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The Dynamic Nexus Between International Tourism and Environmental Degradation in Top Twenty Tourist Destinations: New Insights From Quantile-on-Quantile Approach

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Abstract

Tourism is one of the important factors that can affect the environmental and economic situation of any economy. This study investigates the relationship

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between tourist arrivals and CO2 emission in the top 20 tourist destinations using data from quarterly observations from 1995 to 2018. A unique technique via quantile-on-quantile regression and Granger causality in quantiles was used. In particular, how the quantiles of tourist arrivals impact quantiles of CO2 emission was analyzed. The empirical results suggest a combination of both positive and negative effects of tourist arrivals and CO2 emission in most tourist destinations. Predominantly, at both high and low tails, in the USA, Spain, Hong Kong, and Austria, tourist arrival has a positive effect on CO2 emission, whereas in the case of Canada, France, Germany, Mexico, and Malaysia, the association was negative. On the other hand, China, Greece, Russia, Japan, Italy, South Korea, Thailand, and Turkey have both positive and negative effects of tourism on CO2 emissions at low and high tails. Tourism can be an important factor while formulating policy for environmental and climate aspects.

Keywords
CO_2 emission, tourism, quantile on quantile regression, environments

Introduction

Tourism is one of the fastest-growing industries in the world and has a direct economic impact on several industries, including air travel, hotels, travel agents, commuter services, restaurant and leisure activities, and local industries such as those that provide souvenirs that tourists buy when they visit. According to the World Travel and Tourism Council records of 2018, travel and tourism generated a revenue of $8.8 trillion, with up to 319 million jobs created and sustained by the sector worldwide. Across the globe, one out of five jobs is related to this industry, with expected job creation in the sector estimated to reach 421 million by the year 2029 (World Travel and Tourism Council, 2019). Arain et al. (2020) reported that there is mostly a positive association between tourism development and foreign direct investment, although there may be differences in these outcomes across different nations. A similar positive association between tourism development and economic growth was also suggested by Shahzad et al. (2017), which shows that there is a bilateral relationship between tourism development and economics. This creates a debate on the need to increase tourism opportunities to sustain and grow economic advantages across the world. Yet, whilst tourism development does contribute significantly to the economic structure and growth of any region, it does have negative effects on the environment once the number of visitors increases beyond the capacity of the host environment to absorb them (Asadzadeh and Mousavi, 2017).

Currently, according to scientists, the vital cause for the change in climate and global warming is the swift rise in human-driven carbon emissions during the last five decades (Mossler et al., 2017). According to a report by the World Tourism Organization (UNWTO, 2008), tourism is responsible for 5% of carbon emissions worldwide (Mishra et al., 2019). According to Hart et al. (2005), tourism is considered an energy-intensive sector and a major emitter of carbon emissions. For instance, rise in tourist activities will result in increased use of transportation. The generation of electricity or heat along with the transportation sector generates two thirds of the overall carbon emissions (IEA, 2019). While there is a significant focus on sustainable tourism in most popular tourist destinations across the world, the fact of the matter remains that there is an urgent need to find a balancing ground between the economic benefits of tourism and its negative impact on the environment.

Studies suggest that there is a direct association between tourism development and degradation of environmental resources such as loss of biodiversity, sand dune erosion, depletion of sea life, and depletion of underground water (Ahmed et al., 2018). Similarly, carbon emission is one of the consequences of tourism. Ozturk (2016) found that the CO2 emission level is affected by tourism indicators, which is one of the vital causes of global warming (Godil et al., 2020). The growth rate of carbon emissions has almost increased fourfold since the start of 1960 (Koçak et al., 2020). Considering this alarming situation, researchers have tried to explore the interaction between these two variables, that is, tourism and CO2.

The novelty of the current study is that it examines the relationship between tourism and CO2 emission with respect to the 20 most visited tourist destinations worldwide, namely, China, Thailand, France, Austria, Germany, Malaysia, Italy, Hong Kong, Mexico, Japan, Russia, Spain, Saudi Arabia, Turkey, Poland, South Korea, Greece, Canada, the US, and the UK by employing the quantile-on-quantile (QQ) econometric technique. It is vital to conduct this study by applying the new technique of QQ regression that was propagated by Sim and Zhou (2015). To the best of researchers' knowledge, this research is the first to discover the association between tourists' arrival at the 20 most visited destinations and CO2 emission by applying the QQ methodology. This approach is an amalgamation of nonparametric and quantile regression estimation techniques in which the quantile of one variable is regressed on the quantile of another variable. As the linkage of tourism with CO2 emission is an important aspect of research among academia and practitioners (Mishra et al., 2019; Raza et al., 2017; Sharif et al., 2017; Zha et al., 2020), it would not be justified if the estimation was done through traditional econometric methodologies, for instance, quantile regression and ordinary least square method. Furthermore, this approach provides considerable clarity on the tourism–CO2 emission nexus that would be difficult to analyze through traditional econometric modelling used before. The literature suggests that the relationship between these variables needs to be evaluated by substantial econometric modelling in order to highlight the significance of nonlinear linkages between tourism and CO2 emission (Mishra et al., 2019; Shahzad et al., 2017; Sharif et al., 2019a). To support the non-linearity of variables, the QQ estimation method proves to be a useful technique to measure the influence of the quantile of one variable (i.e., tourism) on the quantile of another variable (i.e. CO2 emission) and also provides a thorough and specific representation of the overall dependence of each variable on the other.

The remaining paper is designed as follows. Section 2 presents a literature review, section 3 is the methodology, section 4 presents data analysis and results, and the conclusion and policy recommendations are shown in the last section.

Literature Review

Tourism is an industry that helps to boost economic growth and create jobs, and it is becoming increasingly important to build a sound economy (Usman et al., 2020). As an economic and environmental driver, tourism has played a significant role in the development of small tourism-dependent regions, particularly when it comes to its contribution to global carbon emissions (Adedoyin & Bekun, 2020). There are many pieces of the literature available on the relationship between tourism and environmental degradation (CO2 emission), and the results may vary country-wise according to different tourist destinations (see New Zealand, Howitt et al., 2010; China, Li et al., 2019; Australia, Dwyer et al., 2010; and Sweden, Gössling & Hall, 2008). A comprehensive review in this context is presented by the UNEP (2008). The report suggests that tourism forms a key part of economic development in many developing countries. Tourism is one of the most significant industries around the world that makes nations rich, not only because of their income levels but as a result of what they learn from other cultures (Tecel et al., 2020). However, it also causes issues of CO2 emission and climate change, which have different impacts according to tourist destinations around the world. Coastal regions are more vulnerable to the negative impact of tourism-related CO2 emissions, causing infrastructure damage, extreme climatic events, coastal erosion, rising sea levels, flooding, water shortage, and water contamination, which led these areas to have low adaptive capacity to cope with these negative events. This is further perpetuated in high tourist seasons, which often coincide with problems such as water management issues and carbon emissions. Similar CO2 emission in mountainous regions also leads to the vulnerability of these regions to climate change, as observed by the loss of snow caps and mountain landscapes. Natural ecosystems are also highly vulnerable to CO2 emission and climate change, particularly given the diversity of their resources and the widespread impact of tourism-based CO2 emissions.

