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Environmental impact of the tourism industry in China: analyses based on multiple environmental factors using novel Quantile Autoregressive Distributed Lag model

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ABSTRACT

This study examines the impact of tourism on China's environmental quality under the framework of the Environment Kuznets Curve. In this study, tourism is measured by the number of tourist arrival and environmental pollution is measured by three proxies: carbon emissions, atmospheric particulate matter, and greenhouse gases. The study additionally controls trade openness effects using annual data from 1995 to 2018. Based on the asymmetric behavior of environmental variables, the study applies the Quantile Autoregressive Distributed Lag model that helps to integrate both dynamic trends and non-linearity. The findings confirmed the validity of Environment Kuznets in the long run and unveiled that tourist arrivals reduce carbon emissions, atmospheric particulate matter, and greenhouse gases in the long run, but in short-run dynamics, tourist arrivals only reduce carbon emissions. Similarly, trade openness increases carbon emissions, atmospheric particulate matter, and greenhouse gases at initial quantiles in the long run. In contrast, in the case of the short run, trade openness reduces atmospheric particulate matter and greenhouse gases. These results imply that the emissions mitigating (contributing) effects of tourism and trade varied across lower and higher quantiles. In conclusion, the findings reveal that the government should take effective measures to implement appropriate strategies required to sustain tourism and trade in China.

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1. Introduction

Tourism is the fastest-growing sector in the economy that plays a vital role in creating employment opportunities and creates a huge number of foreign exchanges and

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ultimately results in the overall economic growth and social development of the countries (An, Razzaq, Haseeb et al. 2021; Lee and Chang 2008). According to the United Nations World Trade Organization (2017), it is reported that tourism has the potential to bring about the economic transformation of a wide range of destinations. Globally, the tourism industry has been rising and developing into the largest growing industry in recent years. According to the World Tourism Organization (2015), about 30% of the world's export earnings have increased due to tourism in both emerging and developing countries. For least developed countries like Gambia, Madagascar, Nepal and Tanzania, tourism is also boomed. Though tourism development is a double-sided sword, in that it generates not only affirmative repercussions such as the creation of jobs but also instigates undesirable ones such as water and air pollution, ecosystem degradation as well as the loss of the socio-cultural environment if it is not properly planned, settled, and coped (Azam et al., 2018; Ozturk et al. 2020; Sharif et al. 2020; Yeoman et al., 2007).

Globally, the tourism sector's actions have been criticized due to factors such as the relationship of tourism with climate change as apathetic and public traveling is being considered reciprocally uncommitted in the industry of tourism (An, Razzaq, Nawaz, et al. 2021; Razzaq et al. 2021c; Weaver, 2011). In simple words, due to the growing trend in the industry, transportation has increased, and carbon neutrality has become a scarce resource, and climate change has become a harmful factor (Razzaq et al. 2021b). The relationship of tourism with the environment is actually the moving and travelling of people, and the anthropogenic activities occurring as a result of travelling influence the environment (Becken, 2013). Tourism involves lots of transportation and accommodation as travellers need to move from one place to another, so tourism is consumed at the cost of environmental degradation as the bulk of carbon dioxide, and greenhouse gases are emitted from the tourism sector (Anwar et al. 2021; Haiyan Song et al., 2013).

Moreover, tourism also influences the land undesirably, followed by water and air pollution. The negative impact of land-based tourism litters the area, which sometimes creates forest fires, threatens the habitats in the particular zones, and creates a vulnerable situation as it endangers the species, especially those living in the forest areas (Sunlu, 2003). The pristine nature of the environment in the forest areas is disturbed by garbage disposal as it becomes the dumping grounds by the tourist. The improper management of garbage collection and littering in the forest leads to forest fire, a great threat to the animals living in the region, leading to the extinction of wild species (Azarmi et al., 2019). The tourism industry develops the infrastructure utilizing hotels and other recreational activities hence increasing the issue of sewage pollution that influences the groundwater quality and creates major concerns for humans as well as for both flora and fauna, especially this issue happens with the coastal tourism where the sewage inflow affects the water quality adversely and creates water pollution by changing the salinity and transparency of the water and leaves a greater threat to the environment (Rath & Gupta, 2017). Thus marine and coastal tourism also lead to various potential threats by discharging solid, liquid and semi-solid hazardous material into the water bodies like rivers and sea (Davies and Cahill, 2000).

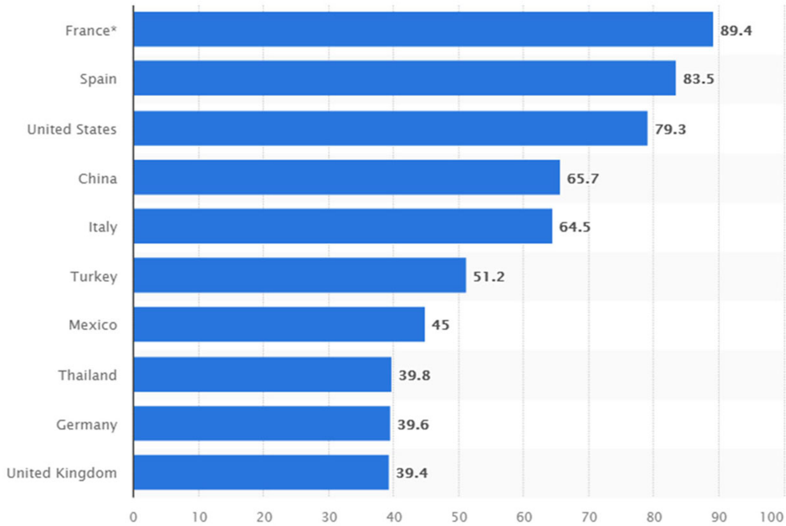

Figure 1. Number of tourist arrivals (in millions).
Source: https://www.statista.com/statistics

It is also debated that the travel and tourism industry also influences the environmental quality of Asian economies, especially in the south-east Asian countries that are highly tourism-oriented and depends on energy to meet the tourist requirement, thus reflecting the poor air quality. Given the profound changes induced by tourism, in this study, we emphasized China as tourism in China has significant networks for conjoint learning and communication between different cultures and countries and an effective means to increase employment and develop the economy. According to the World Tourism Organization (UNWTO), it is reported that France in 2019 attracted roughly 89.4 million tourists while Spain attracted 83.5 million tourists. The United States placed third in the list with around 80 million international arrivals, while China ranked fourth, recording almost 65.7 million inbound arrivals. In the context of the travel and tourism industry, China in 2019 is placed at second in the ranking, with a contribution of 667 billion U.S. dollars to GDP after United States that contributes the largest amount of 580.7 billion U.S. dollars (https://www.statista.com/statistics/2021) (Figure 1).

Though tourism has many apparent positive repercussions, its negative impact can't be ignored. In the prevailing literature, many studies revealed that the negative effects of tourism outstrip the positive effects as the coal-based industries like coal mining and arid climate with improper maintenance have emerged as the main factor of environmental degradation. Tourism, being one of the world's largest industries, is adversely influencing the environment, especially during the peak of tourist season. Therefore, it is required to examine and monitor the impact of tourism on the environment. In this regard, it is required to implement the ecotourism strategies in the world for the conservation, prevention and sustainable protection of the natural environments and mainly to support the local cultures in the particular area (Rath & Gupta, 2017). Globally, CO2 emission is much higher, and the government is already trying to promote eco-friendly products and reduce carbon technology to enhance sustainable tourism growth (Ahmad et al., 2018; Chien et al. 2021; Koondhar et al., 2021; Lingyan et al. 2021; Si et al., 2021). According to the 17 Sustainable Development Goals (SDG's) proposed by the UN, the 13th and 14th goal is also to set up a strong ecological foundation and create sustainable development in the eco-system using available resources. The goals focus on climate change by emphasizing developing innovative and eco-friendly infrastructure to reduce carbon emissions and build a sustainable environment (UNGA, 2015; Khan et al. 2021).

In this regard, the government should take necessary steps to stop the leakages into the environment by finding out the Single-Use Plastic hotspots and should take certain other necessary measures such as changes in policy and infrastructure related to the local, regional and global governing bodies to encourage eco-friendly products especially in the tourism sector (UNEP & WTTC, 2021). The planned and sustainably focused tourism management is anticipated to lead to many economic, social, and environmental benefits; otherwise, the unplanned and mismanaged and improper infrastructure lead to environmental hazards and may create a negative impact on the sector as well as the country and as a result may lose the number of the tourists (Farid, 2015). It is also likely that the chances of the tourist flows might change due to the variation of the destinations. It depends on the environment, recreation and leisure, which depends on the climate and nature. The changes in the climate might affect the tourism destination merits and demerits as the local and national governments govern it. Their policies and functions might become the concern to affect the tourism destinations as part of the larger economy (Gössling & Hall, 2006). Thus, for improving good tourism, the engagement of the community is also essential, and planning and managing the tourism sector through public-private partnerships, technology, and innovation are certain prerequisites to flourish the tourism industry sustainably.

In accord with the rising significance of tourism as a means to promote economic growth and development in China, the adverse effects on the environment (Jiang et al., 1996; Lv, 2003; noise pollution, water pollution, air pollution, and biodiversity loss can't be ignored (Wen et al., 2003; Xie and Zheng, 2001) . So, keeping in view the above discussion, the current study attempts to explore the impact of tourism on the environment by using different proxy variables, for instance, carbon emissions (CE), atmospheric particulate matter (PM2.5) and greenhouse gases (GHGs). The joint use of different variables attempts to portray a clear picture of the impact of the tourism sector on the environment of China. Moreover, unlike the previous studies, the current study uses the novel approach of Quantile Autoregressive Distributed Lag Model (QARDL) model with an advantage that the cointegration coefficients in this method vary across quantile in short-run dynamics; however, the parameters are also ensued to move together in the long run (Xiao, 2009). Besides, the cointegration coefficients diverge along quantiles due to shocks are also assessed by this approach. Moreover, this approach is also superior to the Nonlinear Autoregressive Distributed Lag (NARDL) model of Shin et al. (2014), in which non-linearity is delineated exogenously, i.e., the cutoff is alternatively set to zero instead of determining by a data-driven method.

The paper's remaining structure is organized below. The subsequent section 2 reviewed the potential existing studies on the topic focused in the present study. Data sources and analytical strategies are presented in section 3. The results based on estimations are presented in section 4, and lastly, the conclusion with possible policy recommendations is revealed in section 5.

2. Literature review

In current years, the EKC literature has been repetitively increasing and getting the attention of scholars and researchers (Aziz et al. 2020a, 2020b, 2020c; Bekun et al. 2019; Rafindadi and Usman 2019; Sarkodie and Strezov 2018; Sinha and Shahbaz 2018). This section is supplemented with studies exploring the environmental impact of tourism coupled with foundation of tourism and the choice to decide on tourism. These streams also highlight the EKC hypothesis tested before by earlier researchers in different countries.

