote environmental degradation (CO_2 emissions), P is population measured by urbanization rate, A is for affluence or GDP per capita, T is environmental technology proxied by energy intensity, and ε is an error term. The importance of the STRIPAT model for the econometric modeling of carbon emissions as it can also incorporate other variables of interest. We extend this model by including GDP per capita squared term (A^2), renewable energy (RE), tourism receipts as % of GDP, (TUR) and trade openness (TO). We include GDP per capita squared to account for the EKC framework. The revised STRIPAT model can be presented as follow:

$$I_{i,t} = \alpha + bP_{i,t} + c_1 A_{i,t} + c_2 A_{i,t}^2 + dT_{i,t} + eR_{i,t} + fE_{i,t} + gO_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where $\alpha, b, c_1, c_2, d, e, f,$ and g parameters are to be estimated. The baseline results in our study are assessed using fixed effects (FE) estimator and panel-corrected standard errors (PCSE) method. However, the final choice of econometric method in our study is dictated by a number of aspects. First, in our study, the number of nations (n = 50) greatly exceeds the number of years (t = 16). Second, related research includes lagged carbon emissions in the empirical models (Bakhsh et al., 2021). Third, panel data studies may suffer from cross-national dependence across panels. Finally, it is crucial to consider the problem of simultaneity and heteroskedasticity that may exist in environmental research

Table 1: Definition and sources of the data

Variables	Definition of variables	Sources
Environmental degradation (CO_2)	CO_2 emissions per person	Global Carbon Atlas
Economic Development (ED)	GDP per capita, PPP at constant 2017 international US dollars	World Bank Data
Urbanization (UR)	The percentage of the population that resides in urban areas	World Bank Data
Renewable energy consumption (REC)	Use of renewable energy as a percentage of total final energy consumption	World Bank Data
Renewable electricity output (REO)	Production of renewable power as a share of all electricity production	World Bank Data
Energy intensity (EI)	The level of the energy intensity in primary energy (MJ/$2011 PPP GDP)	World Bank Data
Tourism receipts (TUR)	International tourism, receipts per capita (current US$)	World Bank Data
Trade openness (TO)	It represents the overall trade as a share of GDP.	World Bank Data

(Obydenkova et al., 2016). Therefore, following extant research on environmental sustainability (Khan et al., 2019), we use a two-step GMM estimator that takes into account the above-mentioned nature of the data and empirical modeling (Roodman, 2009 for the technical discussion). Figure 1 illustrates the theoretical framework graphically.

Consequently, in level (2) and first difference (3), we estimate the following specifications:

$$CO2_{i,t} = \sigma_0 + \sigma_1 CO2_{i,t-\tau} + \sigma_2 E_{i,t} + \sum_{h=1}^{k} \rho_h X_{h,i,t-\tau} + u_{i,t} \quad (2)$$

$$CO2_{i,t} - CO2_{i,t-\tau} = \sigma_1 \left(CO2_{i,t-\tau} - CO2_{i,t-2\tau} \right) + \sigma_2 \left(E_{i,t} - E_{i,t-\tau} \right) + \sum_{h=1}^{5} \rho_h \left(X_{h,i,t-\tau} - X_{h,i,t-2\tau} \right) + (u_{i,t} - u_{i,t-\tau}) \quad (3)$$

where σ_0 is a constant term, τ represents the constraint of auto regression, X is the vector of variables from STRIPAT model (GDP per capita, GDP per capita squared, urbanization, tourism receipts, energy intensity) and u is a disturbance term. In this regard, the extended model of the study as follow:

$$CO_{2i,t} = \alpha_0 + \beta_1 ED_{i,t} + \beta_2 ED_{i,t}^2 + \beta_3 UR_{i,t} + \beta_4 REC_{i,t} + \beta_5 REO_{i,t} + \beta_6 EI_{i,t} + \beta_7 TUR_{i,t} + \beta_8 TO_{i,t} + \mu \quad (4)$$