Dogan et al. (2017) found that carbon emission in OECD countries was due to the consumption of energy and tourism. Zhang et al. (2019) found that inbound tourism in Thailand is negatively correlated with carbon emissions and fossil fuels (Zhang et al., 2019). Furthermore, they quoted in their research that according to a report issued by World Bank (2016), Thailand is ranked at fifth position in the Pacific and East Asia region with respect to carbon emission. Moreover, research carried out on the Mediterranean countries showed that the addition in CO2 emission is due to tourism (Balli et al., 2019).

Evidence does suggest that the negative carbon emission effect of tourism is considerable, given the increased demand for travel and transportation. Prior research studies have supported the notion that tourism may have a harmful atmospheric effect in the form of carbon emissions (Lee & Brahmasrene, 2013) specifically due to the transport sector (Scott et al., 2010). Howitt et al. (2010) measured the carbon emissions for the international trips of cruise ships within and out of New Zealand. They found that more carbon is emitted due to international trips through cruises as compared to aviation. According to Nassani et al. (2017), fossil fuel is heavily consumed by transport and as a result emits too much carbon, which ultimately harms environmental sustainability. In Taiwan, Lin (2010) found that private cars emit high carbon due to low load factors. Additionally, the intensity of carbon emission varies with the distance travelled and transportation mode. Likewise, Scott et al. (2010) contended that the tourism business is associated with several economic sectors, for example, air travel, as tourism has become a probable threat to both high emissions of CO2 and environmental degradation. Raza et al. (2017) also suggest that transportation remains a major issue within the tourism industry and has a direct impact on the carbon emissions that are released into the environment. Moreover, the consumption of fossil fuels is primarily dominated by transportation activities due to increased tourism activities, and these ultimately influence carbon emissions. In the case of Beijing, if the transportation sector is excluded, all the sectors of tourism experience three times more indirect emissions of carbon as compared to direct emissions. Transportation was found to result in 38.75% carbon emission related to tourism (Li et al., 2019).

Hall et al. (2013) emphasized that even though the economic effect of global tourism is imperative, carbon emissions due to tourism and its consequent impact on climate change will continue to be a significant challenge for sustainable tourist undertakings. To support their notion, they quoted a report of UNWTO (2008) which estimated that by the year 2035, emission of carbon from tourist activities may be at the top (i.e. 135%) against 2005. Sharif et al. (2017) provided an analysis of tourist-related emission growth in Pakistan and concluded that there is a unidirectional nexus between carbon emission and an influx of tourists. Lemma (2014) further suggested that while the impact of tourism on the environment is present, it is harder to quantify due to limited data available in this respect. The emissions data is over a decade old, which means that more recent tourism development has not been factored in.

There is an equal focus on how tourism can be used to reverse and/or manage these negative effects. Thomas (2014) suggested that the tourism sector, whilst being responsible for significant environmental degradation, can also be used as a tool to address global environmental challenges given its scope and expanse through numerous mitigation measures. Raza et al. (2017) also suggested that tourism activities can be used as contributors to economic growth provided that these are used to promote the use of clean energies. The concept of sustainable tourism is thus critical to the sustainability of this industry. For instance, carbon emission increased in Eastern Europe but has decreased in Western Europe due to tourism (Paramati et al., 2017). Sharif et al. (2019b) explored the relationship between renewable and non-renewable energy resources and carbon emission and found a positive relationship between non-renewable energy consumption and carbon emission and a negative relationship between renewable energy and carbon emission. They further established that the use of renewable energy resources also helps to reduce environmental hazards.

It was thus interesting to find that by using FMOLS methodology (a fully modified form of OLS), as the intensity of tourist arrival increases by 1%, carbon emission was observed to decrease by 0.35%. This reduction in carbon emission was due to the income generated through tourism by central as well as South America which was utilized to reduce CO2 emission with the help of green tourism (Ben Jebli et al., 2019). Similarly, a negative linkage (i.e., decrease in carbon emission with the rise in the influx of tourists) was found between tourism and carbon emission in the case of China. Furthermore, the influx of local tourists showed a more significant impact as than the international one. Both these results depict the expansion of tourism, especially the domestic one and the role of tourism in reducing emissions and conserving energy (Huiyue & Meng, 2019).

All forms of tourism will have some impact on the environment. Since tourism development cannot be rolled back for the obvious economic benefits that it entails, there is a need to look at alternative solutions to the problem of CO2 emission, which is particularly relevant to developing economies that have begun to rely heavily on this industry not only for the foreign exchange it secures but also for the jobs it creates. However, these countries are also the ones most negatively affected by tourism development due to their already scarce and strained resources, and insufficient response to environmental protection problems. The model that eco-tourism seeks to offer may restrict tourism to a few elite classes, and this could be an undesired alternative to these developing economies. There is thus a need to recognize that there is no one-size-fits-all when it comes to tourism development and environment protection, and different destinations would need different solutions to their problems depending on the larger context within which it is situated. These include destination areas and the strategic decisions they would need to make regarding tourism development, including to determine the type and number of tourists they are willing to accommodate.

Methodology

This segment concisely explains the significant aspects of the approach used in this research, that is, the QQ approach by Sim and Zhou (2015). Furthermore, this section also explains the model specification utilized in this research to evaluate the association between tourist arrivals (tourism) and CO2 emission. This method is considered as a generalized form of the quantile regression framework to evaluate how the construct influences the conditional quantile of one other construct. This approach is centred on the blend of nonparametric estimation and quantile regression. Initially, traditional quantile regression is applied to estimate regressor's effect on various quantiles of the predicted construct. Koenker and Bassett (1978) developed the quantile regression methodology, which is considered as an addition to the evergreen linear regression model. However, quantile regression examines the influence of the regressor on predicted variables both at the centre as well as at the tails of the distribution of predicted variables, which is not the case in OLS estimation. This allows a more detailed description of the association between the constructs. The common regression presented by Stone (1977) and Cleveland (1979) avoids the hypothetical "curse of dimensionality" issue especially related to nonparametric frameworks. The elementary idea in the background of this dimension-reduction method locally fits the linear regression near every data in the sample by assigning a higher weight to nearby data sets. Consequently, using both approaches facilitates the modelling of the relation between quantiles of the variables (i.e. regressor and predictor). This will result in more information compared to other regression techniques used for estimation such as the standard quantile or OLS. The existing study used the QQ approach to examine the influence of the quantiles of tourism on the quantiles of CO2 emission of 20 tourist destinations around the world. Initially, it will start with the nonparametric quantile regression model as given below:

$$\mathrm{CO2}_t = \gamma^{\omega}\left(\mathrm{TOR}_t\right) + \varepsilon_t^{\omega}, \tag{1}$$

where $\mathrm{CO2}_t$ denotes environmental degradation (CO2 emission) in period t, TOR_t denotes tourist arrivals in the top 20 tourist destinations in period t, ω is the ω^{th} quantile of the conditional distribution of the ED, and $\varepsilon^{\omega}{}_{t}$ shows the quantile error term whose conditional ω^{th} quantile = 0. $\gamma^{\omega}(.)$ shows an unknown function as no prior information is available to the researcher related to the association between tourism and CO2. While measuring the impact of tourism on CO2 emission, this model allows the influence of tourism to fluctuate across various quantiles of CO2 emission. Flexibility is the key advantage of this type of specification as no hypothesis was formulated with respect to the functional form of the linkage between the variables under study.