Tourism management plays a vital role as it controls the functions efficiently and implies the best management practices to yield benefits in an economy. The literature review on tourism has been analyzed based on best managing practices followed by a theoretical perspective. Back to tourism acts, the Act of 1979 was the foundation of tourism development. In this regard, the first Tourism Master Plan (FTMP) in 1983 discussed tourism development sustainably according to the economy's social and economic development to conserve and preserve the environment. The Second Tourism Master Plan was planned from 1996 to 2005 to develop tourism into mass regions across the globe for the country and the tourists. The third Tourism Master Plan (2007–2011) aimed to establish better resorts in the islands and improve them sustainably. The fourth Tourism Master Plan (2013–2017) is mainly implied for the Maldives' position in the market, managing environmental and conservation issues, and engaging more Maldivians in a tourism career (World Bank, 2016).

The global change in an environment is a great threat to the tourism sectors as it modifies the bio and geochemical factors of topography, and the loss of non-renewable resources leads to the unsustainable use of renewable resources ending in the loss of biodiversity and overall impacting the relationship between the environment and the tourism management. Allison et al. (2009) and Ling et al. (2021), in their book "The Copenhagen Diagnosis: Updating the world on the latest climate science," has pointed out the insufficiency of the research and studies done on the assessment of small-scale weather events that could change the future events and affect the tourism. The sudden changes in the outbreak of natural events affect tourism and lead to heavy economic loss. The recent wildfire on Mediterranean climates like Spain, Greece, southeast Australia and southern California was the impact due to the increase in anthropogenic activities and causing climate change. The glaciers in Greenland flowing faster than 100 meters per year, with an average of 0.84 meters per year, the risk of ice sheet collapse is high in Greenland Antarctica. This information affects not only climate change but also the tourism of the country.

In the context of tourist decisions, Song et al. (2012) strongly mentioned that the tourist's decision to choose the particular destination is influenced by social and psychological factors like their social status, personal interest, and interest in the cultural and geographic nature. The time trend in the tourism demand unction is the ambiguity, and the consumer behavior changes relevant to the consumption of the commodities. As the size of the tourism industry is rapidly growing, the demand for international tourism has been bound regarding the regime of the government policy and economic conditions resulting in the demand elasticity being unchanged over time. In another study, Carey Goh (2012) tries to frame the importance of the tourism demand of economic and non-economic factors by the socio-psychological variable significant to the tourism demand. The tourism demand is influenced by consumer behavior based on the travellers' destination choice. The measures of collecting the factor for the data in the time series are unclear: the impact of changing trend clearly states the value evolves by period, yet few factors like tourism policy, destination accessibility, and culture are stable over the period. In another study, Kim et al. (2019) defined the research related to tourism activities by focusing on the factors influencing tourism demand from consumer behavior using cross-sectional data from a micro perspective. The analytical results indicate that household head age, household income, car ownership and Internet usage positively influence tourism expenditures. Home loan and health and insurance expenditures negatively impact tourism expenditures.

The tourism demand forecasting system (TDFS) is the web-based innovative online system to forecast the tourism-based demand with the help of technology. The study by Song et al. (2013) shows the TDFS has shown full accuracy with the judgemental on statistical forecast survey in the long-haul markets of interests like Japan, Taiwan, US and China. The Delphi survey helps to improve the capability of a good functional forecasting module. Song et al. (2003), in their study, explained the demand in the Hong Kong tourism sector with the time-varying parameter (TVP) model to find the behavioral change of tourists over time, and the forecasting performance has shown positive parameter in demand in the tourism of western European countries. It is indicated that the development of the economy with international tourism by the administration's direct revenues generated in the form of foreign direct investment in the tourism sector (Razzaq et al. 2021d). The policies to be implemented with the local decision-makers as their influence on the nature conservation, employment in local tourism will be more beneficial in the tourism management. McKercher et al. (2008) showed the decline in tourist volumes over a distance; is a function of the virtual disappearance of certain segments rather than a general decline of demand across all segments. Hence, no direct value is registered in the historical heritage due to the public commodity, and the social value is less marketable. While distance may not be an explicit barrier to travel, it is an implicit barrier representing the critical points where the destination becomes unattractive.

In Africa, the Ethiopian government aims to transform the country into one of the top ten tourist places by 2020. With the rising share of the Ethiopian market among the international tourist, the chance of improvement of the condition of the country is improved using economic, political, social, infrastructural, and service ways; hence a good amount of employment will be created for the citizen in the country. It is one of the positive sources that can conserve and preserve the sustainable tourism income by the international tourists and save their cultural heritage (Farid, 2015; WTTC, 2014). According to Kopsch (2012), the demand for domestic air travel in Sweden is calculated by the data on passenger qualities and fares with price elasticity to find the robustness of the leisure travelers. The substitute of the cross-price elasticities is via rail and road. The results show aggregate demand for air travel in the long run compared to the short run; the travellers are sensitive to the price changes. Leisure traveller's demand would largely explain the price change on demanded quantity. A positive cross-price elasticity is found between rail and air travel.

According to Higham and Cohen (2011), the Norwegian government has planned carbon neutrality all across the country's sectors by 2030. The climate impact on air travel is a carbon conscience and a growing concern. Norway is in a leading position in the European tourism market concerning climate sensitivity. Weaver (2012) pointed out that the global financial crisis in the tourism sector's growth would be addressed by the sustainable environment resulting in mass tourism. Mass tourism being sustainable could be achieved with the macro perspective on the evolution of contemporized tourism. Susanne Becken (2013) has addressed the sustainability of tourism management as the gaps that need to be addressed on tourism and climate change's geographic and topical dimension. The research done in the particular domain is liable with very few researchers, which pose a risk to intellectual diversity better to understand the measures of tourism and climate change.

Moving towards the environmental impacts of tourism, many studies proved both the favorable and unfavorable environmental impacts of tourism. In the context of desirable effects, Danish (2018), in the case of the BRICS panel, revealed that tourism helps in improving the quality of the environment. Likewise, in the case of ASEAN countries, Kongbuamai et al. (2020) also portrayed an upturned U-shaped EKC between tourism and ecological footprints. In the case of central and South America, Ben Jebli et al. (2019) revealed the same phenomenon and highlighted that tourism supports improving the environment quality. Other researchers also exhibited the same phenomenon and unveiled the same findings (see Ozturk et al., 2016 and Raza and Shah, 2017). In contrast, many studies argued that tourism is a major contributor to environmental degradation as tourism consumes energy-intensive technologies for its activities. The recent study of Balsalobre-Lorente et al. (2020) in OECD countries, Gulistan et al. (2020) in 112 countries, and Anser et al. (2020) in Group of Seven countries scrutinized the relationship and stated that tourism instigates environmental pollution. In the case of Azerbaijan, Mikayilov et al. (2019) also endorsed the U-shaped EKC hypothesis between tourism and ecological footprints. Zhang and Liu (2019), in 10 Northeast and Southeast Asia countries, found that tourism is the main factor contributing to environmental pollution.

The overall findings showed that tourism has both positive and negative effects. Still, in the case of China, the studies are sparse especially, in the context of exploring the cointegration coefficients across the quantile in short-run dynamics. So the current study is the pioneer in exploring the environmental impact of tourism on the environment by using a quantile dependent approach such as QARDL. The phenomenon is empirically analyzed and discussed in the subsequent sections.

3. Data and methodology

3.1. Data sources

To meet the objectives of the study, variables such as emissions (CE), particulate matter (PM2.5), and greenhouse gases (GHGs) with other selected variables such as economic growth (GDP), tourist arrivals (TOR), and trade openness (TOP) are involved in the empirical analysis. The data spanning the years 1995 to 2018 for China are collected from the World Development Indicators (WDI) and British Petroleum data banks. The selected variables are used in natural logs for the empirical analysis of all variables.

3.2. Descriptive statistics

Table 1 illustrates the descriptive statistics of proxies of environment pollution, i.e., CE, PM2.5, and GHGs, with other selected variables such as GDP, TOR, and TOP. Comparatively, CE and PM2.5, the mean value of GHGs is maximum, i.e., 3.24 with minimum and maximum value of 2.97 and 4.54, respectively. The mean value of GDP is 7.0, with the minimum and maximum values of 6.41 and 8.07. Lastly, the mean value of TOR and TOP are 3.98 and 5.21, respectively. Further, the findings show that the data is not normally distributed according to Jarque-Bera statistics. In this case, it is pertinent to say that using quantile estimations is the best way to deliver broad specifics compared to other conventional models of linear regression (Mishra et al., 2019; Sharif et al., 2019; Troster et al., 2018).

3.3. Quantile Autoregressive Distributed Lag approach

In the present study, an advanced approach of QARDL introduced by Cho et al. (2015) is used to assess the nonlinear association of tourist arrivals with proxy variables of environment pollution. In simple words, the QARDL framework considers tourist arrivals' long-term effect on China's environmental pollution in quantiles. The Wald test further assessed the parameters' dependability in each quantile for both long and short-term symmetries to check the robustness. Mainly, the orthodox framework of linear ARDL is structured below:

$$Z_t = \alpha + \sum_{i}^{p} \beta_1 Z_{t-1} + \sum_{i}^{q} \beta_2 X1_{t-1} + \sum_{i}^{q} \beta_3 X2_{t-1} + \sum_{i}^{q} \beta_4 X3_{t-1} + \varepsilon_t \tag{1}$$

Table 1. Descriptive statistics results.

Variables	Mean	Min.	Max.	Std. Dev.	JB Stats
CE	1.987	0.789	2.201	0.011	18.254***
PM2.5	0.513	0.321	0.803	0.120	26.058***
GHGs	3.214	2.971	4.541	0.041	19.115***
GDP	7.023	6.147	8.070	0.156	21.010***
TOR	3.984	3.018	4.368	0.881	30.517***
TOP	5.215	4.368	6.214	1.035	30.003***

Asteriks ***, ** and * represent the significance level at 1%, 5% and 10% respectively.
Source: Author Estimation.

Where Z represents the dependent variable, i.e., environment pollution in the form of CE, PM2.5, and GHGs, while X1 to X3 represents the explanatory variables that are economic growth (GDP), tourist arrivals (TOR), and trade openness (TOP), and ε_t is error term described through the bottom ground formed by Z_t, $X1_t$, $X2_t$, $X3_t$, Z_t, $X1_{t-1}$, $X2_{t-1}$, $X3_{t-1}$ and p, and q are the lags based on Schwarz Info Criterion (SIC). Additionally, Z_t, $X1_t$, $X2_t$, $X3_t$ specify the natural log series of pollution (CE, PM2.5, and GHGs), GDP, TOR, and TOP.

