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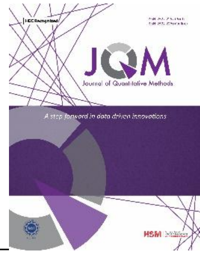

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Title: **International Tourism and CO2 Emissions: An Empirical Analysis**

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International Tourism and CO_2 Emissions: An Empirical Analysis

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Abstract

This paper scrutinizes the dynamic relationship between international tourism and CO2 emissions for countries across the globe spanning over the period 1990-2018. The study uses the panel econometric technique as it accounts for the problems of heteroscedasticity and first order autocorrelation. The results of fixed effects and random effects models explicate that international tourism significantly contributes to increasing the level of CO2 emissions and energy consumption, while urbanization, trade, and Foreign Direct Investment (FDI) have a long-run relationship with CO2 emissions. Energy consumption, urbanization, trade, and FDI are utilized in this study as control or explanatory variables. The long-run association between economic growth and CO2 emissions is examined by using Environmental Kuznets Curve (EKC) hypothesis. The long-run estimates support the EKC hypothesis. The study also examines the impacts of international tourism on CO2 emissions across both developed and developing countries. The empirical findings document that tourism leads to an increase in carbon emissions in developed countries. While, for developing countries, tourism leads to a reduction in carbon emissions. The findings are important for policymakers and suggest that sustainable tourism management policies, environmental protection policies, and lower emission technology should be promoted in international tourism.

***Keywords*:** CO2 emissions, developed countries, developing countries, economic growth, Environmental Kuznets Curve (EKC) hypothesis, Foreign Direct Investment (FDI), international tourism, trade

Introduction

International tourism is a crucial economic sector of the 21st century that supports the development of many national economies. International tourism is regarded as a significant driver of economic growth and generates significant economic activities. United Nations Environment Program (UNEP 2011) reported that there were 935 million international tourists in

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2010, while tourism economy produced 5% of the global GDP and 8% of total employment in the same year. However, according to World Tourism Organization, tourism industry was expected to raise 10.5% of global GDP in 2015 WTTC (2024). International tourism makes an important contribution to the economy of many countries around the world because of its capability to produce hard currency, taxes, income, and employment (Palmer & Riera, 2003; Dwyer & Forsyth, 2008). Hence, international tourism is acknowledged as the white gold of the third millennium. Moreover, according to UNWTO (2017), the tourism sector encourages economic development by producing income, creating jobs, developing lifestyle and societies, promoting exports, and transforming the economy as a whole. This may help to enhance the image of a country and bring consensus among people from different parts of the world (Ahmad et al., 2018).

World Travel & Tourism Council (WTTC 2017) reported that world tourism contributed to 10.2% of the global GDP, generated 292 million jobs, and contributed 6.6% of global exports in 2016. UN nominated the year 2017 as the International Year of Sustainable Tourism for Development, making it timely to review the impacts of tourism and support policies formulating tourism as an important contributor to the United Nations' Sustainable Development Goals (UNSDGs).

The UNWTO and certain partner organizations, along with UNEP, assembled the first international conference on environmental change and tourism in Djerba, Tunisia in 2003. This was the first experience in terms of raising awareness about the consequences of environmental change within the international tourism association. Furthermore, the conference examined the complicated association between the tourism sector and environmental change and authorized an adaptation and alleviation framework for future research and policymaking (Tiwari et al., 2013).

Shujahi and Hussain (2016) and Yazdi and Dariani (2019) argued that although international tourism contributes a significant share to the GDP of a nation, still it remains linked with the deterioration of environmental quality. Similarly, according to UNEP and UNWTO (2008), tourism related emissions were in the order of 5% of global emissions and predicted to escalate 3.2% percent annually by 2015 (Peeters & Dubois, 2010).

The negative impact of international tourism also affects natural resources, since tourists tend to overuse and exploit these resources. Lee and Brahmasrene (2013), Al-Mulali et al. (2015), and Joseph (2016) discovered the impact of international tourism on CO_2 emissions and found that it leads to an increase in CO_2 emissions.

In short, if international tourism is not planned and managed properly, then it can deteriorate the quality of the environment. Muhanna (2006) suggested that environmental management is a crucial factor for sustainable tourism. Tourism results in excessive carbon emissions, more than any other field of economic development (Lenzen et al., 2018). WTTC (2016) asserted that considerable progress in this sector is necessary if the sector aims to meet the target of 50% lower carbon emissions by 2035, as compared to 2005. However, according to UNWTO (2019), tourism-associated transport emissions comprised 22% of all transport emissions in 2016.

Moreover, it was also found that a considerable proportion of travelers strive to develop environmentally friendly tourism and are willing to pay for associated experiences (UNEP, 2011). Başarir and Cakir (2015), Shakouri et al. (2017), and Dogan and Aslan (2017) found that tourism contributes to the reduction of emissions. Empirical results differs and alter from one study to another in this regard.

The related literature describes several factors including economic growth, energy consumption, trade, urbanization, and FDI which exhibit a significant impact on CO_2 emissions (Li & Lin, 2015). The relationship between economic growth and the environment has been the main point of the researchers to investigate the nexus between the variables to determine whether Environmental Kuznets Curve (EKC) exists. EKC hypothesis is the most important theory in the field of environment and economics after the study developed by Grossman and Krueger (1991). The EKC hypothesis analyzes the association between environmental conditions and economic growth more accurately. In the early stages of economic development, environmental degradation increases until the economy reaches a certain average income level. Afterwards, environmental degradation begins to decline. Along with economic growth, energy is also an important factor in economic development and ensures the provision of vital services to improve the well-being of a nation, significantly. Timilsina and Shrestha (2009) found that the main driving forces behind CO_2 emissions in Asia's transport sector include population growth and energy intensity. The production, consumption, and usage of energy results in negative environmental pressures (Rehman & Rashid, 2017; Dogan et al., 2017).