The selection of the bandwidth is vital when utilizing nonparametric estimation practices. The size of the neighbourhood encompassing the target is determined by the bandwidth, and therefore the smoothness of the resultant, that is, estimates, is controlled by the bandwidth. The higher the bandwidth, the higher the chance for biases in the estimates, whereas a smaller bandwidth can lead to estimates with larger variance. Therefore, a balanced bandwidth must be opted. Sim and Zhou (2015) opted for a bandwidth parameter λ = 0.05, and the same was adopted in this study.

Data Analysis and Results

Data Analysis

For the current research, two variables (i.e. tourist arrival and CO2 emission) were selected for the top 20 tourist destinations (China, Thailand, France, Austria, Germany, Malaysia, Italy, Hong Kong, Mexico, Japan, Russia, Spain, Saudi Arabia, Turkey, Poland, South Korea, Greece, Canada, the US, and the UK). Empirical analysis was carried out on an annual data set from 1995 to 2018, which was retrieved from the World Bank and the British Petroleum website. Before applying the statistical tools, the data was converted into quarterly information by opting the quadratic match sum method (Arain et al., 2020; Sharif et al., 2019a). This procedure is useful to convert low-frequency data into high-frequency data as it allows amendments for seasonal deviation by dropping end-to-end data deviation. The tourism data depicts the number of tourist arrivals, whereas CO2 emission was measured in metric ton/capita.

The descriptive analysis is presented in Table 1. The averages of variables show a positive result for all the tourist destinations. France has the highest average influx of tourists (76,108,773), followed by the USA (55,387,091) and Spain (52,720,091), whereas South Korea has the lowest average influx of tourists (7,571,000) followed by Japan (7,925,182) and Saudi Arabia (10,200,455). Other countries lie in between these averages. As far as CO2 emission is concerned, China seems to lead in CO2 emission (6093.143), followed by the USA (5752.915) and Russia (1523.716), whereas Austria (66.603), Hong Kong (74.785), and Greece (93.66) have the lowest levels of CO2 emission. Other countries lie in between these averages. The departure of

Table 1. Results of Descriptive Statistics.

Country	Mean	Minimum	Maximum	Std. Dev.	JB Test	*p*-Value
Panel of tourist arrivals						
France	76108773	59475972	84621619	6455128	44.086	0.000
USA	55387091	40814786	77651398	11113130	28.953	0.000
Spain	52720091	32632299	79730685	10153200	27.007	0.000
China	43109955	18276877	60690630	13514184	29.270	0.000
Italy	41365500	30143711	52972569	5679105	7.301	0.026
UK	27209091	20806115	36315277	4331224	16.027	0.000
Germany	23281273	14763150	35615646	6533644	21.887	0.000
Mexico	22715409	18506378	36517568	4182337	192.975	0.000
Thailand	15013864	6747303	32991058	7499161	43.322	0.000
Turkey	21711227	6687134	41096375	11717008	26.946	0.000
Austria	20789000	16592093	28746574	3293839	23.325	0.000
Malaysia	17157818	5303685	28037685	7599379	26.380	0.000
Hong Kong	15521682	6402796	27941235	7278931	22.751	0.000
Greece	15193364	9161507	25241826	4000398	36.712	0.000
Russia	22688227	6212145	34898039	5393732	33.267	0.000
Japan	7925182	3086997	25420411	5075237	306.971	0.000
Canada	17864909	15603726	20795985	1386430	17.158	0.000
Saudi Arabia	10200455	3020399	18596938	4850394	22.351	0.000
Poland	15755409	11803993	19613530	2267383	12.594	0.002
South Korea	7571000	3661735	20538181	3761855	62.285	0.000

(continued)

Table 1. (continued)

Country	Mean	Minimum	Maximum	Std. Dev.	JB Test	*p*-Value
Panel of carbon dioxide emission						
France	361.204	300.112	390.477	26.369	35.095	0.000
USA	5752.915	5320.952	6146.564	241.152	15.960	0.000
Spain	309.100	242.282	380.773	38.946	11.342	0.003
China	6093.143	2915.052	9259.937	2427.437	30.070	0.000
Italy	414.207	322.941	474.350	43.768	21.561	0.000
UK	533.499	392.284	579.956	48.227	81.380	0.000
Germany	821.311	742.317	912.738	49.535	16.749	0.000
Mexico	415.934	290.851	492.962	61.230	22.782	0.000
Thailand	221.687	142.340	293.735	43.873	18.882	0.000
Turkey	251.288	154.603	374.404	60.065	20.186	0.000
Austria	66.603	59.671	75.727	4.664	23.718	0.000
Malaysia	172.092	83.370	273.878	50.394	11.748	0.003
Hong Kong	74.785	49.558	94.472	16.007	29.385	0.000
Greece	93.660	69.073	109.644	11.004	22.561	0.000
Russia	1523.716	1453.852	1649.495	47.549	19.359	0.000
Japan	1219.630	1096.123	1297.942	43.709	6.475	0.039
Canada	538.368	471.140	573.468	24.457	22.293	0.000
Saudi Arabia	403.524	247.674	622.908	124.441	24.408	0.000
Poland	312.896	287.510	355.612	17.878	35.097	0.000
South Korea	532.974	359.444	665.363	89.324	15.744	0.000

Source: Author estimation.

the dataset from normality was endorsed by the Jarque–Bera test. Here, the hypothesis related to normality was rejected at a 1% level for the entire time-series data. The results confirm that the data is not normal, and hence the researcher can proceed to quantile estimations (Mishra et al., 2019; Sharif et al., 2019a, 2019b; Troster, 2018).

Furthermore, the quantile unit root test was carried out, as shown in Table 2, to check whether the data is stationary or not. The first column, that is, $\alpha(\tau)$, shows the persistence values, whereas the second column shows the t-statistics of tourist arrival and CO2 emission for each country. Table 2 confirms that the outcomes are non-stationary at the level for all quantiles, which means that the researcher can proceed with the next analysis.

In Table 3 output related to quantile, cointegration is displayed, which was presented by Xiao (2009). This statistical tool is utilized to analyze the co-integration association between tourist arrival and CO2 emission variations throughout the quantile distribution. The results of both the variables (i.e. tourism and CO2 emission) show that coefficients value β and γ (supremum norm) is greater than the critical value (CV) at all the levels of significance (CV1 = 1%, CV5 5%, and CV10 10% levels). Thus, it depicts the presence of a nonlinear association between tourist arrival and CO2 emission.