Further, equation one is restructured to portray a framework of quantile ARDL model in the following equation:

$$QZ_t = \alpha(\tau) + \sum_{i}^{p} \beta_1(\tau)Z_{t-1} + \sum_{i}^{q} \beta_2(\tau)X1_{t-1} + \sum_{i}^{q} \beta_3(\tau)X2_{t-1} + \sum_{i}^{q} \beta_4(\tau)X3_{t-1} + \varepsilon_t(\tau) \tag{2}$$

where, $\varepsilon_t(\tau) = Z_t - Q_{Zt}(\tau/\varepsilon_{t-1})$ and $0 > \tau < 1$ presents quantile (Kim & White, 2003).

To achieve the data estimations, the present study employs a couple of quantiles t concerning 0.05 to 0.95, as explained in detail in the results section. Additionally, considering the residuals' serial correlation, the model of quantile ARDL in equation two is reformulated below:

$$\begin{aligned} Q_{Z_t} = {} & \alpha(\tau) + Z_{t-1} + \phi 1X1_{t-1} + \omega_1 X1_{t-1} + \lambda_1 X2_{t-1} + \theta_1\ X3_{t-i} + \sum_{i}^{p} \beta_1(\tau)Z_{t-1} \\ & + \sum_{i}^{q} \beta_2(\tau)X1_{t-1} + \sum_{i}^{q} \beta_3(\tau)X2_{t-1} + \sum_{i}^{q} \beta_4(\tau)X3_{t-1} + \varepsilon_t(\tau) \end{aligned} \tag{3}$$

Likewise, equation three is further restructured (Cho et al., 2015) to exhibit quantiles ARDL model with error correction term:

$$\begin{aligned} Q_{Z_t} = {} & \alpha(\tau) + \rho(\tau)(Z_{t-i} - \phi 1(\tau)X1_{t-i} + \omega_1(\tau)X2_{t-i} + \lambda_1(\tau)X3_{t-i} + \theta_1(\tau)\ X4_{t-i}) \\ & + \sum_{i=1}^{p-1} \beta_1(\tau)Z_{t-1} + \sum_{i=0}^{q-1} \beta_2(\tau)X1_{t-1} + \sum_{i=0}^{q-i} \beta_3(\tau)X2_{t-1} + \sum_{i=0}^{q-1} \beta_4(\tau)X3_{t-1} + \varepsilon_t(\tau) + \varepsilon_t \end{aligned} \tag{4}$$

By employing the delta approach, the joint short-run impact of former pollution on recent pollution is assessed by.$\beta_* \sum_{i=1}^{p-1} \beta_1$ Yet, the joined short-run impact of the previous TOP on the current phase is calculated as $\beta_* \sum_{i=1}^{p-1} \beta_4$. Likewise, the same method for economic growth and tourist arrival is used to assess their combined short-run influence of previous and current dynamics. Finally, it is worth mentioning that the parameters' adjustment speed ρ in equation four should be negative and significant (Cho et al., 2015; Shahbaz et al., 2018). To the end, the long and short-run

Table 2. Unit root test results.

Variables	ADF (Level)	ADF (Δ)	ZA (Level)	Break Year	ZA (Δ)	Break Year
CE	0.245	−4.554***	0.661	2008 Q2	−7.318***	2010 Q1
PM2.5	−0.315	−3.991***	−0.237	2013 Q1	−8.514***	2016 Q1
GHG	−0.894	−6.331***	−0.849	2002 Q1	−5.369***	2011 Q1
GDP	−0.157	−5.871***	−1.041	2016 Q4	−9.155***	2007 Q4
TOR	−1.004	−3.324***	−0.554	2018 Q1	−7.218***	2002 Q1
TOP	−0.648	−4.744***	−0.368	2011 Q1	−6.985***	2017 Q3

Note: The significance of the ADF and ZA tests are represented by ***, **, and * at 1%, 5%, and 10% significance levels.
Source: Author Estimation.

asymmetric impact of TOR, GDP, and TOP is assessed using Wald-test to test the null and alternative hypotheses of long and short-run coefficients.

Referring to Cho et al. (2015), some constructive findings emerged after former computations, such as primarily the long and short-run parameters, indicates that parameters in quantile ARDL may vary, representing that those parameters might be affected at each period. So it is worthy of highlighting that long and short-run parameters should be assessed based on quantiles. Besides, the Wald test limits the long and short-run coefficients between and with the quantiles can be evaluated using the Wald test (Cho et al., 2015; Godil et al. 2020; Razzaq et al. 2021c).

4. Results and discussions

4.1. Unit root test

The unit root is used to check stationarity among variables. Many studies have employed this phenomenon (Aziz et al., 2021; Khan et al., 2020). Table 2 shows that the results of unit root tests such as Augmented Dickey-Fuller (ADF) and Zivot and Andrews (1992) are applied. The advantage of the ZA test is that it also considers the structural breaks present in the data. The ADF and ZA result support that variables have unit root issue. All variables become stationary after taking their first difference at a 1% significance level and portray the time series as I (1), i.e., integrated at first difference. So, in this case, the use of QARDL is an appropriate approach to be employed.

4.2. Quantile Autoregressive Distributed Lag (QARDL) results

In Tables 3–5, the outcomes of QARDL such as the parameter of error correction ($\boldsymbol{\rho}^*$), the long-run coefficient (β), short-run coefficients (φ, ω, λ, θ, $\acute{\varepsilon}$) and also their specific standard errors for all proxies of environment pollution, i.e., CE, PM2.5, and GHGs are exhibited. The results show that ρ^* is significantly negative from 0.05 to 0.70 quantiles for all the three proxies of environmental pollution (see Tables 3–5). For CE, ρ^* is negatively significant in eight quintiles out of eleven quantiles, reflecting the adjustment speed towards equilibrium in the long run. The cointegration parameter of GDP in Table 3 is significantly positive across the quantiles (0.20-0.95), reflecting an ascending pattern of association between CE and GDP at entire quantiles excluding the extreme lowest quantiles (0.05-0.10) in the long run. The increase

Table 3. Quantile Autoregressive Distributed Lag (QARDL) results for carbon emission.

Quantiles (τ)	$\alpha_*(\tau)$	$\rho_*(\tau)$	$\beta_{GDP}(\tau)$	$\beta_{GDP2}(\tau)$	$\beta_{TOR}(\tau)$	$\beta_{TOP}(\tau)$	$\varphi_1(\tau)$	$\omega_0(\tau)$	$\lambda_0(\tau)$	$\theta_0(\tau)$	$\theta_1(\tau)$	$\acute{\varepsilon}_0(\tau)$
0.05	0.010	−0.226***	0.331	−0.126***	−0.201	0.220**	0.362**	0.146*	−0.004	−0.062***	−0.020	0.082***
	(0.011)	(-4.020)	(0.010)	(-4.002)	(-1.002)	(2.010)	(6.026)	(1.864)	(-0.024)	(-5.026)	(-0.102)	(5.028)
0.10	0.102	−0.262***	0.324	−0.198***	−0.230	0.203**	0.480**	0.182*	−0.023	−0.026***	−0.013	0.022***
	(0.010)	(-5.062)	(0.004)	(-5.089)	(-1.002)	(2.002)	(2.008)	(1.698)	(-0.003)	(-4.226)	(-0.103)	(4.202)
0.20	0.012	−0.271***	0.342**	−0.121***	−0.200	0.210	0.330	0.196***	−0.027	−0.024***	−0.045	0.026**
	(0.013)	(-5.001)	(2.024)	(-4.012)	(-1.002)	(1.021)	(1.020)	(7.006)	(-0.070)	(-2.004)	(-0.054)	(2.062)
0.30	0.013	−0.278***	0.367**	−0.227**	−0.251	0.225	0.325	0.172***	−0.057	−0.076**	−0.097	0.072**
	(0.010)	(-3.001)	(2.676)	(-2.072)	(-1.015)	(1.015)	(1.015)	(4.102)	(-0.017)	(-2.006)	(-0.067)	(2.007)
0.40	0.042	−0.262***	0.353**	−0.274**	−0.234*	0.125	0.359	0.121	−0.038	−0.037	−0.079	0.033**
	(0.120)	(-3.162)	(2.035)	(-2.004)	(-1.664)	(1.012)	(1.090)	(0.101)	(0.003)	(-1.021)	(-0.070)	(2.003)
0.50	0.023	−0.252***	0.368***	−0.132	−0.257*	0.126	0.267	0.114	−0.027	−0.036	−0.072	0.032
	(0.013)	(-3.725)	(3.864)	(-1.002)	(-1.757)	(1.026)	(1.076)	(0.002)	(-0.020)	(-1.005)	(-0.012)	(1.012)
0.60	0.203	−0.221***	0.382***	−0.136	−0.243**	0.105	0.267	0.104	−0.021	−0.058	−0.046	0.011
	(0.013)	(-3.663)	(5.278)	(-1.016)	(-2.034)	(1.003)	(1.003)	(1.001)	(-0.001)	(-1.035)	(-0.103)	(1.010)
0.70	0.011	−0.232**	0.445***	−0.072	−0.263**	0.140	0.368	0.093**	−0.017	−0.030	−0.013	0.056
	(0.022)	(-2.732)	(3.055)	(-1.020)	(-2.036)	(1.102)	(1.013)	(2.039)	(-0.017)	(-1.109)	(-0.030)	(1.016)
0.80	0.0134	−0.156	0.428***	−0.163	−0.272***	0.214**	0.426*	0.061**	−0.044	−0.042	−0.037	0.068
	(0.001)	(-1.016)	(6.008)	(-1.131)	(-6.027)	(2.014)	(1.663)	(2.001)	(-0.020)	(-1.024)	(-1.103)	(1.063)
0.90	0.001	−0.167	0.422***	−0.111	−0.296***	0.224**	0.625*	0.082*	−0.017	−0.067	−0.022	0.086
	(0.101)	(-1.050)	(6.012)	(-1.101)	(-5.019)	(2.004)	(1.675)	(1.725)	(-0.010)	(-1.006)	(-1.022)	(1.046)
0.95	0.105	−0.133	0.411***	−0.110	−0.295***	0.254**	0.567*	0.068*	−0.051	−0.017	−0.075	0.050
	(0.051)	(-1.010)	(5.227)	(-1.002)	(-3.059)	(2.370)	(1.677)	(1.698)	(-0.050)	(-1.107)	(-1.005)	(1.003)

Note: The results of the quantile estimation results are reported in this table with t statistics in brackets. Asteriks ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author Estimations.

Table 4. Quantile Autoregressive Distributed Lag (QARDL) results for PM2.5.