Several empirical studies proved that international tourism leads to environmental degradation if appropriate precautions in terms of tourist-friendly policies are not taken into account to assure environmental quality (Hsieh & Kung, 2013; Ozturk, 2016; Al Irsyad et al., 2019). The literature is not limited to tourism as the sole determinant of environmental quality. In this context, energy consumption, economic growth, urbanization, trade, and FDI have been integrated with tourism to explain the cumulative impact of pollutant emissions. Zaman et al. (2017) and Ben Jebli and Hadri (2018) determined the impact of tourism, energy use, carbon emissions, and economic growth for top ten tourism destinations. Eyuboglu and Uzar (2020) studied for Turkey; trade and renewable energy were examined by Dogan and Seker (2016) in case of top renewable energy countries; urbanization was scrutinized by Solarin (2014) for Malaysia, and FDI was studied by Lee and Brahmasrene (2013) in case of EU countries. None of the above studies examined the combined impact of international tourism on CO_2 emissions using economic growth, energy consumption, urbanization, trade, and FDI. Hence, this study aims to redress this situation and explores the effect of international tourism on CO_2 emissions for countries across the globe by taking the combined effect of the above factors under consideration.

The contribution of the current study to the extant literature is fourfold: Firstly, many previous studies explored the impact of international tourism on CO_2 emissions for a variety of countries individually (Abeydeera et al., 2019; León et al., 2014; Ozturk, 2016; Paramati et al., 2017; Yazdi et al., 2014). The current study uses a single analysis to analyze the dynamic association between international tourism and CO_2 emissions in countries across the globe. Secondly, this is the first study that questions whether the impact of tourism on CO_2 emissions is similar across the developed and developing countries of the world. Lastly, this study examines the EKC hypothesis to determine the relationship between economic growth and CO_2 emissions.

The rest of the paper is organized as follows: Section 2 presents the literature review, Section 3 details the data sources and descriptive statistics, Section 4 discusses the econometric methodology and the empirical model, Section 5 explains variable construction and data sources, Section 6 describes and discusses the results, while Section 7 offers the conclusion and policy implications.

Literature Review

This section summarizes the relevant literature in relation to the objectives of the paper as stated above. Besides the impact of international tourism on carbon emissions, energy use, urbanization, economic growth, trade, and FDI are included to control the omitted variable bias.

The impact of international tourism on CO_2 emissions is a significant issue and an increasing number of studies have examined it (see Table 1). Becken (2002) examined the relationship between international tourism, energy use, and greenhouse gas (GHGs) emissions for New Zealand and found that fossil fuel consumption in air travel leads to an increase in CO_2 emissions. Tourists tend to choose their own transport. This causes considerable deterioration of environmental quality (Balli et al., 2019; Dubois and Ceron, 2006; Gössling, 2002; Koçak et al., 2020).

Typically, a positive association between international tourism and CO_2 emissions has been identified in empirical literature. Previous studies described that international tourism has a positive relationship with CO_2 emissions (Al Irsyad et al., 2019; Eyuboglu & Uzar, 2020; Lee & Brahmasrene, 2013; León et al., 2014; Tsai et al., 2014; Tiwari et al., 2013; Yazdi et al., 2014). Furthermore, international tourism is associated with the transportation and hosting of tourism consumers and depends on a wide category of infrastructure services, such as airports and telecommunications. These services generate considerable environmental impacts (Hsieh & Kung, 2013). Katircioglu et al. (2014) postulated that international tourism increases the demand for energy consumption and also increases CO_2 emissions in Cyprus, while the country's natural resources should be used in such a way that ensures environmental protection. 'The Travel and Tourism Competitiveness Report 2019' contends that tourism development is associated with higher environmental risks.

However, the findings of various studies disclosed that international tourism leads to the reduction of carbon emissions by increasing the awareness of environmental values, contributing to environmental conservation and protection, and financing the preservation of natural areas to increase their economic importance (Azam et al., 2018; Başarir & Cakir, 2015; Dogan & Aslan, 2017; Muhanna, 2006; Rabbany et al., 2013). Jebli et al. (2019) scrutinized 22 Central and South American countries. The study found that an increase in tourism leads to environmental improvement. It further argued that tourists are more conscious about environmental protection and express their awareness by using more clean technologies.

Mahmood and Shahab (2014) investigated the relationship among energy use, carbon emissions, and GDP for Pakistan. The study indicates that being an agrarian economy, Pakistan consumes a small amount of fossil fuels which results in less adverse environmental impacts. Although, in industrialized sectors, the use of fossil fuels increases CO_2 emissions and GDP per capita in the long-run. Hence, energy consumption degrades environmental quality (Gamage et al., 2017; Gökmenoğlu & Taspinar, 2016; Kuo & Chen, 2009; Zhang & Gao, 2016). Martínez-Zarzoso and Maruotti (2011) suggested that energy efficiency leads to lower emission levels.

On the contrary, some studies found that an increase in energy use is associated with environmental improvement. Ben Jebli and Hadri (2018) discovered that an increase in tourism activities and energy use leads to a reduction in carbon emissions, although economic growth leads to a higher emission level. Moreover, Jebli et al. (2019) argued that an increase in renewable energy use reduces fossil energy consumption and the related pollution emissions. Dogan et al. (2017) investigated the impacts of international tourism, trade, GDP, and energy use on carbon emissions for the Organization for Economic Co-operation and Development (OECD) countries. The findings indicated that energy consumption and international tourism contribute to environmental degradation, while trade leads to reduced CO_2 emissions.

Economic growth refers to an increase in the output of a nation. Any increase in the production process and output acceleration increases pollution emissions, so economic growth has a drastic effect on the environmental quality of a nation. Kivyiro and Arminen (2014) examined the link between carbon emissions, energy use, FDI, and economic development in six Sub-Saharan African countries and found that EKC hypothesis is authentic for the Democratic Republic of Congo (DRC), Kenya, and Zimbabwe. However, by using the EKC hypothesis, the tourists may contribute to a decline in CO_2 emissions in the long-run. Tourists prefer regions where pollution tends to be low. Moreover, as GDP increases, CO_2 emissions per capita initially increase and then decrease after a certain level. Heidari et al. (2015) explained the relationship between economic growth, CO_2 emissions, and energy use for five ASEAN countries. The results indicated that there exists a non-linear relationship among these variables. However, economic growth enhances carbon emissions (Martins et al., 2019; Raza et al., 2017;). Table 1 presents the summary of the studies used in our analysis.