The causality between variables was analyzed through Granger causality, as proposed by Troster (2018). The focus of this methodology is on nonlinear situations in the quantile regression model. The results presented in Table 4 confirm the presence of bi-directional causality in all 20 countries between tourist arrival and CO2 emission at all the quantiles except for quantile level 0.50. This shows that both variables of this study (i.e. tourist arrival and CO2 emission) affect each other.

Results of the QQ Approach

This section illustrates the empirical outcomes of the analysis obtained by applying the QQ approach to tourism and CO2 emission for the top 20 visited tourist destinations of the world. The estimates of slope coefficient γ_1 (ω,κ) are displayed in Figure 1 (1–20), capturing the impact of the κ^{th} and ω^{th} quantile of tourism and CO2 emission, respectively, at various values of κ^{th} and ω^{th} for the 20 countries under study. Numerous interesting outcomes emerged, as shown in the graphs of Figure 1. Initially, mixed results were found in the majority of countries between tourism and CO2 emission; however, there was significant heterogeneity in the result of tourism–CO2 emission nexus across countries. This heterogeneity justifies both the significance of tourism of that specific country as well as the government policies to save environmental degradation. Secondly, there was considerable fluctuation in the slope coefficient of each country at various quantiles of tourism and CO2 emission, showing the uneven relation between tourism and CO2 emission. This uneven association

Table 2. Quantile Unit Root Test.

	France				USA				Spain				China				Italy			
	TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2	
Quantile	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats
0.05	0.975	−0.796	0.982	−0.253	0.993	−0.168	0.962	−0.577	1.007	0.214	0.993	−0.302	0.966	−0.660	0.990	−0.676	0.985	−0.258	0.992	−0.292
0.25	0.992	−2.104	0.996	−1.531	0.999	−0.409	0.986	−1.625	0.997	−1.173	0.999	−0.364	0.989	−2.082	0.994	−0.961	0.985	−2.186	0.994	−0.360
0.50	0.997	−1.859	0.985	−1.886	0.999	−0.828	0.994	−2.252	0.997	−1.884	0.999	−1.400	0.998	−1.240	0.996	−2.221	0.982	−1.781	0.999	−1.366
0.75	0.999	−0.491	0.979	−1.531	0.993	−2.008	0.993	−1.845	0.996	−1.426	0.999	−0.604	0.998	−0.813	0.999	−0.568	0.985	−0.796	0.998	−1.194
0.95	0.997	−0.060	0.975	−0.408	0.992	−0.222	0.991	−0.121	0.973	−1.102	0.997	−0.118	0.984	−0.234	1.003	0.183	0.992	−0.119	1.002	0.060
	UK				Germany				Mexico				Thailand				Turkey			
	TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2	
Quantile	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats	α(τ)	t-Stats
0.05	1.012	0.281	0.993	−0.121	0.982	−0.172	0.973	−0.175	1.002	0.043	1.004	0.112	0.994	−0.063	1.000	−0.008	1.038	0.500	0.974	−0.192
0.25	0.996	−0.928	1.003	1.179	0.997	−0.395	0.982	−1.861	1.007	4.184	1.000	0.039	0.996	−0.863	0.989	−2.194	1.012	2.242	0.984	−2.351
0.50	0.996	−1.541	1.005	2.691	0.994	−2.208	0.987	−2.312	1.005	2.269	1.001	0.347	0.993	−2.219	0.994	−2.028	0.999	−0.693	0.992	−1.672
0.75	0.988	−2.116	1.006	2.381	0.977	−1.122	0.978	−1.911	0.998	−0.387	1.008	3.360	0.986	−1.459	0.992	−1.981	0.998	−0.492	0.996	−1.047
0.95	0.970	−0.861	0.978	−0.358	0.946	−0.542	0.929	−0.679	0.987	−0.248	1.008	0.199	0.976	−0.326	0.973	−0.424	0.961	−0.564	0.960	−0.351

(continued)

Table 2. (continued)

	Austria				Malaysia				Hong Kong				Greece				Russia			
	TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2	
Quantile	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats
0.05	0.986	−0.265	0.967	−0.638	0.987	−0.137	0.974	−0.293	0.972	−0.206	0.981	−0.274	0.995	−0.103	0.993	−0.313	1.016	0.285	0.967	−0.341
0.25	0.993	−2.239	0.992	−1.534	1.003	0.723	0.985	−1.424	0.993	−1.779	0.993	−1.902	1.002	0.692	0.999	−0.355	1.012	4.325	0.983	−2.552
0.50	0.998	−1.350	0.994	−2.484	0.997	−0.984	0.993	−2.219	0.994	−1.607	0.999	−0.368	0.995	−1.592	0.995	−1.147	0.999	−1.212	0.992	−1.638
0.75	0.996	−2.094	0.994	−1.856	0.987	−2.298	0.988	−1.639	0.986	−2.409	1.004	0.721	0.992	−2.387	1.000	−0.098	0.997	−1.067	0.989	−1.531
0.95	0.979	−0.296	1.008	0.106	0.974	−0.365	0.976	−0.378	0.963	−0.344	0.997	−0.034	0.949	−1.578	1.001	0.026	0.976	−0.472	0.972	−0.348

	Japan				Canada				Saudi Arabia				Poland				South Korea			
	TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2		TOR		CO2	
Quantile	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats	$\alpha(\tau)$	t-Stats
0.05	1.036	0.469	0.986	−0.096	0.973	−0.352	0.982	−0.237	0.940	−0.727	0.965	−0.832	1.006	0.245	0.983	−0.257	0.994	−0.059	0.992	−0.060
0.25	1.008	1.713	0.993	−1.166	0.995	−1.093	0.990	−1.067	0.979	−2.288	0.993	−2.193	0.998	−0.867	0.989	−1.652	0.996	−0.951	0.990	−1.603
0.50	0.997	−1.367	0.990	−2.063	0.999	−0.871	0.993	−2.084	0.986	−1.910	0.996	−1.477	0.999	−1.521	0.995	−1.456	1.001	0.956	0.990	−2.497
0.75	0.996	−0.985	0.990	−2.382	1.002	0.705	0.997	−1.352	0.987	−2.261	0.986	−1.973	0.998	−1.442	0.995	−1.439	1.002	3.195	0.988	−2.283
0.95	0.967	−0.578	0.966	−0.385	1.003	0.064	1.005	0.084	1.001	0.013	0.993	−0.147	0.987	−0.730	0.960	−0.578	1.009	0.115	0.976	−0.349

Notes: The table shows point estimates, t-statistics, and critical values for the 5% significance level. Here, the t-statistic is numerically smaller than the critical value, so we reject the null hypothesis of $\alpha(\tau) = 1$ at the 5% level.

Table 3. Quantile Cointegration Test.