$\alpha_*(\tau)$	$\rho_*(\tau)$	$\beta_{GDP}(\tau)$	$\beta_{GDP2}(\tau)$	$\beta_{TOR}(\tau)$	$\beta_{TOP}(\tau)$
0.024	−0.236**	0.040	−0.165***	−0.142	0.201***
(0.042)	(-3.036)	(0.020)	(-5.056)	(-1.012)	(3.010)
0.315	−0.276***	0.156	−0.184***	−0.112	0.357***
(0.051)	(-5.086)	(0.016)	(-6.046)	(-0.010)	(3.037)
0.047	−0.247***	1.230**	−0.185***	−0.231	0.327***
(0.107)	(-4.007)	(2.003)	(-4.045)	(-1.013)	(3.037)
0.169	−0.223**	1.172**	−0.137**	−0.276	0.130
(0.096)	(-2.032)	(2.027)	(-2.035)	(-1.546)	(1.013)
0.174	−0.257**	1.267**	−0.179**	−0.388*	0.146
(0.017)	(-2.035)	(2.067)	(-2.039)	(-1.788)	(1.040)
0.261	−0.243**	0.878***	−0.132	−0.353*	0.164
(0.101)	(-2.034)	(6.078)	(-1.010)	(-1.853)	(1.042)
0.368	−0.123*	0.935***	−0.053	−0.383**	0.067
(0.103)	(-1.655)	(7.035)	(-1.030)	(-2.038)	(1.013)
0.070	−0.138*	0.842***	−0.064	−0.419**	0.042
(0.011)	(-1.738)	(5.248)	(-1.043)	(-2.078)	(1.020)
0.243	−0.071	0.664***	−0.085	−0.463***	0.032
(0.023)	(-0.070)	(4.404)	(-1.013)	(-6.036)	(1.030)
0.321	−0.077	0.533***	−0.105	−0.457***	0.071
(0.102)	(-0.050)	(3.033)	(-1.005)	(-6.057)	(1.210)
0.202	−0.031	0.484***	−0.112	−0.425***	0.043
(0.020)	(-0.010)	(2.994)	(-1.121)	(-4.101)	(0.840)

Note: The results of quantile estimation are reported in the table with t-statistics in brackets. The significance level is presented by asterisks such as ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author Estimations.

of CE concerning GDP is expected and analogous to the earlier researchers such as Salahuddin et al. (2018), Al-Mulali et al. (2015a), & Shahbaz et al. (2013b). The significant positive outcome in the case of GDP is probable and parallel with the researchers who believed that increasing GDP proliferates energy consumption and subsequently leads to hazardous pollutants in the environment. It also deduces that China, a globally leading economy, relies on more energy to keep pace with the increased economic development and releases the lethal pollutants in the initial stages of development. Furthermore, the production of the goods also demands more energy and thus leads to more waning of environment quality. Udemba et al. (2019) in China also revealed the same findings in the relationship between GDP and the environment by using the CO2 proxy.

On the other hand, the negative coefficient of GDP2 from lowest to medium quantiles (0.05-0.40) endorses an EKC hypothesis between GDP2 and CE in China. Moreover, it hinges on the balance between the environmental quality and the economic growth of the country as when the economy of any country grows; the energy consumption shifts towards efficient and conventional sources of energy such as renewable energy, that limits the emissions of carbon the same way as the results of GDP2 and CE in our case portrays. The results correspond well with Sarkodie and Strezov's (2019) study, who also revealed the same findings between economic growth and environment in the case of developing countries. Another study by Usman et al. (2019) in the case of India endorsed the EKC hypothesis between economic growth and the environment. In Africa, Rafindadi and Usman et al. (2019) also endorsed the EKC in the region. Udemba et al. (2019), in the case of Indonesia, recommended that country's better economic growth leads to lesser emissions and improved environmental quality. Consequently, the increased economic growth lets economies curb

Table 5. Quantile Autoregressive Distributed Lag (QARDL) results for greenhouse gas emission.

Quantiles (τ)	$\alpha_*(\tau)$	$\rho_*(\tau)$	$\beta_{GDP}(\tau)$	$\beta_{GDP2}(\tau)$	$\beta_{TOR}(\tau)$	$\beta_{TOP}(\tau)$	$\varphi_1(\tau)$	$\omega_0(\tau)$	$\omega_1(\tau)$	$\lambda_0(\tau)$	$\theta_0(\tau)$	$\acute{\varepsilon}_0(\tau)$	$\acute{\varepsilon}_1(\tau)$
0.05	0.030	−0.148***	0.180	−0.175***	−0.134***	0.213*	0.545***	0.076*	0.043	−0.035	−0.086***	0.083***	0.051
	(0.003)	(-4.084)	(0.010)	(-6.578)	(-3.020)	(1.721)	(5.054)	(1.676)	(1.349)	(-0.053)	(-3.056)	(3.030)	(1.015)
0.10	0.204	−0.198***	0.243	−0.176***	−0.144***	0.216*	0.564***	0.083*	0.053	−0.061	−0.065***	0.071***	0.087
	(0.042)	(-6.088)	(0.011)	(-6.069)	(-3.024)	(1.810)	(6.074)	(1.683)	(1.350)	(-0.030)	(-4.156)	(3.020)	(1.067)
0.20	0.136	−0.156***	0.254**	−0.077	−0.133*	0.235*	0.528***	0.048***	0.062	−0.041	−0.085***	0.066**	0.086
	(0.010)	(-5.706)	(2.004)	(-1.077)	(-1.704)	(1.943)	(3.018)	(7.084)	(1.026)	(-0.021)	(-3.586)	(2.562)	(1.003)
0.30	0.153	−0.112***	0.162**	−0.156	−0.064	0.162	0.436***	0.067***	0.061	−0.025	−0.046**	0.053**	0.032
	(0.035)	(-3.001)	(2.002)	(-1.006)	(-0.840)	(1.212)	(3.363)	(5.067)	(1.051)	(-0.052)	(-5.046)	(2.030)	(1.024)
0.40	0.087	−0.131***	0.149**	−0.048	−0.076	0.146	0.359***	0.024	0.032	−0.034	−0.103	0.067	0.047
	(0.007)	(-3.013)	(2.049)	(-1.084)	(-1.055)	(1.026)	(3.095)	(0.040)	(0.992)	(0.020)	(-1.010)	(1.610)	(1.057)
0.50	0.245	−0.123***	0.090***	−0.120	−0.120	0.157	0.450***	0.022	0.018	−0.015	−0.035	0.023	0.013
	(0.025)	(-3.021)	(6.080)	(-1.210)	(-1.540)	(1.037)	(3.050)	(0.102)	(1.018)	(-0.050)	(-1.020)	(1.010)	(1.010)
0.60	0.156	−0.156*	0.224***	−0.124	−0.072	0.104	0.438***	0.034	0.043	−0.067	−0.068	0.041	0.054
	(0.016)	(-1.165)	(5.024)	(-1.340)	(-1.627)	(0.930)	(3.180)	(1.040)	(1.053)	(-0.076)	(-1.080)	(1.040)	(1.040)
0.70	0.117	−0.172*	0.247***	−0.147	−0.075	0.081	0.552***	0.038	0.067	−0.018	−0.065	0.016	0.012
	(0.010)	(-1.742)	(4.067)	(-1.067)	(-1.056)	(1.110)	(3.150)	(1.038)	(1.074)	(-0.018)	(-1.063)	(0.102)	(0.810)
0.80	0.357	−0.064	0.234***	−0.156	−0.132*	0.152	0.412***	0.078	0.035	−0.080	−0.041	0.042	0.063
	(0.037)	(-0.034)	(2.995)	(-1.160)	(-1.927)	(1.152)	(3.721)	(1.078)	(1.335)	(-0.040)	(-1.014)	(1.020)	(1.023)
0.90	0.214	−0.080	0.276***	−0.167	−0.166**	0.081	0.573***	0.031	0.035	−0.050	−0.056	0.034	0.032
	(0.040)	(-0.060)	(4.076)	(-1.070)	(-2.535)	(1.016)	(3.735)	(1.030)	(1.595)	(-0.102)	(-1.045)	(1.030)	(1.020)
0.95	0.301	−0.051	0.279***	−0.126	−0.220***	0.101	0.428***	0.020	0.055	−0.035	−0.023	0.035	0.052
	(0.001)	(-0.010)	(3.975)	(-1.020)	(-3.099)	(1.010)	(3.662)	(1.020)	(1.505)	(-0.030)	(-1.030)	(1.103)	(1.025)

Note: The results of quantile estimation are reported in the table with t-statistics in brackets. The significance level is presented by asterisks such as ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author Estimations.

their dependency on traditional fossil fuels and use cleaner environmental technologies. Unexpectedly, the GDP2 results turn insignificant while moving to upper quantiles and signify that the higher economic growth levels do not help the Chinese economy reduce carbon emissions. It further entails that the Chinese economy still needs to strengthen its strategies to conserve the environmental issues.

In the case of tourist arrivals, the long-run relationship of TOR is found negatively significant from medium to highest quantiles (0.40-0.95). The results align with the study of Sharif et al. (2020), who also exhibited the negative effect of tourism on CO2 emissions at higher quantiles in the case of Malaysia. It indicates that the increase of tourist arrivals and other tourism activities decreases the CE at higher quantiles. Interestingly, it is found that the tourism industry in China is increased with an average annual growth rate of approximately 21.57% from 2010 to 2016 (National Tourism Administration of the People's Republic of China, 2017). The reason for such an increase may be the subsiding air fair prices and the progress of the middle class. Generally, it is believed that the tourism sector increases the CE due to heavy reliance on energy (see Anser et al. 2020; Aziz et al. 2020b; Balsalobre-Lorente et al. 2020; de Vita et al. 2015; Fethi and Senyucel 2021; Nepal et al., 2019). But contrary to these studies, our verdict in this study reveals interesting findings that tourism development in China is not necessarily increasing pollution. It reflects the point that nowadays, China is adhering to utilize an innovative technology that ensures efficient utilization of resources, particularly energy utilization, efficiently (The Diplomat, 2018). Moreover, the analytical findings demonstrate that the tourism sector of China has the propensity to diminish environment pollution at a maximum rate as the revenue generated from tourist arrivals is used to conserve the ecosystem, so in this vein, it's pertinent to say that tourist arrivals in China can help regenerate the environment. These results are consistent with those of Katircioglu (2014), Lee and Brahmasrene (2013), Raza and Shah (2017), Ben Jebli et al. (2019), Danish (2018), and Kongbuamai et al. (2020) but contradictory to the findings of Anser et al. (2020) in Group of Seven countries, Gulistan et al. (2020) in 122 countries, Balsalobre-Lorente et al. (2020) in OECD Countries and Fethi and Senyucel (2021) in 50 tourist destinations.

Moreover, the TOP results are positively significant only at the extreme lowest and extreme highest quantiles. The CE's positive outcome reveals that an upsurge in output concerning trade contributes to carbon emissions. The trade may involve the production and transfer of goods from one country to another. The increased production of goods fuelled by excessive utilization of fossil fuels acts as a source of pollution. The studies of Kurniawan and Managi (2018), Zhang et al. (2017a, 2017b), Udeagha & Ngepah (2019) and Kwamena Tachie et al. (2020) also found that trade has noticeable unfavorable concerns for the environment. Moving towards the paradigm of short-term dynamics, the results reveal that CE's past values positively affect current values of CE at the extreme lowest (0.05-0.10) and extreme highest quantiles (0.80-0.95). The short-term dynamics further reveal that current and past changes in GDP are significant at the lower bottom (0.05-0.30) and higher bottom quantiles (0.70-0.95) of CE, and TOR is also found significant at the lowest quantiles (0.05-0.30) of CE. Unlike the long-run findings, GDP2 and TOP outcomes in the short-run are found insignificant across all quantiles of CE.