Table 1

Summary of Literature

Author	Country	Period	Methods	Variables	Findings
Becken (2002)	New Zealand	1999-2000	Theoretical Framework	CO_2, EC, AT	↑Air travel→ EC↑, CO_2↑
Dubois and Ceron (2006)	France	_	Theoretical Framework	CO_2, TOR, CC	↑TOR→ CO_2↑
Mahmood and Shahab (2014)	Pakistan	1991-2001	ARDL, Cointegration, Unit root test	CO_2, EC, GFCF, Y	↑EC→ CO2↑
Kivyiro and Arminen (2014)	Sub Saharan Africa (Kenya, South Africa, Zambia & Zambabwe)	1971-2009	Cointegration, Granger Causality Test, ARDL test	CO_2, EC, FDI, Y	↑EC, ↑EG, ↑FDI→ CO_2↑; Results supports EKC hypothesis.
Kelly and Williams (2007)	Canada	Forecasts	First generation forecasting model	CO_2, EC, GHG, TOR	↑TOR→ EC↑, CO_2↑
Kuo and Chen (2009)	Pengu Island in Taiwan	Theoretical Framework	Life cycle assessment approach	EC, CO_2, Y	Transport sector are main contributor in CO_2
Gössling (2000)	Developing Countries	Forecast upto 2050	Theoretical Framework	CO_2, EC	↑EC→ CO_2↑
Pu and Peihua (2011)	China	Theoretical Framework	_	CO_2, EC, TOR	↑TOR→ CO_2↑, EC↑

Azlina and Mustapha (2012)	Malaysia	1970-2010	Co-integration, VECM	CO_2, EC, EG	↑EG→ EC↑; ↑EC→ CO_2↑
Arouri et al. (2012)	Middle East and North African Countries	1981-2005	Panel unit root test, Second generation panel Cointegration	CO_2, Y, EC	↑Y→ CO_2↑; ↑EC→ CO_2↑
Hsieh and kung (2013)	Taiwan	2000-2010	Theoretical Framework	CO_2, TOR	↑TOR→ CO_2↑
Lee and Brahmasrene (2014)	EU	1988-2009	Unit root, Cointegration test	CO_2, TOR, FDI, EG	↑TOR, ↑FDI→ CO_2↑
Tiwari et al. (2013)	OECD Countries	1995-2005	Panel unit root test, Panel VAR, LLC, ADF	CO_2, TOR, ITR, EC, ITA, TR	↑TR→ CO_2↑
Katircioglu et al. (2014)	Cyprus	1970-2009	ECM, Granger Causality, Bounds test	CO_2, TOR, EC, EG	↑TOR→ ↑EC, CO_2↑
Tsai et al. (2014)	Taiwan	2007-2011	Sampling investigation methods,	CO_2, TOR, EC	↑TOR→ CO_2↑
Solarin (2014)	Malaysia	1972-2010	Cointegration, Granger Causality Test, Unit root	CO_2, Y, EC, FDI, TOR, ED	↑TOR→ CO_2↑
Katircioglu (2014)	Turkey	1960-2010	Unit root, Bound test, ARDL	CO_2, Y, EC, TOR,	↑TOR→ EC↑, CO_2↑
León et al. (2014)	Developed & developing countries	1998-2006	GMM, FGLS, FE model	CO_2, TOR, Y, EE	↑TOR→ CO_2↑
Zhang and Gao (2016)	China	1995-2011	Cointegration technique, Unit root, Causality test	CO_2, EG, TOR	↑TOR→ EG↑, CO_2↑
Zaman et al. (2016)	Developed and developing countries	2005-2013	Panel 2SLS, FE model, panel least	CO_2, TOR, EC, EG	↑TOR→ EG↑, CO_2↑; EC↑→ CO_2↑

			square technique		
Gökmenoğlu and Taspinar (2016)	Turkey	1974-2010	Bound test, Causality test	CO_2, FDI, EC, EG	↑EC, ↑EG, ↑FDI→ CO_2↑
Dogan and Seker (2016)	Indonesia, Chile, France, Denmark, UK, Sweden, Belgium	1985-2011	FMOLS, DOLS, Unit root, LM bootstrap Cointegration	CO_2, Y, EG, TR, FDI	↑Renewable EC, ↑TR, ↑FDI→ CO_2↓; Non renewable EC→ CO_2↑
Robaina-Alves et al. (2016)	Portugal	2000-2008	LDMI	CO_2, EC, CO_2, EI	↑TOR → CO_2↑
Al-Mulali et al. (2015)	48 international tourism destinations	1995-2009	Granger Causality test, Unit root, Cointegration	CO_2, EC, Urb, Y	↑EC, ↑EG, ↑Urb, TOR→ CO_2↑; TOR has no long run effect on CO_2 in case of European Countries
Bekhet et al. (2017)	GCC Countries	1980-2011	Granger Causality test, Cointegration	CO_2, EC, Y, FDI, EG	↑EC, ↑EG→ CO_2↑
Işik et al. (2017)	Greece	1970-2014	Causality, Unit root test	CO_2, TOR, EG, FDI, TR	↑EG, ↑FDI, ↑TR, TOR→ CO_2↑
Balogh and Jambor (2017)	168 Countries	1990-2012	Cointegration, Unit root	CO_2, EC	↑TOR, ↑TR→ CO_2↑; ↑FDI→ CO_2↓
Shujahi and Hussain (2016)	Abbottabad (Pakistan)	1950- 2010	Theoretical Framework	CO_2, TOR, EG	↑TOR→ EG↑, CO_2↑
Tang et al. (2016)	India	1971-2012	Unit root test, Cointegration	CO_2, EC, EG, TOR	↑TOR→ EG↑
Paramati et al. (2017)	Eastern and Western European Countries	1991-2013	Panel econometric technique, Cointegration test, CSD test	CO_2, EC, FDI, TOR	↑TOR→ CO_2↑ in Eastern European countries; ↑TOR→ CO_2↓ in Western