France						Austria					
Model	Coeff.	$Sup_\tau \mid V_n(\tau) \mid$	CV1	CV5	CV10	Model	Coeff.	$Sup_\tau \mid V_n(\tau) \mid$	CV1	CV5	CV10
CO2t vs. TORt	β	62091.824	56410.996	55402.578	54882.313	CO2t vs. TORt	β	19607.729	14626.827	9760.318	7372.234
	γ	2434.043	1506.760	1476.670	1461.053		γ	2363.127	1724.786	994.877	672.598
USA						Malaysia					
Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10	Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10
CO2t vs. TORt	β	7718.885	5115.134	4203.267	3751.033	CO2t vs. TORt	β	2992.363	2591.718	1747.737	1289.307
	γ	176.281	102.103	53.045	39.100		γ	193.298	177.381	113.200	88.473
Spain						Hong Kong					
Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10	Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10
CO2t vs. TORt	β	4255.292	3593.489	2326.722	1948.466	CO2t vs. TORt	β	9558.981	6823.545	5275.691	4059.175
	γ	122.298	102.339	60.773	48.916		γ	1114.060	791.919	409.357	333.252
China						Greece					
Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10	Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10
CO2t vs. TORt	β	6152.755	3157.881	2385.316	1948.987	CO2t vs. TORt	β	13089.169	11572.432	6681.634	5873.667
	γ	176.171	79.851	56.601	50.017		γ	1478.019	767.729	636.860	541.226
Italy						Russia					
Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10	Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10
CO2t vs. TORt	β	39580.795	34858.188	33777.570	33283.695	CO2t vs. TORt	β	960899.630	867744.250	823037.750	818062.630
	γ	1132.562	952.336	925.326	917.845		γ	61832.760	54800.633	52935.020	52575.016

(continued)

Table 3. (continued)

Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10	Model	Coeff.	Supτ | Vn(τ) |	CV1	CV5	CV10
UK						Japan					
CO2t vs. TORt	β	32080.199	22169.781	21513.309	20724.934	CO2t vs. TORt	β	427081.810	207697.590	193095.970	11470.482
	γ	942.584	613.367	558.246	535.408		γ	30154.943	11470.482	10499.346	10223.217
Germany						Canada					
CO2t vs. TORt	β	73228.922	62596.492	54229.820	45197.355	CO2t vs. TORt	β	47193.801	20239.861	16011.038	15140.781
	γ	5451.390	5143.253	2374.428	1996.643		γ	3757.330	1542.300	1008.696	711.849
Mexico						Saudi Arabia					
CO2t vs. TORt	β	2787.149	2151.910	1873.261	1645.470	CO2t vs. TORt	β	2615.805	1481.843	744.143	636.373
	γ	238.357	155.075	126.969	99.685		γ	222.833	115.939	57.651	48.474
Thailand						Poland					
CO2t vs. TORt	β	3285.488	2599.209	1976.873	1601.977	CO2t vs. TORt	β	92405.242	84684.500	73875.039	69671.594
	γ	301.466	248.411	188.719	121.586		γ	5768.786	1368.712	1077.769	815.416
Turkey						South Korea					
$CO2_t$ vs. TOR_t	β	7164.472	4684.255	3768.601	2507.453	$CO2_t$ vs. TOR_t	β	8145.723	7176.362	4822.472	3955.169
	γ	638.772	376.450	213.604	161.354		γ	649.827	594.662	342.075	249.069

Source: Author estimations.

Table 4. Granger Causality in Quantile Test Results.

		France							USA				
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.120	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.185	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.759	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.060	0.000	0.000
		Spain							China				
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.528	0.000	0.009	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.384	0.000	0.003	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.667	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.718	0.000	0.000
		Italy							UK				
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.046	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.546	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.931	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.523	0.000	0.000
		Germany							Mexico				
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.829	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.921	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.639	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.199	0.000	0.000
		Thailand							Turkey				
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.255	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.407	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.468	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.181	0.000	0.000

(continued)

Table 4. (continued)

	Austria							Malaysia					
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.949	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.634	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.657	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.134	0.000	0.000
	Hong Kong							Greece					
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.042	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.231	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.801	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.556	0.000	0.000
	Russia							Japan					
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.236	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.204	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.759	0.000	0.000	0.000	0.065	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.676	0.000	0.000
	Canada							Saudi Arabia					
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.287	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.787	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.954	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.361	0.000	0.000
	Poland							South Korea					
	[0.05–0.95]	0.050	0.250	0.500	0.750	0.950		[0.05–0.95]	0.050	0.250	0.500	0.75	0.95
ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.588	0.000	0.000	ΔTOR_t to $\Delta CO2_t$	0.000	0.000	0.000	0.106	0.000	0.000
$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.102	0.000	0.000	$\Delta CO2_t$ to ΔTOR_t	0.000	0.000	0.000	0.898	0.000	0.000

Source: Author estimations.

is contingent on the sign and magnitude of tourism variation in that specific country and CO2 emission.

The outcomes show that in general, in the case of the USA, Austria, and Spain, the effect of tourism on CO2 emission is positive at all quantile levels. Some of the quantiles show a quite powerful positive effect; however, the intensity varies at different quantiles. For the USA, the intensity of the effect is highly positive at quantile level (0.45–0.55) for tourism and (0.45–0.55) of CO2 and in the case of Austria, it is (0.35–0.55) for tourism and (0.3–0.65) for CO2, which means that even low tourist arrival increases CO2 emission, but this effect gets weaker at a higher level of quantiles. For Spain, the intensity is highly positive at quantile level (0.80 to across all) for tourism and (0.35 to across all) for CO2 emission, which means that the high intensity of tourist arrival has an adverse effect on CO2 emission and the condition of the environment will worsen as the number of tourists increases. The direct relation is supported by previous studies, for example, Eyuboglu and Uzar (2020).

In the case of France, a negative impact was observed at all the levels of quantiles; however, the intensity is highly negative at the quantile level (0.1–0.35) for tourism and at (0.5 to across all) for CO2 emission. This suggests good environmental policies in France because according to the results, low tourist arrival will have a negative effect on the environment, which means that the environment will improve due to the low arrival of tourists. However, after the saturation point, these policies will not be as effective as in the current condition because after a certain limit, tourist arrival will begin degrading the environment. According to Figure 1, the outcomes of Greece, the UK, Japan, Poland, China, Turkey, Thailand, Hong Kong, and Russia show a mixture of positive and negative quantiles; however, overall results show a positive impact with the greater number of quantiles. Further, the outcomes of Greece depict that it is highly positive at higher quantiles of tourism and CO2 emission (0.90 to across all) for both tourism and CO2 emission. The result depicts that under worse environmental conditions, high intensity of tourists will further degrade the environment.