Like CE, the results in PM2.5 reveal the same findings that the ρ^* is significantly negative among quantiles (0.05-0.70), reflecting the adjustment speed to the equilibrium in the long run. The GDP coefficient is positive and highly significant across quantiles of 0.20-0.95. The level of significance increases while moving to higher quantiles while the GDP2 on the other side is highly and significantly negative at the extreme lowest quantiles, i.e., 0.05-0.40. Like CE, the positive and negative outcome of GDP and GDP2 validates the EKC hypothesis in the case of PM2.5 in China. Still, moving from medium to upper quantiles, the results turn insignificant, revealing that higher economic activities boost economic growth at the cost of environmental degradation. Shaheen et al. (2019) also confirmed an inverted U-shaped association between tourism and environment in the panel of the top 10 countries. Like CE, TOR results are also negatively significant from medium to upper extreme quantiles (0.40-0.95). The negative and significant cointegrating parameter of long-term TOR indicates the reduction of PM2.5 with increased tourist arrivals. Like Paramati et al. (2017a, b), the outcome illustrates that tourist arrivals cannot be overlooked in decreasing PM2.5. And it further reflects that the Chinese government has adopted stricter environmental regulations focused on conserving energy in freight and passenger transport, which is expected not to harm the environment with increasing tourists.

The United Nations Environment Programme also delivered the same that tourism-induced emissions can be lessened if the activities and transportation allied with tourism are escorted with eco-friendly technology. Ohlan (2017) & Işik et al. (2017) also stated that tourism is advantageous for economic growth if environment-friendly interventions regulate tourism-led emissions. In the TOP case, the long-term cointegrating parameter is found positively significant at the lowest quintiles specifying a positive association between PM2.5 and TOP in the long run in China. It shows that PM2.5 can be aggravated due to the rise in TOP as China is known to have the world's most enormous trading volume worth \$4.1 with \$2260 billion of exports (World Bank, 2018). The increased trade and resultantly increased domestic production in China intensified the scale of industries and led to pollution. The recent study of Jun et al. (2020) also showed that pollution in China increased due to trade openness, especially after 2001 when China joined WTO. After joining WTO in 2001, trade quadrupled and reached \$620.7 in 2002. Most of the quantiles are found insignificant for PM2.5, and it may be since China has adopted new technologies and high environmental standards. Some negligible environmental effects of trade are also reported by some other scholars in various countries such as Oh and Bhuyan (2018) in case of Bangladesh, Shahzad et al. (2017) in case of Pakistan, and Saidi and Mbarek (2017) in the case of 19 emerging economies. Moving towards the short-term dynamics, the findings reveal that the past values of PM2.5 have a significant and positive effect on the current PM2.5 across all quantiles. The current and past GDP changes have positive and significant effects at extreme lowest and highest quantiles, while the GDP2 is found insignificant across all quantiles. Unlike the long run, the TOR results in short-term dynamics are found insignificant across all quantiles of PM2.5, while TOP is found positively significant at upper quantiles.

In GHGs, the ρ^* at the lowest quintiles is again highly significant at a 1% significance level, while it is significant at 10% at the medium quintiles. Further, in the long run, the reversion to equilibrium is also evidenced by its negative sign across all quantiles. In Table 5, the results for economic growth display that GDP is significantly positive at the upper quintiles. But the results for GDP2 are found highly and negatively significant only at lower extreme quintiles. The findings support the EKC hypothesis that initial economic growth phases aggravate the environment by emitting pollutants in the form GHGs. Later on, the increased income can help the economy lessen environmental damage by opting for environment-friendly technologies. But in medium to higher quantiles, the results turn insignificant, which infers that economic growth does not further help the economy improve the environment quality. The TOR outcome is negatively significant, primarily at the extreme lowest and then at the highest quintiles. Like CE and PM2.5, the results suggest that the sustainable transportation policies in serving tourists in China effectively mitigate tourism-induced emissions. The results align with the findings of Zhang and Jing (2016) for China and Lee and Brahmasrene (2013) for European countries that also evidenced the same environmental consequences of tourism. Zhao and Shu-Min (2018) evidenced that a series of other measures such as green hotel programs and further green technology innovation has been implemented in China to reduce pollution (Razzaq, Wang, et al. 2021; Razzaq et al. 2021a). Moreover, improved infrastructure construction and enhanced environmental awareness concerning traffic pollution, the high energy consumption of hotels, and tourists' uncivilized behavior have discouraged combating pollution in China.

Moreover, the outcome of TOP at the lowest quintiles is found positively significant but at a 10% significance level, and after that, the results turn insignificant. The results infer that trade increases the GHGs at the lowest quantiles. The TOR proliferate the consumption of fossil fuels that is recognized as a significant contributory factor in the global environment pollution (Aziz et al. 2020c; Kurniawan and Managi 2018; Fang et al. 2018; Balin et al. 2017; Jamel and Maktouf 2017; Fernández-Amador et al. 2017; Kebede 2017). The results propose that switching to renewable energy sources can improve the environment (Koondhar et al., 2021; Si et al. 2021). But from medium to highest quantiles, the results again turn insignificant like CE and PM2.5, reflecting that trade openness is not influencing the GHGs in the long run. The short-run dynamics results reveal that past values of GHGs are positively significant on the current GHGs across all quantiles. Like other proxy variables such as CE and PM2.5, the present and past GDP changes are only significant at the lower bottom of GHGs. In contrast, the results for GDP2 are not found significant throughout the quantiles of GHGs. Unexpectedly, in the case of TOR and TOP, the results are only found significant for trade openness, and unlike the long run, the short-run reveals that trade openness helps reduce GHGs in the short run. The results of Kim et al. (2019) and Le et al. (2016) also stressed that trade openness could reduce pollution through the technique effect. In the case of China, Gordon (2012), De Sousa et al. (2015), and Xu et al. 2019 revealed that China's scientific and technological behavior does effectively play a role in environmental protection.

The Wald test has been applied to further assess the asymmetries in the relationship between exogenous variables, i.e., GDP, GDP2, TOR, TOP, with all proxies of environment pollution. Generally, the Wald test doesn't exhibit the standard

Table 6. Wald test results for the constancy of parameters.

Variables	Wald-statistics (CE)	Wald-statistics (PM2.5)	Wald-statistics (GHG)
ρ	7.123*** [0.000]	5.321*** [0.000]	19.417*** [0.000]
β_{GDP}	6.351*** [0.000]	4.951*** [0.000]	8.310*** [0.000]
β_{GDP2}	1.030 [0.162]	9.990*** [0.000]	0.750 [0.358]
β_{TOR}	5.976*** [0.000]	18.010*** [0.000]	10.417*** [0.000]
β_{TOP}	5.159*** [0.000]	3.939*** [0.000]	7.017*** [0.000]
φ_1	3.011*** [0.001]	10.498*** [0.000]	6.103*** [0.000]
ω_0	2.975*** [0.005]	2.010** [0.045]	5.020** [0.000]
ω_1	–	0.977 [0.184]	0.016 [0.999]
λ_0	6.202*** [0.000]	1.019 [0.169]	6.665*** [0.000]
θ_0	8.145*** [0.000]	5.059*** [0.000]	3.357*** [0.000]
θ_1	0.789 [0.217]	–	–
$\acute{\varepsilon}_0$	0.315 [0.999]	4.025*** [0.000]	16.215*** [0.000]
$\acute{\varepsilon}_1$	–	–	1.010 [0.172]
Cumulative short-term effect:			
ω^*	–	3.579*** [0.000]	1.110 [0.413]
θ^*	1.054 [0.345]	–	–
$\acute{\varepsilon}^*$	–	–	0.846 [0.621]

Note: Wald-test estimation results are reported in this table. Moreover, square brackets enclosed the p-values. Asterisk ***, ** and * denote the significance level at 1%, 5% and 10%, respectively.
Source: Author Estimations.

asymptotic distribution but detects the instability for both intercept and coefficients. The Wald test has the further advantage of identifying the structural changes both with known and unknown breakpoints. Table 6, the Wald test results for all types of environment pollution, suggest an asymmetric relationship between GDP, TOR, and TOP, with CE, PM2.5, and GHGs in the long run. Still, there is a symmetric relationship of GDP2 with CE and GHGs as the null hypothesis, in the long run, is rejected by the Wald test at a 1% significance level. The parameters' dependability for association in the short run is also rejected as most of the coefficients are significant for all proxies. But, shifting towards the collective effect in the short term reveals a substantial difference between all proxy variables. Referring to the collective short-term effect, the variables are not found asymmetrically related to CE and GHGs. In contrast, variables portrayed the asymmetric relationships with PM2.5 based on collective effects.

Lastly, the causality between the quantiles of key variables is detected using the Troster (2018) test. Table 7 provides the granger-causality test results in quantiles and illustrates that a uni-directional causal relationship runs from TOR to CE and PM2.5. This finding corresponds well with the previous finding of Dogan and Aslan (2017)

Table 7. Test results of granger causality in quantile.

Quantiles	[0.05-0.95]	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
ΔTOR_t to CE_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ΔCE_t to ΔTOR_t	0.489	0.485	0.480	0.480	0.487	0.492	0.510	0.486	0.489	0.489	0.490	0.490
ΔTOR_t to GHG_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ΔCE_t to ΔTOR_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ΔTOR_t to $PM2.5_t$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta PM2.5_t$ to ΔTOR_t	0.605	0.620	0.610	0.554	0.542	0.490	0.566	0.515	0.720	0.675	0.716	0.709

Null hypothesis: No Casual association exist.
Soure: Authors estimations.

that also manifested the one-way long-run causal relationship between tourism and CE. In contrast, Jebli et al. (2014) manifested the bidirectional causality between tourism and CE. In the case of GHGs, Khan et al. (2019) found a uni-directional relationship between tourism and GHGs in high-income countries. Still, our study supported a bi-directional causal association running between the TOR and GHGs in China. The overall verdicts illustrate that the Chinese government can decrease the emissions by altering the percentage of renewable sources in the energy mix and using environment-friendly vehicles and machines to entertain the bulk of tourists to sustain unpolluted and viable tourism in China.