					European countries
Joseph (2016)	Kerala	-	-	CO_2, EC, TOR	↑TOR→ CO_2↑
Raza et al. (2017)	United States	1996-2015	Theoretical Framework	CO_2, EC, EG, TOR	↑TOR→ CO_2↑; ↑EC→ EG↑, CO_2↑
Sharif et al. (2017)	Pakistan	1972-2013	Cointegration test, FMOLS	CO_2, Y, FDI, CO_2, TA	↑TOR→ CO_2↑
Asadzadeh and Mousavi (2017)	-	-	Theoretical Framework	CO_2, Y, EC, TOR	↑TOR→ CO_2↑
Gamage et al. (2017)	Sri Lanka	1974-2013	Cointegration, ADF test, VECM	CO_2, Y, EC, TOR, TR	↑EC→ TOR↑; ↑TOR→ CO_2↑
Qureshi et al. (2017)	37 Countries	1995-2015	GMM, FEM, REM, Unit root	CO_2, Y, EC, TOR, TR, FDI	↑EG, ↑TR, ↑FDI→ TOR↑
Heidari et al. (2015)	ASEAN Countries (Indonesia, Malaysia, Philippines, Singapore, Thailand)	1980-2008	Panel smooth transition regression	CO_2, Y, EC, TOR, TR, FDI	↑EC→ CO_2↑; EKC hypothesis is valid.
Chen et al. (2018)	China	2001-2015	Logarithmic Mean Divisia Index	CO_2, Y, TOR, EI	↑EI→ CO_2↓; ↑TOR→ CO_2↑
Ahmad et al. (2018)	China	1991-2016	Gregory-Hansen test, FMOLS, Unit root	CO_2, Y, TOR	↑TOR→ CO_2↑; ↑Eco dev→ CO_2↑
Raza and Shah (2018)	Pakistan	1972-2014	Unit root, Cointegration test, OLS	CO_2, Y, FDI, EC	↑EC, ↑FDI→ CO_2↑
Al Irsyad et al. (2019)	Nepal	1975-2014	Causality test, ARDL	CO_2, Y, TOR, EC	↑TOR→ CO_2↑
Niñerola et al. (2019)	US	1987-2018	Theoretical Framework	CO_2, Y, TOR, EC	↑TOR→ CO_2↑

Eyuboglu and Uzar (2020)	Turkey	1960-2014	ADL, ARDL, VECM	CO_2, Y, TOR, EC	↑TOR→ CO_2↑
Martins et al. (2019)	European Countries	Forecasts upto 2050	Theoretical Framework	CO_2, Y, EC	↑EC→ CO_2↑
Zaman et al. (2017)	11 transit economies	1995-2013	FE, RE, Panel causality test	CO_2, Y, TOR, EC	↑Y→ CO_2↑; ↑TOR→ CO_2↑
Martínez-Zarzoso and Maruotti (2011)	Developing economies	1975-2003	Theoretical framework	CO_2, Y, Urb	↑Urb→ CO_2↓; ↑EE→ CO_2↓
Abeydeera et al. (2019)	China	1980-2018	Theoretical framework	CO_2, Y	Developing carbon emissions control policies
Yazdi and Dariani (2019)	Asian Countries	1980-2014	Unit root, panel Granger causality test	CO_2,Y, Urb, EC	↑Urb→ EC↑, CO↑
Husain (2011)	Newly Industrialized countries	1971-2007	Unit root, Granger causality test, Cointegration	CO_2, Y, TR	↑EC→ CO_2↑
Yazdi et al. (2014)	Iran	1975-2011	Panel unit root test, Panel Granger causality test, Cointegration test	CO_2, Y, TOR, EC	↑TR→ CO_2↓; ↑Y, ↑EC, ↑TOR→ CO_2↑
Li and Lin (2015)	73 Countries	1971-2010	FMOLS, FE, RE, FGLS	CO_2, Y, Urb, EC	↑Urb→ EC↓, CO_2↑
Ozturk (2016)	34 developed & developing countries	2005-2013	FMOLS	CO_2, Y, TOR, EC	↑TOR→ CO_2↑; ↑EC → TOR↓
Dogan et al. (2017)	OECD countries	1995-2010	CADF, CIPS, DOLS, LM Cointegration	CO_2, TOR, TR	↑TOR→ CO_2↑; ↑TR→ CO_2↓
Studies that found positive environmental impacts of international tourism					
Muhanna (2006)	Developing Countries	1987-1992	Theoretical Framework	CO_2, TOR, EC	↑TOR→ CO_2↓

Rabbany et al. (2013)	Pakistan	_	Theoretical Framework	CO_2, TOR	↑TOR→ Environmental protection↑
Başarir and Cakir (2015)	Turkey, Italy, Spain, France & Greece	1995-2010	Unit root test, Panel Causality analysis, Cointegration	CO_2, FDI, EC, TOR	↑EC→ CO_2↑; ↑FDI, ↑TOR→ CO_2↓
Jebli et al. (2019)	22 Central and South American Countries	1995-2010	Causality test, Cointegration	CO_2, TR, Y, TOR	↑EC, ↑FDI, ↑TOR→ CO_2↓
Ben Jebli and Hadhri (2018)	Tunisia	1995-2013	Causality test, Cointegration, VECM	CO_2, Y, TOR	↑EG→ CO_2↑; ↑TOR, ↑EC→ CO_2↓
Dogan and Aslan (2017)	EU Countries	1995-2011	OLS, FMOLS, RE, FE, DOLS	CO_2, EC, Y, TOR	↑EC→ CO_2↑; ↑TOR, ↑Y→ CO_2↓
Shakouri et al. (2017)	Asia Pacific Countries	1995-2013	Granger Causality test	CO_2, GDP^2, Y, TOR, EC	↑TOR→ CO_2↓; ↑EC→ CO_2↑
Azam et al. (2018)	Malaysia, Singapore, Thailand	1990-2014	FMOLS	CO_2, TOR, EC	↑TOR→ CO_2↓

Note: EC: Energy consumption; EG: Economic Growth; EE: Energy efficiency; EI: Energy intensity; Y: Real income; TOR: International tourism; TR: Trade; 2SLS: Two Stage Least Square; FE: Fixed Effects; RE: Random Effect; GMM: Generalized Method of Moment; CSD: Cross Sectional Dependence.