The results of the UK and Poland show the weak positive result at maximum numbers of quantiles; however, a strong negative impact was also noticed at higher quantiles of tourism, that is, (0.9 to across all) for both countries, that is, the UK and Poland and at 0.05–0.15) and (0.3–0.4) in case of Poland, whereas at all the quantiles of CO2 emission in the UK. In addition to this, the UK also has a strong negative result at lower quantiles of tourism (0.1–0.25) and higher quantiles of CO2 emission (0.9 to across all). This means that in the case of Poland, where environmental conditions are quite good, even the high intensity of tourist arrival will not have a much harmful effect on the environment, and the environmental situation will improve due to the arrival of tourists. The same is observed in the case of the UK, where under low to high CO2 emission conditions, the intensity of low or high tourist

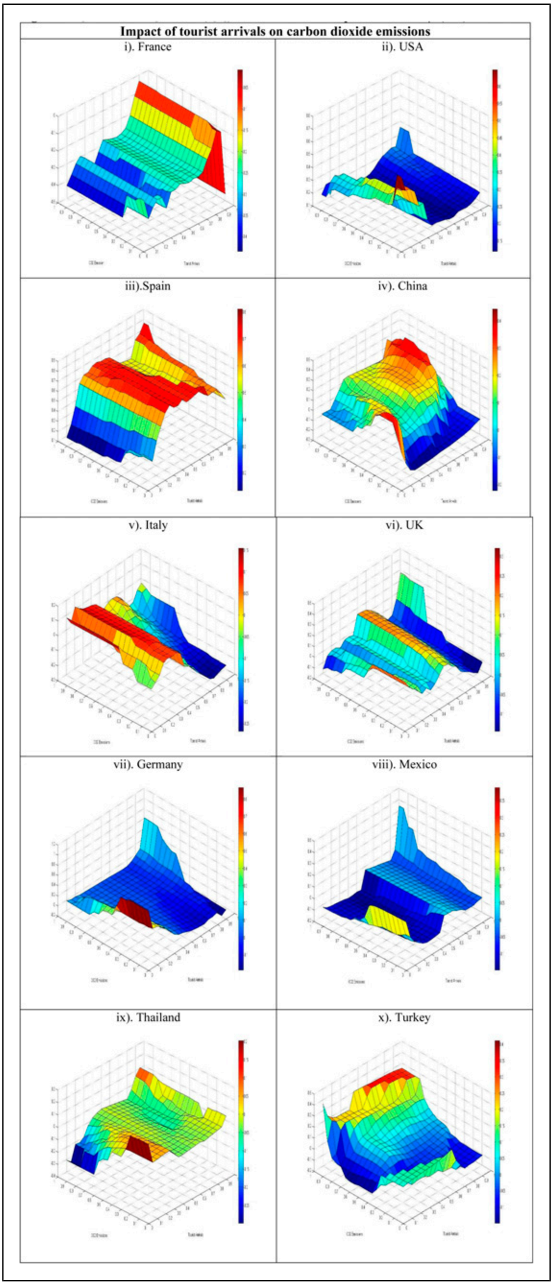

Figure 1. Quantile-on-quantile (QQ) estimates of the slope coefficient, γ_1 (ω,κ). Note: The graphs show the estimates of the slope coefficient γ_1 (ω,κ) in the *z*-axis against the quantiles of CO2 emissions in the *y*-axis and the quantiles of tourist arrivals in the *x*-axis.

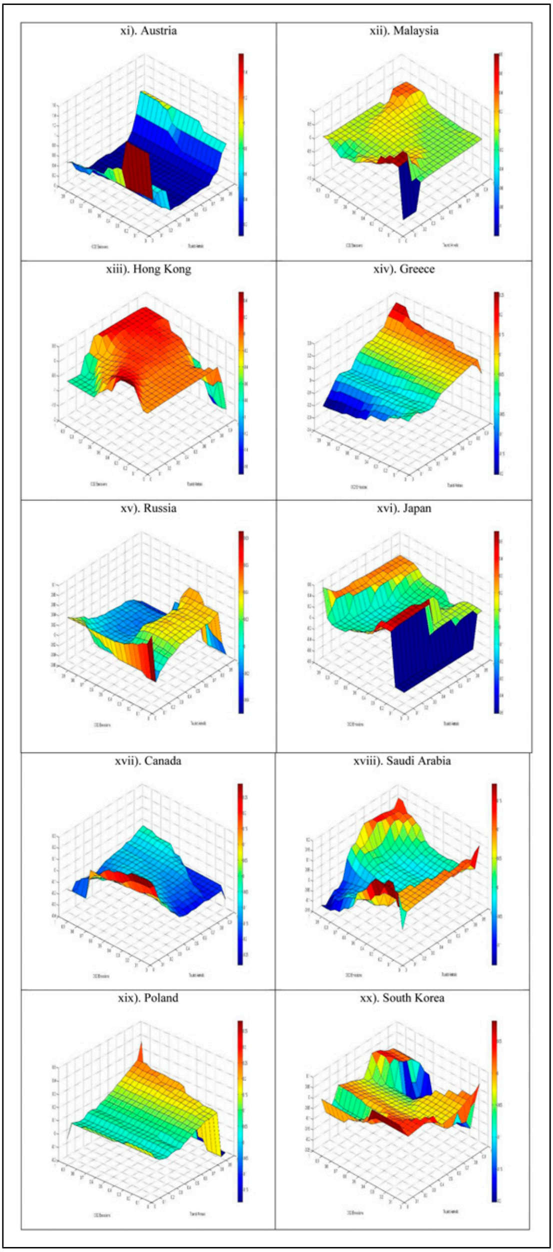

Figure 1. Continued.

arrivals will not have a much harmful effect on the environment, and the environment will improve due to the arrival of tourists. This depicts good environmental policies by the government of both countries.

In the case of Japan, quite interesting results were noticed. Overall, the results were positive at the majority of quantiles; however, both strong positive and negative results were also noticed. High negative results can be seen from (0.2 to across all) quantiles for tourism, whereas for CO2 emission, it is at (0.2–0.8). This shows that low to high intensity of tourist arrival in the case of low to moderately high CO2 emission will have a negative effect on CO2 emission, which means that there will be a decline in the quantity of CO2 emission due to the arrival of tourists. Furthermore, when the situation of CO2 emission is high (0.8–0.95), this low or moderate arrival of tourists (0.2–0.25) will have a positive effect on the environment, which means that this arrival of tourists will deteriorate the environment.

Furthermore, the outcomes of China show an overall positive impact of tourism on CO2 emission. However, the results are highly negative at quantile (0.25 to across all) for tourism and for quantile (0.1–0.35) for CO2 emission. This shows that under low CO2 emission, tourist arrival will result in the improvement of the environment; however, as the intensity of CO2 emission increases, further tourist arrival will not be useful for the CO2 emission because of the high positive association between both variables. The same can be seen at the upper quantiles of both variables.

In the case of Turkey, overall outcomes seem positive; however, highly negative results are also seen at higher quantiles (0.85 to across all) for tourism and (0.1–0.4) for CO2 emission. This means that even high tourist arrivals under low CO2 emission conditions will not have a much worse effect on CO2 emission, and even under this high intensity of tourist conditions of CO2, emission will improve. In the case of Turkey, another highly negative result is also seen at the lower quantiles of tourism, that is, (0.1–0.25) and (0.35 to across all) for CO2 emission. This shows that low tourist arrival at low or high CO2 emission conditions will decrease the CO2 emission. This highlights the good environmental policies by the government of Turkey. Thailand shows positive results in the majority of quantiles. However, the negative result is also shown at quantile (0.1–0.40) for tourism and at quantile (0.85 to across all) for CO2 emission. This means that even under high CO2 emission, the arrival of low tourists will have a negative impact on the environment. The environment will improve further; however, this effect will be reversed at a moderate level of tourist arrival (0.65–0.75) and at high CO2 emission (0.6–0.85), which means that as the number of tourist increases, this will cause harmful effects on the environment under high CO2 emission.