5. Conclusions & policy implications

This study aims to empirically explore the role of tourist arrivals towards environmental pollution in China by using the recent approach of QARDL. This study is useful as it provides comprehensive explanations of the association among variables along various quantiles, which otherwise may be ignored by the traditional methods. The study further tests the EKC hypothesis in the sample country across quantiles, the quantile-level desegregation of EKCs is a new addition to the existing literature of EKC. Many recent studies have used this trend to explore the EKC hypothesis in many countries, such as Aziz et al. (2020a) in Pakistan, Arshian et al. (2020) in turkey, Norazah et al. (2020) in Malaysia, etc. Following the trend, this study also attempts to explore the quantile-dependent EKC in tourism towards the environment in China. Unlike the previous studies, the study used different proxy variables of the environment (such as CE, PM2.5, and GHGs) under the EKC framework. Using QARDL, the findings reveal that EKC is endorsed in China but only in the long run. Moreover, it is found that tourist arrivals reduce CE, PM2.5, and GHGs in the long run. In the case of short-run dynamics, tourist arrivals only reduce CE and do not reduce PM2.5 and GHGs, which means tourism helps the Chinese economy reduce only carbon emissions in the short-run dynamics.

Furthermore, the study also includes trade openness (TOP) in the model for empirical analysis. According to the results, it is found that TOP increases CE, PM2.5, and GHGs at initial quantiles in the long run, while in the case of the short run, TOP only reduces PM2.5 and GHGs that means that trade openness aggravates the pollution in the form of carbon emissions. The expected negative values of ECM across all quantiles further provide evidence of a return to equilibrium in the long run. From these results, the Chinese government in tourism uses low sustainable carbon and pollution-intensive strategies to entertain the bulk of tourists. China's tourism industry is financing in those actions that are helpful both for the industry itself and the environment. Overlooking the protection of environment, the tourism industry can be lost its prospects and the real essence of recreational purpose. Still, it is also suggested that trade transform the traditional industries engaged in trade to utilize cleaner energy sources in the production of goods and services (He et al. 2021). The recent study of Raza et al. (2021) also suggested that each nation should make an effort to improve its environmental performance and economic development. The utilization of green innovation and renewable energy is very crucial in this regard in the context of trade.

For overall sustainable development, the synchronized growth of the environment with tourism and trade is of particular importance. In this regard, the government should establish new technologies to improve China's environmental condition and maintain the global environment. Our results in the case of tourism are quite interesting, which yield that although China already takes several concrete countermeasures in the tourism sector such as the expansion of bio-energy, energy-saving vehicles for transport, implementation of pollution tax, green innovation technology, etc., these countermeasures should be continued sustainably in future too. Concurrently, it is also necessary to emphasize the present trade allied environmental concerns; if necessary, significant laws and rules should be enacted to balance adverse impacts of environment ensuing from increasing trade. Particular attention needs to be paid to use clean technologies in the production of goods and services. The trade sector should design low-carbon trade products and technology through research and development. Conclusively, the impact of the factors escalating the severity of pollution in China is thought-provoking and requires considerable government commitment and solemnity. To sum up, considering the increasing influence of the tourism and trade sector on the environment, the Chinese government must promptly implement appropriate strategies to help develop a sustainable tourism and trade sector. Future studies can expand the same at other regions to draw the heterogenous effects across developed and developed countries.

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References

Ahmad, F., Draz, M., Su, L., Ozturk, I., & Rauf, A. (2018). Tourism and environmental pollution: Evidence from the one belt one road provinces of Western China. *Sustainability*, *10*(10), 3520–3522. https://doi.org/10.3390/su10103520

Allison, I., Bindoff, N. L., Bindschadler, R. A., Cox, P. M., De Noblet, N., England, M. H., Francis, J. E., Gruber, N., Haywood, A. M., Karoly, D. J., Kaser, G., Le Quéré, C., Lenton, T. M., Mann, M. E., McNeil, B. I., Pitman, A. J., Rahmstorf, S., Rignot, E., Schellnhuber, H. J., Schneider, S. H., … & Weaver, A. J. (2009). *The copenhagen diagnosis. Updating the World on the Latest Climate Science*. Sidney: The University of New South Wales Climate Change Research Centre.

Al-Mulali, U., Weng-Wai, C., Sheau-Ting, L., & Mohammed, A. H. (2015). Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. *Ecological Indicators*, *48*, 315–323. https://doi.org/10.1016/j.ecolind.2014.08.029

An, H., Razzaq, A., Haseeb, M., & Mihardjo, L. W. (2021). The role of technology innovation and people's connectivity in testing environmental Kuznets curve and pollution heaven hypotheses across the Belt and Road host countries: New evidence from Method of Moments Quantile Regression. *Environmental Science and Pollution Research International*, *28*(5), 5254–5270.

An, H., Razzaq, A., Nawaz, A., Noman, S. M., & Khan, S. A. R. (2021a). Nexus between green logistic operations and triple bottom line: Evidence from infrastructure-led Chinese outward foreign direct investment in Belt and Road host countries. *Environmental Science and Pollution Research International*, *28*(37), 51022–51024. https://doi.org/10.1007/s11356-021-12470-3

Anser, M. K., Yousaf, Z., Nassani, A. A., Abro, M. M. Q., & Zaman, K. (2020). International tourism, social distribution, and environmental Kuznets curve: Evidence from a panel of G-7 countries. *Environmental Science and Pollution Research International*, *27*(3), 2707–2720. https://doi.org/10.1007/s11356-019-07196-2

Anwar, A., Siddique, M., Dogan, E., & Sharif, A. (2021). The moderating role of renewable and non-renewable energy in environment-income nexus for ASEAN countries: Evidence from Method of Moments Quantile Regression. *Renewable Energy*, *164*, 956–967. https://doi.org/10.1016/j.renene.2020.09.128

Azam, M., Mahmudul Alam, M., & Haroon Hafeez, M. (2018). Effect of tourism on environmental pollution: Further evidence from Malaysia, Singapore and Thailand. *Journal of Cleaner Production*, *190*, 330–338. https://doi.org/10.1016/j.jclepro.2018.04.168

Azarmi, S. L., Vaziri, R., Kole, A., Oladipo, A. A., & Göksel, A. B. (2019). *Chapter: Environmental impact of the ugly face of tourism, The Routledge Handbook of Tourism Impacts* (1st ed.). Oxfordshire, UK: Routledge.

Aziz, N., He, J., Raza, A., Sui, H., & Yue, W. (2021). Elucidating the macroeconomic determinants of undernourishment in South Asian countries: Building the framework for action. *Frontiers in Public Health*, *9*, 696789 https://doi.org/10.3389/fpubh.2021.696789

Aziz, N., Mihardjo, L. W. W., Sharif, A., & Jermsittiparsert, K. (2020b). The role of tourism and renewable energy in testing the environmental Kuznets curve in the BRICS countries: Fresh evidence from methods of moments quantile regression. *Environmental Science and Pollution Research International*, *27*(31), 39427–39441. https://doi.org/10.1007/s11356-020-10011-y

Aziz, N., Sharif, A., Raza, A., & Jermsittiparsert, K. (2020c). The role of natural resources, globalization, and renewable energy in testing the EKC hypothesis in MINT countries: New evidence from Method of Moments Quantile Regression approach. *Environmental Science and Pollution Research*, *28*(11), 13454–13468. https://doi.org/10.1007/s11356-020-11540-2

Aziz, N., Sharif, A., Raza, A., & Rong, K. (2020a). Revisiting the role of forestry, agriculture, and renewable energy in testing environment Kuznets curve in Pakistan: Evidence from Quantile ARDL approach. *Environmental Science and Pollution Research International*, *27*(9), 10115–10128. https://doi.org/10.1007/s11356-020-07798-1

Balin, B. E., Akan, H. D. M., & Altayligil, Y. B. (2017). *Trade liberalization and environmental degradation: A time series analysis for Turkey* [Paper presentation]. Paper Prepared for the 19th Annual Conference of ETSG.

Balsalobre-Lorente, D., Driha, O. M., Shahbaz, M., & Sinha, A. (2020). The effects of tourism and globalization over environmental degradation in developed countries. *Environmental Science and Pollution Research*, *27*(7), 7130–7144. https://doi.org/10.1007/s11356-019-07372-4

Becken, S. (2013). A review of tourism and climate change as an evolving knowledge domain. *Tourism Management Perspectives*, *6*, 53–62. https://www.researchgate.net/publication/257743466_A_review_of_tourism_and_climate_change_as_an_evolving_knowledge_domain https://doi.org/10.1016/j.tmp.2012.11.006

Bekun, F. V., Alola, A. A., & Sarkodie, S. A. (2019). Toward a sustainable environment: Nexus between CO2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries. *The Science of the Total Environment*, *657*, 1023–1029. https://doi.org/10.1016/j.scitotenv.2018.12.104

Ben Jebli, M., Ben Youssef, S., & Apergis, N. (2019). The dynamic linkage between renewable energy, tourism, CO 2 emissions, economic growth, foreign direct investment, and trade. *Latin American Economic Review*, *28*(1), 1–19. https://doi.org/10.1186/s40503-019-0063-7

Chien, F., Anwar, A., Hsu, C. C., Sharif, A., Razzaq, A., & Sinha, A. (2021). The role of information and communication technology in encountering environmental degradation: Proposing an SDG framework for the BRICS countries. *Technology in Society*, *65*, 101587. https://doi.org/10.1016/j.techsoc.2021.101587

Cho, J. S., Kim, T. H., & Shin, Y. (2015). Quantile cointegration in the autoregressive distributed-lag modeling framework. *Journal of Econometrics*, *188*(1), 281–300. https://doi.org/10.1016/j.jeconom.2015.05.003

Danish & Wang, Z. (2018) Dynamic relationship between tourism, economic growth, and environmental quality. *Journal of Sustainable Tourism*, *26*(11), 1928–1943. https://doi.org/10.1080/09669582.2018.1526293

Davies, T., & Cahill, S. (2000). Environmental implications of the tourism industry. Discussion Paper.

de Sousa, J., Laura, H., & Sandra, P. (2015). Has trade openness reduced pollution in China? CEPII Working Paper.

de Vita, G., Katircioglu, S., Altinay, L., Fethi, S., & Mercan, M. (2015). Revisiting the environmental Kuznets curve hypothesis in a tourism development context. *Environmental Science and Pollution Research International*, *22*(21), 16652–16663. https://doi.org/10.1007/s11356-015-4861-4

Dogan, E., & Aslan, A. (2017). Exploring the relationship among CO2 emissions, real GDP, energy consumption and tourism in the EU and candidate countries: Evidence from panel models robust to heterogeneity and cross-sectional dependence. *Renewable and Sustainable Energy Reviews*, *77*, 239–245. https://doi.org/10.1016/j.rser.2017.03.111

Fang, Z., Huang, B., & Yang, Z. (2018). *Trade openness and the environmental Kuznets Curve: Evidence from Cities in the People's Republic of China* (Working Paper No. 882). Asian Development Bank Institute. https://www.adb.org/sites/default/files/publication/464116/adbi-wp882.pdf