Methodology

Granger causality test is a good way to examine the causality relationship (the cause-and-effect relationship) between two variables. Insight into the causal association helps policymakers to enforce policies for economic growth and sustainable environment. For this purpose, Granger causality tests are employed in this study.

OLS results rely on several assumptions based on the classical linear regression model (CLRM). If any one of the assumptions is disproved, then OLS does not produce efficient results. Moreover, to check multicollinearity, Variance Inflation Factor (VIF) test is applied.

Multicollinearity is a statistical issue in which two or more than two regressors of a regression model are greatly associated with each other.

To check whether the error term has a constant variance, Breusch-Pagan test is used in this study. Wooldridge (2002) test is used to prove the existence of first order serial correlation in the residuals, as the *p*-value is significant. Furthermore, fixed effects and random effects regression models are used to find out the long-run relationship between independent and dependent variables. Fixed effects model is the appropriate model to tackle heterogeneity. It absorbs country-specific characteristics in its intercept. However, the limitation of fixed effects model is that it also absorbs time invariant characteristics into its intercept. So, random effects model is employed in the current empirical framework. The study employed Hausman test to determine which regression model is appropriate for analysis. Hausman test is a post-estimation technique which checks the feasibility of the results of fixed effects model and random effects model.

Empirical Model

$$\mathrm{CO}_{2\mathrm{it}} = \alpha_{0\mathrm{it}} + \alpha_1 Y_{it} + \alpha_2 ENG_{\mathrm{it}} + \alpha_3 \mathrm{URB}_{\mathrm{it}} + \alpha_4 \mathrm{TRD}_{\mathrm{it}} + \alpha_5 \mathrm{FDI}_{\mathrm{it}} + \alpha_6 \mathrm{TOR}_{\mathrm{it}} + \mu_{\mathrm{it}} \quad (1)$$

In equation 1, α_{0it} is the intercept, where i denotes cross sections from 1 to N and t is the concerned time period. Further, α_1, α_2, α_3, α_4, α_5, α_6, and α_7 depict the elasticity of carbon emissions with respect to GDP, energy consumption, urbanization, trade, FDI, and international tourism, respectively. Y indicates GDP, ENG stands for energy consumption, URB represents urbanization, and TOR denotes international tourism, while μ_{it} is the error term in Model 1. Tourism is the focused variable in this study. Numerous studies have utilized international tourism receipts, such as Gössling (2000), Lee and Brahmasrene (2013), Ozturk (2016), Qureshi et al. (2017), and others. So, international tourism receipt is used in the current analysis. The EKC model is specified as follows:

$$\mathrm{CO}_{2\mathrm{it}} = \alpha_{0\mathrm{it}} + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 \mathrm{ENG}_{\mathrm{it}} + \alpha_4 \mathrm{URB}_{\mathrm{it}} + \alpha_5 \mathrm{TRD}_{\mathrm{it}} + \alpha_6 \mathrm{FDI}_{\mathrm{it}} + \alpha_7 \mathrm{TOR}_{\mathrm{it}} + \mu_{\mathrm{it}} \quad (2)$$

The normalization of the data is crucial to transform the values to the same unit of measurement. Transformation into a natural logarithm alleviates any possible distortions of the dynamic properties of the series. The transforming of the data into a natural log makes data consistent in terms of mean and median and shows an average level of skewness. Taking the natural logarithm of variables for equation 2, the model becomes

$$LCO_{2it} = \alpha_{0it} + \alpha_1 LY_{it} + \alpha_2 LY_{it}^2 + \alpha_3 LENG_{it} + \alpha_4 URB_{it} + \alpha_5 TRD_{it} + \alpha_6 FDI_{it} + \alpha_7 TOR_{it} + \mu_{it} \qquad (3)$$

Variable Construction and Data Source

Data of all the variables used in the current study was obtained from the World Bank Development Indicators (WDI, 2019). Data was obtained for the period 1990-2018.

Table 2

Definitions of the variables

Variable	Definition	Unit of measurement
CO_2 emissions	CO_2 emissions serve as a proxy indicator of environmental deterioration in the current study. CO_2 is an uncolored, unscented, poisonless gas formed by the burning of fossil fuel and in the ventilation of living creature and is considered as a Greenhouse Gas (GHGs)	Metric tons per capita
GDP	Economic growth refers to an increase in the amount of the total output of a nation over a long period of time. GDP is used as the proxy for economic growth.	Constant 2010 US $
Energy Consumption	Energy consumption refers to all the energy consumed by an activity. Energy consumption in production process is used by fossil fuel consumption, coil, oil and gas	Kg of oil equivalent per capita

Urbanization	Urban population refers to the population living in urban areas as the share of total population of any country.	Percentage of total population
Trade	Trade reflects the sum of exports and imports of goods and services in exchange for money.	Percentage of GDP
Foreign Direct Investment	FDI is an investment in the confirmation of manages ownership in a business in an economy, reinvesting profits earns from abroad.	Percentage of GDP
International Tourism	International tourism refers to tourism that crosses national boundaries. Tourism refers to a well-liked leisure activity at the national level. WTO (2015) refers to tourists as people traveling to and staying at the places far from their accustomed environment for not more than one successive period of time (for instance, one year) for leisure, business, or any other motive.	Receipt (percentage of total exports)

Results and Discussion

Summary statistics give information about the sample data and describe the values in the data set. This includes where the average, maximum, and minimum values lie and whether the data is skewed. Detailed descriptive statistics are given in Panel A of Table 3. The statistics indicate that Qatar is making/has the highest carbon emissions with the highest mean value of 70.0422 metric tons per capita, while Chad generates the lowest mean value of 0.010 metric tons per capita. This shows that Qatar is at the top for CO_2 emissions in Asian countries. Moreover, 170.479 was the highest mean value in the year 2005 and 0.000956 was the lowest mean value in the year

2015 of international tourism in Maldives and Congo Democratic Republic, respectively.