In Hong Kong, the overall result is also mixed, where both positive and negative quantiles can be seen in Figure 1, but the result is highly positive at the majority of quantiles. Both the variables are highly positive at higher levels of quantiles, that is, (0.5 to across all) for tourism and (0.7 to across all) for CO2 emission. This means that under moderate or high CO2 emissions, the arrival of tourists will further degrade the environmental conditions. In Russia, overall result is mixed; however, the majority of the quantile show a positive impact of tourist arrival on CO2 emission. Furthermore, at quantile (0.25–0.35) for tourism and at quantile (0.35–0.45) for CO2 emission, this effect is highly positive, which shows that even at low CO2 emission, the low intensity of tourist arrivals will further harm the environment; however, this will turn to a negative impact, that is, high intensity of tourist arrival (0.9 and above) in high CO2 emission (0.65 to across all) will decrease the CO2 emission.

In the case of the remaining countries, Figure 1 shows a mixture of positive and negative quantiles; however, overall results show a negative impact at a greater number of quantiles. For example, the cases of Italy and Canada are similar. In these two countries, the overall result is mixed, where both positive and negative quantiles can be seen in Figure 1, but the result is highly negative at the majority of quantiles. For these two countries, tourism is highly negative at the upper quantiles, that is, (0.8 to across all) for Italy and (0.65 to across all) for Canada, and at the low or medium intensity of CO2 emission, it is (0.1–0.7) for Italy and (0.1–0.55) for Italy. This means that the governments of both countries have good environmental policies as high tourist arrivals under low or medium CO2 emission situation further decrease the CO2 emission.

For Malaysia and Mexico, the effect of tourism on CO2 emission is negative in general. However, a positive result can be seen at a few quantiles, whereas Germany shows a weak negative result. The effect of tourism on CO2 emission is highly negative from lower to middle or upper–middle quantiles of Malaysia and Mexico, that is, (0.15–0.55) and (0.10–0.75), respectively, for tourism and (0.15–0.6) and (0.15–0.25), respectively, for CO2 emission. In addition, Mexico also shows a high negative impact at the upper level of quantiles, that is, (0.7 to across all) for CO2 emission. This shows the negative impact of tourism on CO2 emission, which means that low or medium intensity of tourist arrivals in low or medium CO2 emission figure situations will not have much harmful effect on the environment, and the environment will improve due to the arrival of tourists. Furthermore, in the case of Mexico, even if the situation of CO2 emission is high, these tourists will not cause much harm to the environment and will result in a decline in CO2 emission. This specifies good environmental policies by the government of both countries. However, in the case of Malaysia, a high positive impact is also seen at quantile (0.5–0.65) for tourism and (0.55–0.75) for CO2 emission. This means that under moderate CO2 emissions, the tourist arrivals will further harm the environment, which was not the case in low CO2 emission situations. For Germany, in addition to weak negative results as discussed above, some of the quantiles also show a powerful positive effect. As far as the intensity of the effect is concerned, there is a high positive effect at the lower quantile of both

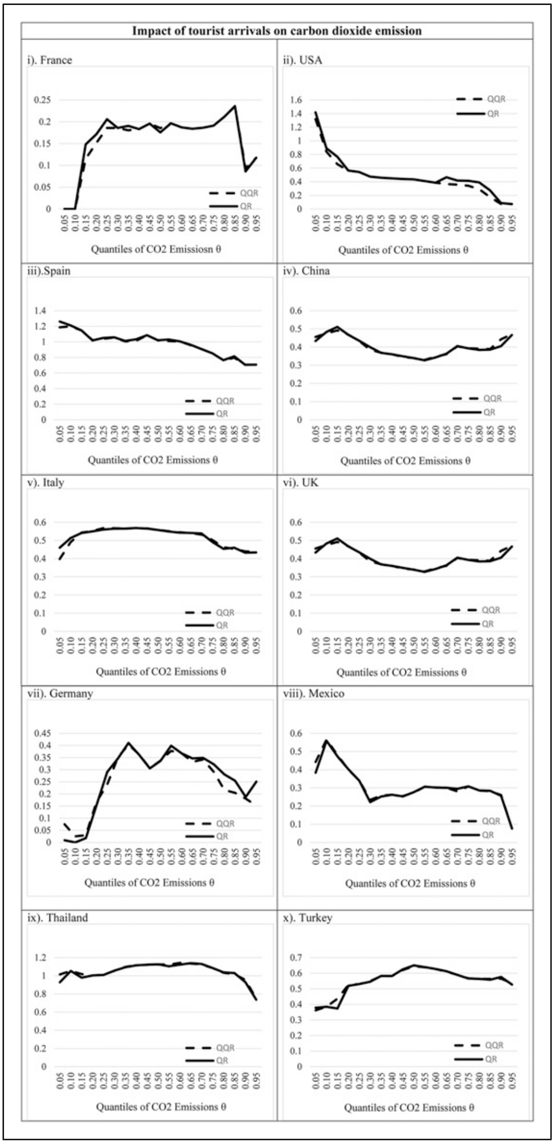

Figure 2. Comparison of quantile regression and QQ estimates. Note: The graphs display the estimates of the standard quantile regression parameters, denoted by QR (continuous black line), and the averaged QQR parameters, denoted by QQR (dashed black line), at different quantiles of tourist arrivals and carbon dioxide emissions for all countries examined.

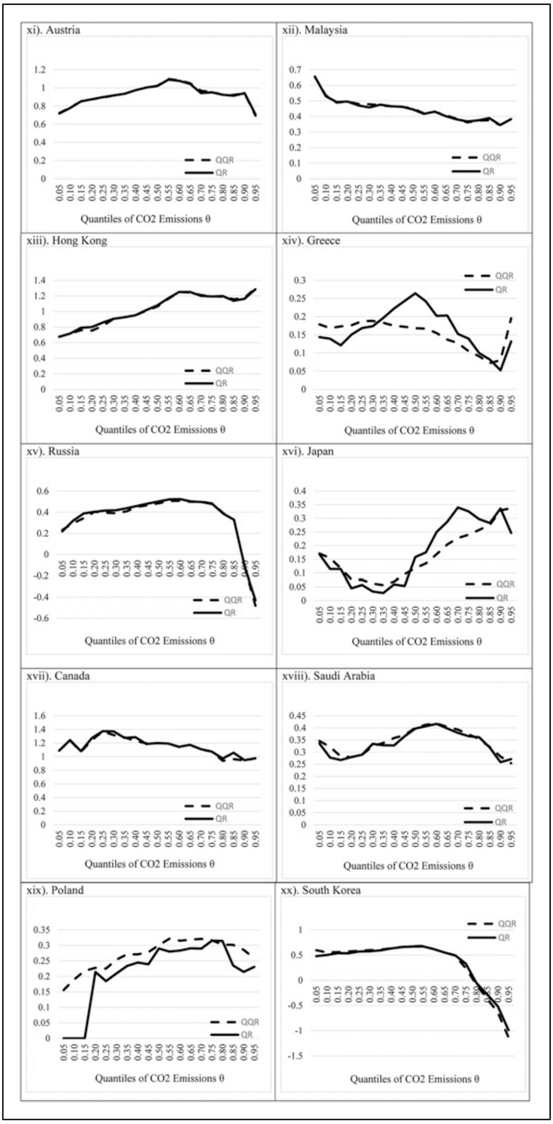

Figure 2. Continued.

the variables, that is, (0.35–0.45) for tourism and (0.35–0.65) for CO2. This means that low tourist arrival has a positive effect on CO2 emission, but as the arrival of tourists' increases, its effect on the environment decreases. This means that the government of Germany has devised strong policies to mitigate the effect of high tourist arrivals on the environment.