Farid, S. M. (2015). Tourism management in world heritage sites and its impact on economic development in Mali and Ethiopia. *Procedia - Social and Behavioral Sciences*, *211*, 595–604. https://www.sciencedirect.com/science/article/pii/S187704281505418X https://doi.org/10.1016/j.sbspro.2015.11.078

Fernández-Amador, O., Francois, J. F., Oberdabernig, D. A., & Tomberger, P. (2017). Carbon dioxide emissions and economic growth: An assessment based on production and consumption emission inventories. *Ecological Economics*, *135*, 269–279. https://doi.org/10.1016/j.ecolecon.2017.01.004

Fethi, S., & Senyucel, E. (2021). The role of tourism development on CO2 emission reduction in an extended version of the environmental Kuznets curve: Evidence from top 50 tourist destination countries. *Environment, Development and Sustainability*, *23*(2), 1499–1524. https://doi.org/10.1007/s10668-020-00633-0

Godil, D. I., Sarwat, S., Sharif, A., & Jermsittiparsert, K. (2020). How oil prices, gold prices, uncertainty and risk impact Islamic and conventional stocks? Empirical evidence from QARDL technique. *Resources Policy*, *66*, 101638. https://doi.org/10.1016/j.resourpol.2020.101638

Goh, C. (2012). Tourism demand has been extensively studied by tourism economists under the economic framework. Exploring impact of climate on tourism demand. *Annals of Tourism Research*, *39*(4), 1859–1883. https://www.sciencedirect.com/science/article/pii/S0160738312000837 https://doi.org/10.1016/j.annals.2012.05.027

Gordon, R. (2012). The environmental implications of China's engagement with Sub- Saharan Africa. *Envtl. L. Rep. News & Analysis*, *42*, 11109. https://doi.org/10.1016/J.RSER.2017.06.009

Gössling, S., & Hall, C. M. (2006). Uncertainties in predicting tourist flows under scenarios of climate change. *Climatic Change*, *79*(3–4), 163–173. https://doi.org/10.1007/s10584-006-9081-y

Gulistan, A., Tariq, Y. B., & Bashir, M. F. (2020). Dynamic relationship among economic growth, energy, trade openness, tourism, and environmental degradation: Fresh global evidence. *Environmental Science and Pollution Research International*, *27*(12), 13477–13487. https://doi.org/10.1007/s11356-020-07875-5

He, X., Mishra, S., Aman, A., Shahbaz, M., Razzaq, A., & Sharif, A. (2021). The linkage between clean energy stocks and the fluctuations in oil price and financial stress in the US and Europe? Evidence from QARDL approach. *Resources Policy*, *72*, 102021. https://doi.org/10.1016/j.resourpol.2021.102021

Higham, J. E., & Cohen, S. A. (2011). Canary in the coalmine: Norwegian attitudes towards climate change and extreme long-haul air travel to Aotearoa/New Zealand. *Tourism Management*, *32*(1), 98–105.

Işik, C., Kasımatı, E., & Ongan, S. (2017). Analyzing the causalities between economic growth, financial development, international trade, tourism expenditure and/on the CO2 emissions in Greece. *Energy Sources, Part B: Economics, Planning, and Policy*, *12*(7), 665–673. https://doi.org/10.1080/15567249.2016.1263251

Jamel, L., & Maktouf, S. (2017). The nexus between economic growth, financial development, trade openness, and CO2 emissions in European countries. *Cogent Economics & Finance*, *5*(1), 1341456. https://doi.org/10.1080/23322039.2017.1341456

Jebli, M. B., Youssef, S. B., & Apergis, N. (2014). *The dynamic linkage between CO2 emissions, economic growth, renewable energy consumption, number of tourist arrivals and trade*. MPRA Paper No. 57261, Munich Personal RePEc Archive.

Jiang, W., Zhu, L., Li, J., & Deng, W. (1996). Study on the effect of tourism on the ecological environment of mountain and protective strategy. *Chinese Journal of Environment Science*, *17*, 48–51.

Jun, W., Hamid, M., & Muhammad, Z. (2020). Impact of trade openness on environment in China. *Journal of Business Economics and Management*, *21*(4), 1185–1202. https://doi.org/10.3846/jbem.2020.12050

Katircioglu, S. T. (2014). International tourism, energy consumption, andenvironmental pollution: The case of Turkey. *Renewable and Sustainable Energy Reviews*, *36*, 180–187. https://doi.org/10.1016/j.rser.2014.04.058

Kebede, S. (2017). *Modeling energy consumption, CO2 emissions and economic growth nexus in Ethiopia: Evidence fromARDL approach to cointegration and causality analysis*. Munich Personal RePEc Archive (MPRA) Paper No. 83214.

Khan, M. T. I., Muhammad, R. Y., & Qamar, A. (2019). Nexus between financial development, tourism, renewable energy, and greenhouse gas emission in high-income countries: A continent-wise analysis. *Energy Economics*, *83*(2019), 293–310. https://doi.org/10.1016/j.eneco.2019.07.018

Khan, S. A. R., Razzaq, A., Yu, Z., & Miller, S. (2021). Industry 4.0 and circular economy practices: A new era business strategies for environmental sustainability. *Business Strategy and the Environment*. https://onlinelibrary.wiley.com/doi/abs/10.1002/bse.2853

Khan, Z. A., Koondhar, M. A., Aziz, N., Ali, U., & Tianjun, L. (2020). Revisiting the effects of relevant factors on Pakistan's agricultural products export. *Agricultural Economics (Zemědělská Ekonomika)*, *66*(12), 527–541. https://doi.org/10.17221/252/2020-AGRICECON

Kim, D. H., Suen, Y. B., & Lin, S. C. (2019). Carbon dioxide emissions and trade: Evidence from disaggregate trade data. *Energy Economics*, *78*, 13–28. https://doi.org/10.1016/j.eneco.2018.08.019

Kim, T. H., & White, H. (2003). *Estimation, inference, and specification testing for possibly misspecified quantile regression*. Emerald Group Publishing Limited.

Kongbuamai, N., Bui, Q., Yousaf, H. M. A. U., & Liu, Y. (2020). The impact of tourism and natural resources on the ecological footprint: A case study of ASEAN countries. *Environmental Science and Pollution Research International*, *27*(16), 19251–19264. https://doi.org/10.1007/s11356-020-08582-x

Koondhar, A. K., Aziz, N., Tan, Z., Yang, S., Abbasi, K. R., & Kong, R. (2021). Green growth of cereal food production under the constraints of agricultural carbon emissions: A new insights from ARDL and VECM models. *Sustainable Energy Technologies and Assessments*, *47*(2021), 101452. https://doi.org/10.1016/j.seta.2021.101452

Kopsch, F. (2012). A demand model for domestic air travel in Sweden. *Journal of Air Transport Management*, *20*, 46–48.

Kurniawan, R., & Managi, S. (2018). Coal consumption, urbanization, and trade openness linkage in Indonesia. *Energy Policy*, *121*, 576–583. https://doi.org/10.1016/j.enpol.2018.07.023

Kwamena Tachie, Long, X., & Lamini, D., Claudia, N. M., Florence, A. T., & Isaac, A. M. (2020). The influence of trade openness on environmental pollution in EU-18 countries. *Environmental Science and Pollution Research International*, *27*(28), 35535–35555. https://doi.org/10.1007/s11356-020-09718-9

Le, T. H., Chang, Y., & Park, D. (2016). Trade openness and environmental quality: International evidence. *Energy Policy*, *92*, 45–55. https://doi.org/10.1016/j.enpol.2016.01.030

Lee, C. C., & Chang, C. P. (2008). Tourism development and economic growth: A closer look at panels. *Tourism Management*, *29*(1), 180–192. https://doi.org/10.1016/j.tourman.2007.02.013

Lee, J. W., & Brahmasrene, T. (2013). Investigating the influence of tourism on economic growth and carbon emissions: Evidence from panel analysis of the European Union. *Tourism Management*, *38*, 69–76. https://doi.org/10.1016/j.tourman.2013.02.016

Ling, G., Razzaq, A., Guo, Y., Fatima, T., & Shahzad, F. (2021). Asymmetric and time-varying linkages between carbon emissions, globalization, natural resources and financial development in China. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-021-01724-2

Lingyan, M., Zhao, Z., Malik, H. A., Razzaq, A., An, H., & Hassan, M. (2021). Asymmetric impact of fiscal decentralization and environmental innovation on carbon emissions: Evidence from highly decentralized countries. *Energy & Environment*. https://doi.org/10.1177/0958305X211018453

Lv, L. (2003). Negative influence of tour to environment. *Heilongjiang Environmental Journal*, *27*, 69–70.

McKercher, B., Okumus, F., & Okumus, B. (2008). Food tourism as a viable market segment: it's all how you cook the numbers!. *Journal of travel & tourism marketing*, *25*(2), 137–148.

Mikayilov, J. I., Mukhtarov, S., Mammadov, J., & Azizov, M. (2019). Re-evaluating the environmental impacts of tourism: Does EKC exist? *Environmental Science and Pollution Research International*, *26*(19), 19389–19402. https://doi.org/10.1007/s11356-019-05269-w

Mishra, S., Sharif, A., Khuntia, S., Meo, S. A., & Khan, S. A. R. (2019). Does oil prices impede Islamic stock indices? Fresh insights from wavelet-based quantile-on-quantile approach. *Resources Policy*, *62*, 292–304. https://doi.org/10.1016/j.resourpol.2019.04.005

National Tourism Administration of the People's Republic of China. (2017). *China tourism statistics bulletin in 2016*. http://www.cnta.gov.cn/zwgk/lysj/201711/t20171108_846343.shtml

Nepal, R., Al Irsyad, M. I., & Nepal, S. K. (2019). Tourist arrivals, energy consumption and pollutant emissions in a developing economy implications for sustainable tourism. *Tourism Management*, *72*, 145–154. https://doi.org/10.1016/j.tourman.2018.08.025