The outcomes of the correlation matrix demonstrate some interesting findings. Panel B of Table 3 shows that there is a negative correlation between international tourism and CO_2 emissions. The results show the highest positive correlation of CO_2 emissions with energy consumption. It indicates that increased energy consumption leads to enhanced CO_2 emissions. GDP, FDI, and trade also have a positive correlation with CO_2 emissions.

Table 3

Descriptive Statistics and Correlation Matrix

Panel A. Descriptive Statistics							
	CO_2 Emissions	**International Tourism**	**Energy Consumption**	**GDP**	**Urban Population**	**Trade**	**FDI**
Observations	4,951	3,799	6,014	5,411	6,014	5,024	5,077
Mean	4.797849	16.92501	2424.348	2780000	56.22989	87.42831	8.133217
Standard Deviation	6.586397	18.91243	2920.405	1140000	24.77811	55.2636	56.78203
Minimum	0.0107203	0.0009562	4.596469	8.091797	-0.052907	0.0209992	-58.32288
Maximum	70.04223	170.4793	22120.37	1730000	100	860.8	1846.596
Panel B. Correlation Matrix							
CO_2 Emissions	1.0000	-	-	-	-	-	-
International Tourism	-0.0967	1.0000	-	-	-	-	-
Energy Consumption	0.8651	-0.2138	1.0000	-	-	-	-
GDP	0.2911	-0.1185	0.2625	1.0000	-	-	-
Urban Population	0.5795	-0.2072	0.6177	0.1826	1.0000	-	-
Trade	0.2138	0.0364	0.1908	-0.1945	0.2365	1.0000	-

FDI	0.0473	0.0347	0.0281	-0.0461	0.1125	0.2867	1.0000

Observations: 2410; Source: Authors' calculation using STATA 14.

Table 4 reports the results of the Granger causality test. The results show that there is a bidirectional causality between international tourism and carbon emissions, which establishes the feedback relationship and long-run interdependence between international tourism and CO_2 emissions in the countries concerned. The causality result supports the studies of (Yazdi et al. 2014; Başarir and Cakir, 2015). Dogan and Aslan (2017) and Dogan et al. (2017) determined the causality between carbon emissions and energy use in the case of EU nations and OECD countries, respectively. CO_2 emissions were found to cause economic growth, consistent with the findings of Azlina and Mustapha (2012) for Malaysia. The causality results have significant policy implications. Carbon polluting industries substantially boost a country's per capita income. Furthermore, the study found that economic growth is not a harmful predictor of environment over the study period.

Table 4.

Granger Causality Test

Null Hypothesis	F-statistics	Probability Value	Decision
International tourism → CO_2 emissions	7.30061	0.0007	Tourism led emissions
CO_2 emissions → international tourism	3.75696	0.0235	Emissions led tourism
Energy consumption → CO_2 emissions	2.42006	0.0891	≠
CO_2 emissions → energy consumption	100.205	0.0000	Emissions led energy consumption
GDP → CO_2 emissions	0.15651	0.8551	≠
CO_2 emissions → GDP	9.83180	0.0000	Emissions led GDP
Urbanization → CO_2 emissions	2.95473	0.0522	≠
CO_2 emissions → urbanization	0.98301	0.3743	≠
Trade → CO_2 emissions	0.33120	0.7181	≠
CO_2 emissions → trade	2.59111	0.0751	≠

FDI → CO_2 emissions	0.22429	0.7991	≠
CO_2 emissions → FDI	1.00033	0.3679	≠

Note: the symbols → implies that the variables do not Granger cause the others. Similarly, ≠ indicates no causal association between the variables.

Table 5 presents the results of the diagnostic tests. There is no evidence of multicollinearity, as indicated by the results of the VIF test. However, the results of the Breusch-Pagan test indicate that there is a heteroscedasticity problem. Similarly, the results of Wooldridge (2002) test confirm the existence of first order serial correlation.

Hausman test was conducted to determine model appropriateness. The results favored fixed effects regression model. Moreover, the problems of autocorrelation and heteroscedasticity were found in the global panel discussion. So, system GMM was used to tackle these problems. System GMM controls the issue of endogeneity and serial correlation in the residuals. From the results of fixed effects regression model and system GMM regression, it was determined that 1% increase in international tourism leads to 0.003% and 0.012% increase in CO_2 emissions, respectively. So, the results indicate a positive and significant association between international tourism and CO_2 emissions, consistent with the previous studies. However, Al Irsyad et al. (2019) suggested that environmental impacts can be minimized if tourism is well-planned, keeping in view the principles of sustainable tourism development.

The current results contradict the findings of Ben Jebli and Hadri (2018) in the case of Tunisia. They argued that international tourism and energy consumption both contribute to the reduction in emissions from transportation. They further suggested that increasing the number of tourist arrivals and energy efficiency could be a good way to lessen CO_2 emissions. However, the biggest deficiency/obstacle to the growth of international tourism is its high dependency on transportation, which may also be responsible for the insufficient impact of tourism on the economy. Also, strict environmental regulations are required to ensure the insignificant effect of international tourism on CO_2 emissions.

GDP was found to have a positive and significant relationship with carbon emissions, in compliance with the study of (Poumanyvong and Kaneko, 2010; Zaman et al. 2017). Historically, there has been a strong association between economic growth and carbon emissions. As economies grow, the environment deteriorates (Adams & Jeanrenaud, 2008). However, the current findings disprove the findings of Dogan and Aslan (2017) and Rauf et al. (2018) for EU countries who asserted that real income growth reduces carbon emissions.

The relationship between economic growth and CO_2 emissions was examined via the EKC hypothesis. The results confirm the current analysis. This is due to the fact that at the later stages of economic growth, environmental quality improves due to the structural changes in the economy that tend to decrease carbon emissions (Dinda, 2004). These results are consistent with the study of Arouri et al. (2012) for MENA region.

The current findings are consistent with the existing literature with regard to the positive association between energy consumption and CO_2 emissions. Arouri et al. (2012) found that energy use has a significant and positive relationship with carbon emissions. This is because most of the CO_2 emissions come from/are generated by the burning of fossil fuels, coal, oil, and gas. The results contradict the findings of Ben Jebli and Hadri (2018), who argued that international tourism and energy consumption contribute to lower carbon emissions through the transport sector. Similarly, urbanization is associated with environmental deterioration (Poumanyvong and Kaneko, 2010; Li & Lin, 2015). The results support Environmental Risk Transition (ERT) and Urban Environmental Transition (UET) theory developed by Smith. ERT is a process that associates urban pollution with environmental health issues, while UET postulates that environmental degradation is associated with different levels of development and urbanization.