Table 2: Summary statistics

Variables	Mean	SD	Min	Max
CO_2	8.62	8.49	0.91	67.01
GDP per capita	39.13	25.72	8.65	161.94
Trade openness	136.26	92.96	29.13	860.80
Urbanization	69.93	22.64	18.45	100.00
Energy intensity	4.52	2.85	0.43	19.22
Renewable energy consumption	12.65	16.23	0.00	77.34
Renewable electricity output	19.51	27.49	0.00	99.99
Tourism receipts	4.49	7.28	0.21	75.63

4. RESULTS AND DISCUSSION

4.1. Results of the Descriptive Statistics

The estimate of descriptive statistics of all the variables that were taken into account is shown in Table 2. This statistic provides information on the mean, median, maximum, and minimum values for all the variables included in the model. Therefore, the mean values of CO_2 emission, ED, TO, UR, EI, REC, REO, and TUR are 8.62, 39.13, 136.26, 69.93, 4.52, 12.65, 19.51, and 4.49, respectively.

4.2. Baseline Results

Table 3 presents the first findings. Columns 1 and 2 present the fixed effects regression estimates, while columns 3 and 4 present for Panel corrected standard errors. Across all columns, renewable energy measures are statistically significant and negatively linked to CO_2 emissions. To provide just one example, a decrease in CO_2 emissions per person of 0.84% is related to a 1% rise in the share of renewable energy in total energy consumption. (Column 1). However, the results reported in Table 3 only offer correlational evidence between renewable energy and CO_2 emissions as they don't account for the issues of endogeneity, simultaneity and causality.

Table 3: Baseline results

Variables	I	II	III	IV
CO_2	0.3618 (5.21)***	0.3465 (5.49)***	0.8445 (36.45)***	0.8559 (38.81)***
ED	0.0186 (2.88)***	0.0197 (3.26)***	0.0059 (4.17)***	0.0052 (3.78)***
ED^2	−0.0001 (2.64)**	−0.0001 (3.14)***	−0.0000 (2.58)***	−0.0000 (2.12)**
TO	−0.0001 (0.21)	−0.0002 (0.75)	−0.0001 (0.75)	−0.0001 (0.60)
UR	−0.0006 (0.13)	−0.0019 (0.40)	−0.0003 (1.16)	−0.0003 (1.20)
EI	0.5239 (6.35)***	0.4536 (4.23)***	0.1547 (7.10)***	0.1358 (7.14)***
TUR	0.0037 (1.87)*	0.0066 (2.43)**	−0.0002 (0.09)	−0.0012 (0.72)
REC	−0.0084 (3.21)***		−0.0024 (4.87)***	
REO		−0.0062 (7.26)***		−0.0012 (4.69)***
Constant	0.1168 (0.27)	0.3531 (0.74)	−0.0373 (1.43)	−0.0230 (0.89)
R^2	0.62	0.62	0.98	0.98
Method	553	553	553	553
n	538	538	538	538

*P<0.1; **P<0.05; ***P<0.01

Figure 1: Graphical theoretical farmwork

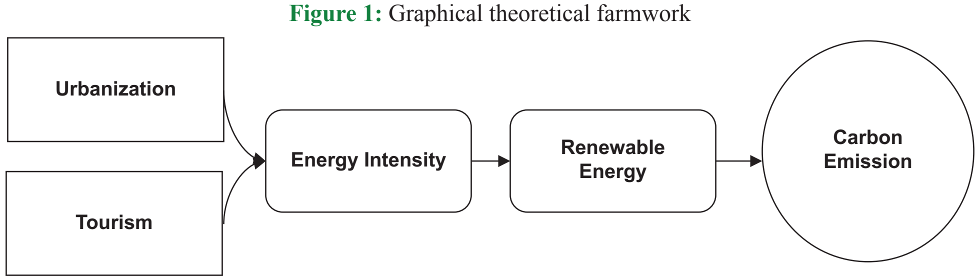

Table 4: Two-step GMM

Variables	I	II
CO_2	0.5197 (23.41)***	0.4769 (10.53)***
ED	0.0193 (12.03)***	0.0158 (6.75)***
ED2	−0.0001 (11.60)***	−0.0001 (4.69)***
TO	−0.0000 (0.25)	−0.0002 (1.58)
UR	0.0026 (1.86)*	0.0046 (2.43)**
EI	0.4428 (14.17)***	0.3868 (6.64)***
TUR	0.0008 (0.43)	−0.0136 (4.63)***
REC	−0.0103 (8.72)***	
REO		−0.0085 (5.63)***
Constant	−0.3161 (4.50)***	−0.0830 (0.94)
AR (1)	0.005	0.002
AR (2)	0.666	0.898
Hansen p-value	0.323	0.700
n	553	553