In South Korea, tourists have a negative impact on CO2 emission; however, this negative impact is significantly high at the upper level of quantiles for tourism, that is, (0.9 and above) and for CO2 emission, this high negative impact is at two levels of quantiles, that is, (0.25–0.35) and (0.6–0.75). In South Korea, the intensity of tourist arrival is high; however, the large number of tourists will not further degrade the environment in both low and upper–middle CO2 emissions. This means that for Korea, these tourists will be helpful in reducing the environmental effect of CO2 emissions. However, it is interesting to note that a high positive effect is also seen at the upper–middle quantile of tourists, that is, (0.6–0.7) and (0.6–0.9) for CO2 emission. This shows that at the moderate-intensity level of tourist arrival and under moderate to high CO2 emission situations, tourists will degrade the environment, which after a certain point, the high intensity of tourist arrivals will not be harmful to the environment as discussed above. Finally, Saudi Arabia also shows negative results at the majority of quantiles, and the highly negative side is at the lower quantile of tourist arrival, that is, (0.1–0.40), and at the higher level of CO2 emission, that is, from (0.85 to across all). This result shows that in Saudi Arabia, low tourist arrival will improve the situation of CO2 emission, which shows that the government of Saudi Arabia has devised strong policies to mitigate the effect of tourist arrival on the environment.

The Validity of the QQ Method

The QQ methodology can be regarded as a methodology that disintegrates the estimates of the traditional quantile regression framework that enables the achievement of explicit estimates for various quantiles of the predictor variables. Simply put, the validity of the QQ methodology can be scrutinized by comparing the estimates of traditional quantile regression parameters with the κ-averaged QQ parameters. The graphs (1–20) in Figure 2 that show the results of all countries depict that irrespective of quantiles, the mean QQ estimates of the slope coefficient are reasonably the same as the quantile regression estimates. Consequently, the robustness of the result obtained through the QQ approach is confirmed from Figure 2.

Conclusion and Policy Recommendations

In existing research, we have attempted to investigate the association between tourist arrivals and CO2 emission in the top 20 tourist destinations worldwide. The dataset chosen for this study is composed of quarterly observations from 1995 to 2018. The researchers have utilized the novel technique of quantile-on-quantile regression (QQ) proposed by Sim and Zhou (2015) and Granger causality in the quantiles proposed by Troster (2018). In particular, how the quantiles of tourist arrivals affect quantiles of CO2 emission was examined. Therefore, the findings of this research show the overall dependence between tourist arrivals and CO2 emission. Initially, mixed results were found in the majority of countries between tourism and CO2 emission; however, there is significant heterogeneity in the result of tourism–CO2 emission nexus across countries. This heterogeneity justifies both the significance of tourism in that specific country as well as the government policies to save CO2 emissions. The empirical results suggest a significant positive relationship between tourist arrivals and CO2 emission in most tourist destinations, predominantly in both high and low tails. The results further suggest a negative effect of tourist arrivals on CO2 emission for the case of France, Germany, Canada, Italy, the UK, Mexico, Malaysia, and Turkey.

Countries with a negative impact of tourism on CO2 emission show that their government has devised strong policies to mitigate the effect of tourist arrival on the environment. The same was found by Alam and Paramati (2017). According to them, an investment in tourism not only stimulates tourism but also supports the reduction of CO2 emissions. Therefore, countries that show a positive association between the variables will be much interested in devising policies to minimize CO2 emission and protect the environment from degradation. As a matter of fact, countries with a positive relationship between the variables should be more concerned about energy consumption through the transport sector, where the greater the intensity of tourists, the greater the consumption of energy (Ben Jebli & Hadhri, 2018). For the betterment of the economy and ecosystem, authorities must show great concern towards the implementation of green tourism (Ben Jebli et al., 2019). Regulatory policy implementation is required to minimize the level of environmental degradation through the expansion of the tourism industry (Pulido-Fernández et al., 2019). Asmelash and Kumar (2019) highlighted the importance of stakeholder's inclusion in the decision-making of green tourism.

It is imperative for these countries to devise an efficient investment framework to augment the arrival of tourists on one hand and curtail the CO2 emission on the other. Clean energy choices have become increasingly important as technologies and environmental protection have advanced (Bekun, 2022).

Regulatory policy implementation is required to minimize the level of environmental degradation through the expansion of the tourism industry (Pulido-Fernández et al., 2019). In order to reduce the level of CO2 emission, the taxation policy should be levied upon sectors that emit CO2 in countries as a social cost of carbon emission (Lundgren & Marklund, 2013). Countries emitting more CO2 due to the high intensity of tourist arrivals should adopt technology that is eco-friendly in order to sustain the environmental quality at its best. Hence, the government and tourism department need to focus on clean and efficient energy usage.

Lu et al. (2019) found that France has the highest annual influx of tourists followed by the USA and China. China and Turkey have 5% tourism expansion, Germany and the United Kingdom stand at 1% growth in tourism, further, Mexico and china spend 10% investment in tourism, whereas Japan spends 1% on the tourism sector. The UK and South Korea invested 10% in renewable sources of energy utilization. On the contrary, Saudi Arabia and Russia depended on conventional sources of energy.

These statistics depict that the focus on investment in the tourism industry not only increases the revenues of the country but also attracts more tourists. Therefore, it is imperative for policymakers to promote investment in the tourism industry, regularization of CO2 emissions, usage of conventional non-renewable energy, green tourism campaign, and eco-friendly tourism activities (Lu et al., 2019).

An emerging economy needs to have sustainable development, but the growth patterns from tourism might make that hard to achieve. Therefore, tourism could be a potential determinant of environmental degradation in emerging nations, especially from a policymaking perspective. This short review of the relation between tourism and the environment indicates that tourism could potentially have an impact on the environment. This effect could be either positive or negative depending on the tourism indicator, the perspective of the study, and its duration. This may be the cause behind incongruences such as the relationship between these two indicators. Thus, considering tourism is an important social and economic industry, future research is required to uncover the possible impact (negative or positive) on the environment.

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