The results show that the value of trade coefficient is positive but insignificant. The findings support the studies of (Işik et al. 2017; Jebli et al. 2019). Balogh and Jambor (2017) asserted that international trade deteriorates the environment through the transport and trading of goods or through the movement of production to areas with lower environmental standards. However, the findings contradict the study of Yazdi et al. (2014), who suggested that utilization of natural resources would lead to better environmental conservation in the long-run. Moreover, Dogan and Seker (2016) and Dogan et al. (2017) argued that trade is not necessarily harmful to the environment, as in the case of many renewable energy consuming countries.

According to previous studies, FDI significantly contributes to environmental deterioration (Sasana et al., 2018; Zaman et al., 2017). Pollution haven hypothesis is generally validated by the current analysis, which posits that when industrialized nations set up factories in foreign nations, especially in developing ones, it leads to environmental deterioration in host countries. The findings support the study of Lee and Brahmasrene (2013). However, the current analysis contradicts the findings of Jebli et al. (2019), who argued that FDI goes to energy efficient projects or renewable energy production projects which protect the environment and sustain the environmental quality. In order to have an effective policy for attracting FDI, the host country's policymakers need to know clearly and exactly the optimal level of FDI for their country. The optimal level of FDI, based on the threshold, can be estimated to assure a good balance between preserving the environment and stimulating growth.

After resolving the problem of endogeneity, the results of system GMM regression indicate that FDI is associated with environmental improvement and also supports pollution halo hypothesis. This hypothesis asserts that multinational companies transfer their greener technology to the host country through FDI. The results support the study of Jebli et al. (2019) as well as the Porter hypothesis, that is, FDI can reduce CO_2 emissions by inducing technical innovations. This is because FDI can reduce carbon emissions per unit of output by promoting the transfer of cleaner technologies.

Table 5

Fixed Effects, Random Effects, and System GMM

Variables	Fixed Effects CO_2 Emissions	Random Effects CO_2 Emissions	System GMM CO_2 Emissions
International Tourism	0.00385***	0.00299**	0.0127***
	(0.000960)	(0.000983)	(0.00238)
Gross Domestic Product	0.0299***	0.0362***	0.0846*
	(0.00812)	(0.00869)	(0.0257)
Gross Domestic Product^2	-0.000457***	-0.000552**	-0.00122**
	(0.000125)	(0.000134)	(0.000397)
Energy Consumption	0.0634***	0.0938***	2.292***

	(0.0135)	(0.0144)	(0.0754)
Urban Population	0.00522***	0.00759***	0.00102***
	(0.000642)	(0.000669)	(0.00142)
Trade	0.000759**	0.000956***	0.00355***
	(0.000251)	(0.000236)	(0.000628)
FDI	0.000518*	0.000478	0.0000177
	(0.000243)	(0.000260)	(0.00188)
Constant	0.0305	-0.391***	-8.166***
	(0.0929)	(0.114)	(0.262)
Observations	2395	2395	2378
R^2	0.060		
Adjusted R^2	-0.009		
AR (1) in first differences			0.000
AR (2) in first differences			0.889
No of groups			157
No of instruments			131
Sargan test			0.186
Hausman Test			
Probability Value	0.0000		

Variance Inflation Factor (VIF) Multicollinearity Test

Variable	**VIF**	**1/VIF**
GDP	1.02	0.981168
Energy consumption	1.72	0.581774
Urban population	1.77	0.564022
Trade	1.15	0.865995
FDI	1.10	0.912071
International tourism	1.07	0.935830
Mean VIF	1.31	

Bruesh Pagan Heteroskedasticity Test

Chi2(1)	377.65
Prob > chi2	0.0000

Wooldgidge Autocorrelation Test

F(1, 150)	161,770
Prob > F	0.0000
Standard errors in parentheses (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)	

Table 6 reports the results to examine whether the impact of international tourism on environmental degradation is similar across developed and developing countries. Hausman test results favor fixed effects regression model in case of developed countries and random effects model for developing countries. Fixed effects model results show that international tourism is positively associated with environmental deterioration in developed countries. The results support the study of León et al. (2014), who argued that international tourism degrades environmental quality, but the impact is greater in developed countries than less developed countries. The results also confirm the EKC hypothesis. Random effects model results show that international tourism is negatively associated with environmental degradation in developing countries, contrary to the findings of (Al-Mulali et al., 2015).

Table 6

Comparative Analysis between Developed and Developing Countries

	Developed Countries		Developing Countries	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Variables	CO_2 Emissions	CO_2 Emissions	CO_2 Emissions	CO_2 Emissions
International Tourism	0.00476^{**}	0.00379^{*}	0.000421	-0.000207
	(0.00152)	(0.00148)	(0.00128)	(0.00127)
Gross Domestic Product	0.216^{*}	0.256^{**}	0.0369^{***}	0.0412^{***}
	(0.0977)	(0.0918)	(0.0110)	(0.0116)
Gross Domestic Product^2	-0.00686^{*}	-0.00816^{**}	-0.000559^{***}	-0.000623^{***}
	(0.00317)	(0.00298)	(0.000168)	(0.000177)
Energy Consumption	0.114^{***}	0.135^{***}	0.0544^{**}	0.0765^{***}

	(0.0243)	(0.0249)	(0.0170)	(0.0179)
Urban Population	0.00355***	0.00394***	0.000735	0.00330**
	(0.000932)	(0.000937)	(0.000982)	(0.00100)
Trade	-0.00105***	-0.000969***	0.00261***	0.00282***
	(0.000233)	(0.000228)	(0.000452)	(0.000469)
Foreign Direct Investment	0.000233	0.000181	0.00662***	0.00623***
	(0.000175)	(0.000178)	(0.00152)	(0.00161)
Constant	-0.102	-0.463	-0.449***	-0.780***
	(0.696)	(0.657)	(0.120)	(0.145)
Observations	847	847	1544	1544
R^2	0.089		0.064	
Adjusted R^2	0.027		-0.011	
Hausman Test				
Probability Value	0.000		0.9666	

Standard errors in parentheses (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

Conclusion and Policy Implications

This paper analyzes the dynamic association between CO_2 emissions, international tourism, energy use, urbanization, trade, and FDI and also tests the EKC hypothesis for countries across the world. Moreover, it examines whether the impacts of international tourism on environmental quality are similar across developed and developing countries. It employs the fixed effects model, random effects model, and system GMM regression technique to examine the relationship between the selected variables. The results indicate that international tourism increases carbon emissions in countries across the world, although the impact of international tourism on environmental quality is not similar across developing and developed countries. For developed countries, an increase in international tourism increases CO_2 emissions. While, in case of developing countries, tourism mitigates CO_2 emissions.