*P<0.1; **P<0.05; ***P<0.01

4.3. Results of Two-Step GMM

The main results from the estimating two-step GMM method are reported in Table 4. The results demonstrate that using renewable energy sources reduces carbon dioxide emissions. Our results align with many studies confirming renewable's importance in curbing carbon emissions (Wang et al., 2023; Iqbal et al., 2023). In the first column, a 1% rise in renewable energy consumption results in an almost 1% decrease in CO_2 emissions. Arellano and Bond's (AR) criterion for autocorrelation of the second order (AR(2)) and Hansen's (HOI) overidentification limitation validate the validity of the two-step GMM estimator (OIR). Turning to other variables, we discover that GDP per capita has an inverted U-shape connection with carbon emissions. We confirm the presence of the EKC framework in line with a plethora of studies in the field of environmental research (Wang et al., 2023; Jung and Song, 2023). Energy intensity increases environmental degradation (Ulucak and Khan, 2020; Ayad et al., 2023). For instance, a 1% increase in energy intensity increases CO_2 emissions by 0.52-0.13%. The positive effect of energy inefficiency on CO_2 emissions has also been documented by Adebayo et al. (2023) and Cheng and Hu (2023). In column 2, we also find that urbanization increases air pollution. Indeed, urbanization increases carbon footprint through the surge in energy consumption and level of economic activity (Wei et al., 2023).

5. CONCLUSION AND POLICY SUGGESTIONS

This research uses data from a panel of the top 50 tourism-dependent nations from 2000 to 2015 to analyze the correlation between renewable energy, CO_2 emissions, and international travel. Using FE estimator, PCSE method, and two-step GMM estimator, we confirmed that renewable energy sources significantly reduce per-person CO_2 emissions. Most importantly, our results are robust even after considering the role of economic progress, demographic changes, global integration, and energy intensity.

Our study offers a number of policy implications for countries that rely on the tourism sector as an important driver of economic growth. Tourism-oriented countries heavily depend on non-renewable energy sources, which leads to environmental degradation. These countries should rapidly adopt renewable energy technologies to achieve sustainable economic development. Moreover, extant research also finds that renewable energy benefits the environment and stimulates economic growth. Policymakers should ease the administrative procedures associated with adopting renewable energies by companies and households. Development of PPP (public-private partnership) encourages investment more in renewable energy sources, as a result, a private investor may be able to participate more actively in RE activities.

As it is clear, renewable energy sources require a high cost of technology which is not affordable even for developed countries. Two of the most often stated issues regarding the implementation of renewable energy in the literature (Carlos and Lorente, 2020; Key et al., 2020; Koengkan et al., 2020) are the lack of necessary infrastructure and technology. Therefore, it is essential for the government authorities to initiate new public policies to encourage investment and facilitate the implementation of renewable energy technologies. In a more detailed way, policymakers should develop measures with public banks to provide loan subsidies for businesses looking to invest in renewable energy. Moreover, policymakers can cooperate with international financial institutions and donors to ease the transition toward green energy. At the same time, one of the main obstacles among people is their lack of knowledge and awareness of renewable energy for a sustainable environment (Eshchanov et al., 2021). A deficiency of information about the advantages of clean energy makes it much more difficult to make projects feasible. Even in some tourist areas population still prefers the wood stove, and these barriers guide governments to draw the right strategies to address the problems. The development of green tourism should be the first priority for top tourism intense countries. Public transportation and infrastructure need to be improved by local governments to provide better and energy-efficient facilities for international tourists. Prospective studies should explore the role of other variables that may play an important role in predicting CO2 emissions for tourism-dependent markets, such as human capital or institutional quality (Obydenkova and Salahodjaev, 2017). Moreover, assessing the RE-CO2 emissions nexus using subnational data for specific tourism regions such as small island states or Central Asia is essential.

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