In today's world, international tourism is regarded more due to its economic impact, while its environmental impacts are ignored to some extent.

However, tourism generally is not to be blamed, since economic organizations should use more clean energy and an appropriate tourism infrastructure. Sustained and long-run environmentally friendly policies, with regard to international tourism development, should be the main aim across the globe for attracting tourists. However, a lack of appropriate policy planning and application leads to serious environmental deterioration.

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Sample Countries

Appendix A. Developing Countries

No	Country	No	Country	No	Country	No	Country
1	Afghanistan	38	Central African Republic	75	Guinea-Bissau	112	Mauritania
2	Antigua and Barbuda	39	Chad	76	Guam	113	Mauritius
3	Albania	40	Colombia	77	Guyana	114	Mexico
4	Aruba	41	Comoros	78	Haiti	115	Micronesia, Fed. Sts.
5	Algeria	42	Cayman Islands	79	Honduras	116	Moldova
6	American Samoa	43	Congo, Rep.	80	India	117	Mongolia
7	Angola	44	Congo, Dem. Rep.	81	Indonesia	118	Montenegro
8	Argentina	45	Costa Rica	82	Iran, Islamic Rep.	119	Morocco
9	Armenia	46	Cuba	83	Iraq	120	Mozambique
10	Azerbaijan	47	Darussalam	84	Jamaica	121	Namibia
11	Bangladesh	48	Djibouti	85	Jordan	122	Nauru
12	Barbados	49	Dominica	86	Kazakhstan	123	Nepal
13	Belarus	50	Dominican Republic	87	Kenya	124	Nicaragua
14	British Virgin Islands	51	Ecuador	88	Kiribati	125	Niger
15	Belize	52	Egypt, Arab Rep.	89	Korea, Dem. People’s Rep.	126	Nigeria

No	Country	No	Country	No	Country	No	Country
16	Benin	53	El Salvador	90	Kosovo	127	North Macedonia
17	Bhutan	54	Equatorial Guinea	91	Kyrgyz Republic	128	Pakistan
18	Bolivia	55	Eritrea	92	Lao PDR	129	Papua New Guinea
19	Bosnia and Herzegovina	56	Eswatini	93	Lebanon	130	Paraguay
20	Botswana	57	Ethiopia	94	Lesotho	131	Peru
21	Brazil	58	Fiji	95	Liberia	132	Philippines
22	Brunei	59	Gabon	96	Libya	133	Romania
23	Bulgaria	60	Gambia, The	97	Madagascar	134	Russian Federation
24	Burkina Faso	61	Georgia	98	Malawi	135	Rwanda
25	Burundi	62	Ghana	99	Malaysia	136	Samoa
26	Cabo Verde	63	Grenada	100	Maldives	137	Sao Tome and Principe
27	Cameroon	64	Guatemala	101	Mali	138	Senegal
28	Cambodia	65	Guinea	102	Marshall Islands	139	Serbia
29	Sierra Leone	66	Solomon Islands	103	Myanmar	140	South Sudan
30	Somalia	67	Saudi Arabia	104	Uzbekistan	141	Ukraine
31	South Africa	68	St. Lucia	105	Vanuatu	142	West Bank and Gaza
32	Sri Lanka	69	Thailand	106	Togo	143	Yemen, Rep.
33	Uganda	70	Tuvalu	107	Venezuela, RB	144	Zambia
34	Turkmenistan	71	Turkey	108	Vietnam	145	Zimbabwe

No	Country	No	Country	No	Country	No	Country
35	Tonga	72	Sudan	109	Syrian Arab Republic		
36	St. Vincent and the Grenadines	73	Timor-Leste	110	Suriname		
37	Tunisia	74	Tajikistan	111	Tanzania		

Appendix B. Developed Countries

No	Country	No	Country	No	Country	No	Country
1	Andorra	21	Ireland	41	Singapore	61	Greenland
2	Australia	22	Isle of Man	42	Oman	62	Panama
3	Austria	23	Italy	43	Sint Maarten (Dutch part)	63	Greece
4	Bahamas	24	Israel	44	Slovenia	64	Palau
5	Bahrain	25	Iceland	45	Spain	65	Gibraltar
6	Belgium	26	Japan	46	St. Kitts and Nevis	66	Puerto Rico
7	Bermuda	27	Kuwait	47	Seychelles	67	Portugal
8	Canada	28	Korea, Rep	48	Sweden	68	Germany
9	Channel Islands	29	Lithuania	49	Switzerland	69	Poland
10	Chile	30	Luxembourg	50	Trinidad and Tobago	70	French Polynesia
11	China	31	Latvia	51	Slovak Republic		
12	Croatia	32	Liechtenstein	52	Turks and Caicos Islands		
13	Curacoa	33	Monaco	53	Uruguay		
14	Cyprus	34	Macao SAR, China	54	United Arab Emirates		

No	Country	No	Country	No	Country	No	Country
15	Czech Republic	35	Malta	55	United States		
16	Denmark	36	New Caledonia	56	Virgin Islands		
17	Estonia	37	Northern Mariana Islands	57	Hungary		
18	Faroe Islands	38	Norway	58	San Merino		
19	Finland	39	Netherlands	59	Hong Kong SAR		
20	France	40	New Zealand	60	Qatar		