Norazah, M. S., Arshian, S., Sahar, A., & Norbayah, M. S. (2020). Revisiting the Environmental Kuznets Curve in Malaysia: The role of globalization in sustainable environment. *Journal of Cleaner Production*, *264*(2020), 121669.
Oh, K. Y., & Bhuyan, M. I. (2018). Trade openness and CO 2 emissions: Evidence of Bangladesh. *Asian Journal of Atmospheric Environment*, *12*(1), 30–36. https://doi.org/10.5572/ajae.2018.12.1.030
Ohlan, R. (2017). The relationship between tourism, financial development and economic growth in India. *Future Business Journal*, *3*(1), 9–22. https://doi.org/10.1016/j.fbj.2017.01.003
Ozturk, I., Al-Mulali, U., & Saboori, B. (2016). Investigating the environmental Kuznets curve hypothesis: The role of tourism and ecological footprint. *Environmental Science and Pollution Research International*, *23*(2), 1916–1928. https://doi.org/10.1007/s11356-015-5447-x
Paramati, S. R., Alam, M. S., & Chen, C. F. (2017a). The effects of tourism on economic growth and CO2 emissions: A comparison between developed and developing economies. *Journal of Travel Research*, *56*(6), 712–724. https://doi.org/10.1177/0047287516667848
Paramati, S. R., Shahbaz, M., & Alam, M. S. (2017b). Does tourism degrade environmental quality? A comparative study of eastern and Western European Union. *Transportation Research Part D: Transport and Environment*, *50*, 1–13. https://doi.org/10.1016/j.trd.2016.10.034
Rafindadi, A. A., & Usman, O. (2019). Globalization, energy use, and environmental degradation in South Africa: Startling empirical evidence from the Maki-cointegration test. *Journal of Environmental Management*, *244*, 265–275. https://doi.org/10.1016/j.jenvman.2019.05.048
Rath, N., & Gupta, R. (2017). Environmental impact of tourism. *IJARIIE-ISSN(O)*, *2*(3), 2395–4396. https://ijariie.com/AdminUploadPdf/ENVIRONMENTAL_IMPACT_OF_TOURISM_1436.pdf
Raza, A., Sui, H., Jermsittiparsert, K., Żukiewicz-Sobczak, W., & Sobczak, P. (2021). Trade liberalization and environmental performance index: Mediation role of climate change performance and greenfield investment. *Sustainability*, *13*(17), 9734. https://doi.org/10.3390/su13179734
Raza, S. A., & Shah, N. (2017). Tourism growth and income inequality: Does Kuznets curve hypothesis exist in top tourist arrival countries. *Asia Pacific Journal of Tourism Research*, *22*(8), 874–884. https://doi.org/10.1080/10941665.2017.1343742
Razzaq, A., Ajaz, T., Li, J. C., Irfan, M., & Suksatan, W. (2021a). Investigating the asymmetric linkages between infrastructure development, green innovation, and consumption-based material footprint: Novel empirical estimations from highly resource-consuming economies. *Resources Policy*, *74*, 102302. https://doi.org/10.1016/j.resourpol.2021.102302
Razzaq, A., An, H., & Delpachitra, S. (2021d). Does technology gap increase FDI spillovers on productivity growth? Evidence from Chinese outward FDI in Belt and Road host countries. *Technological Forecasting and Social Change*, *172*, 121050. https://doi.org/10.1016/j.techfore.2021.121050
Razzaq, A., Sharif, A., Ahmad, P., & Jermsittiparsert, K. (2021c). Asymmetric role of tourism development and technology innovation on carbon dioxide emission reduction in the Chinese economy: Fresh insights from QARDL approach. *Sustainable Development*, *29*(1), 176–193. https://doi.org/10.1002/sd.2139
Razzaq, A., Sharif, A., Najmi, A., Tseng, M. L., & Lim, M. K. (2021b). Dynamic and causality interrelationships from municipal solid waste recycling to economic growth, carbon emissions and energy efficiency using a novel bootstrapping Autoregressive Distributed Lag. *Resources, Conservation and Recycling*, *166*, 105372. https://doi.org/10.1016/j.resconrec.2020.105372
Razzaq, A., Wang, Y., Chupradit, S., Suksatan, W., & Shahzad, F. (2021). Asymmetric interlinkages between green technology innovation and consumption-based carbon emissions in BRICS countries using quantile-on-quantile framework. *Technology in Society*, *66*, 101656. https://doi.org/10.1016/j.techsoc.2021.101656
Saidi, K., & Mbarek, M. B. (2017). The impact of income, trade, urbanization, and financial development on CO2 emissions in 19 emerging economies. *Environmental Science and*

Pollution Research International, *24*(14), 12748–12757. https://doi.org/10.1007/s11356-016-6303-3

Salahuddin, M., Alam, K., Ozturk, I., & Sohag, K. (2018). The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO2 emissions in Kuwait. *Renewable and Sustainable Energy Reviews*, *81*, 2002–2010. https://doi.org/10.1016/j.rser.2017.06.009

Sarkodie, S. A., & Strezov, V. (2018). Empirical study of the environmental Kuznets curve and environmental sustainability curve hypothesis for Australia, China, Ghana and USA. *Journal of Cleaner Production*, *201*, 98–110. https://doi.org/10.1016/j.jclepro.2018.08.039

Sarkodie, S. A., & Strezov, V. (2019). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *The Science of the Total Environment*, *646*, 862–871. https://doi.org/10.1016/j.scitotenv.2018.07.365

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. *Renewable and Sustainable Energy Reviews*, *25*, 109–121. https://doi.org/10.1016/j.rser.2013.04.009

Shahbaz, M., Lahiani, A., Abosedra, S., & Hammoudeh, S. (2018). The role of globalization in energy consumption: A quantile cointegrating regression approach. *Energy Economics*, *71*, 161–170. https://doi.org/10.1016/j.eneco.2018.02.009

Shaheen, K., Zaman, K., Batool, R., Khurshid, M. A., Aamir, A., Shoukry, A. M., Sharkawy, M. A., Aldeek, F., Khader, J., & Gani, S. (2019). Dynamic linkages between tourism, energy, environment, and economic growth: Evidence from top 10 tourism-induced countries. *Environmental Science and Pollution Research International*, *26*(30), 31273–31283. https://doi.org/10.1007/s11356-019-06252-1

Shahzad, S. J. H., Kumar, R. R., Zakaria, M., & Hurr, M. (2017). Carbon emission, energy consumption, trade openness and financial development in Pakistan: A revisit. *Renewable and Sustainable Energy Reviews*, *70*, 185–192. https://doi.org/10.1016/j.rser.2016.11.042

Sharif, A., Baris-Tuzemen, O., Uzuner, G., Ozturk, I., & Sinha, A. (2020). Revisiting the role of renewable and non-renewable energy consumption on Turkey's ecological footprint: Evidence from Quantile ARDL approach. *Sustainable Cities and Society*, *57*, 102138.

Sharif, A., Raza, S. A., Ozturk, I., & Afshan, S. (2019). The dynamic relationship of renewable and nonrenewable energy consumption with carbon emission: A global study with the application of heterogeneous panel estimations. *Renewable Energy*, *133*, 685–691. https://doi.org/10.1016/j.renene.2018.10.052

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In W. Horrace, & R. Sickles (Eds.), *The Festschrift in Honor of Peter Schmidt.: Econometric Methods and Applications* (pp. 281–314). New York, NY, USA: Springer.

Si, R., Aziz, N., & Raza, A. (2021). Short and long-run causal effects of agriculture, forestry, and other land use on greenhouse gas emissions: Evidence from China using VECM approach. *Environmental Science and Pollution Research*, *28*, 64419–64430. https://doi.org/10.1007/s11356-021-15474-1

Sinha, A., & Shahbaz, M. (2018). Estimation of environmental Kuznets curve for CO2 emission: Role of renewable energy generation in India. *Renewable Energy*, *119*, 703–711. https://doi.org/10.1016/j.renene.2017.12.058

Song, H., Dwyer, L., Li, G., & Cao, Z. (2012). Tourism economics research: A review and assessment. *Annals of tourism research*, *39*(3), 1653–1682.

Song, H., Gao, B. Z., & Lin, V. S. (2013). Combining statistical and judgmental forecasts via a web-based tourism demand forecasting system. *International Journal of Forecasting*, *29*(2), 295–310. https://www.sciencedirect.com/science/article/pii/S0169207012000064 https://doi.org/10.1016/j.ijforecast.2011.12.003

Song, H., Wong, K. K., & Chon, K. K. (2003). Modelling and forecasting the demand for Hong Kong tourism. *International Journal of Hospitality Management*, *22*(4), 435-451.

Suki, N. M., Sharif, A., Afshan, S., & Suki, N. M. (2020). Revisiting the environmental Kuznets Curve in Malaysia: the role of globalization in sustainable environment. *Journal of Cleaner Production*, *264*, 121669.

Sunlu, U. (2003). *Environmental impacts of tourism*. https://www.researchgate.net/publication/275349611_Environmental_impacts_of_tourism

The Diplomat. (2018). *China's empty promises of green energy for Africa* [WWW document]. https://thediplomat.com/2018/09/chinas-empty-promises-of-green-energy-for-africa/.

Troster, V., Shahbaz, M., & Uddin, G. S. (2018). Renewable energy, oil prices, and economic activity: A Granger-causality in quantiles analysis. *Energy Economics*, *70*, 440–452. https://doi.org/10.1016/j.eneco.2018.01.029

Udeagha, M. C., & Ngepah, N. (2019). Revisiting trade and environment nexus in South Africa: Fresh evidence from new measure. *Environmental Science and Pollution Research International*, *26*(28), 29283–29306. https://doi.org/10.1007/s11356-019-05944-y

Udemba, E. N., Güngör, H., & Bekun, F. V. (2019). Environmental implication of offshore economic activities in Indonesia: A dual analyses of cointegration and causality. *Environmental Science and Pollution Research International*, *26*(31), 32460–32475. https://doi.org/10.1007/s11356-019-06352-y

United Nations Environment Programme and World Travel & Tourism Council. (2021). *Rethinking single-use plastic products in travel & tourism - impacts, management practices and recommendations*.

United Nations General Assembly. (2015). *Transforming our world: The 2030 agenda for sustainable development*. https://sustainabledevelopment.un.org/post2015/transformingourworld

Usman, O., Iorember, P. T., & Olanipekun, I. O. (2019). Revisiting the environmental Kuznets curve (EKC) hypothesis in India: The effects of energy consumption and democracy. *Environmental Science and Pollution Research International*, *26*(13), 13390–13400. https://doi.org/10.1007/s11356-019-04696-z

Weaver, D. (2011). Can sustainable tourism survive climate change? *Journal of Sustainable Tourism*, *19*(1), 5–15. https://www.tandfonline.com/doi/full/10.1080/09669582.2010.536242 https://doi.org/10.1080/09669582.2010.536242

Weaver, D. B. (2012). Organic, incremental and induced paths to sustainable mass tourism convergence. *Tourism Management*, *33*(5), 1030–1037.

Wen, C., Yang, G., & Wang, H. (2003). Environmental effects of ecotourism in Shangri La ecotourism demonstration region, northwestern Yunnan. *Journal of Agro Environmental Science*, *22*, 82–85. (in Chinese)

World Bank. (2016). *International bank for reconstruction and development*. https://documents1.worldbank.org/curated/en/524541503688261330/pdf/106504-REVISED-ADD-SERIES-NO-4-PUBLIC-P154324-Tourismbackgroundfinal.pdf

World Bank. (2018). *World development report*. https://www.worldbank.org/en/publication/wdr2018

World Tourism Organization. (2015). *UNWTO annual report 2014*, UNWTO.

World Travel and Tourism Council (WTTC). (2014). *Economic impact reports*. https://wttc.org/Research/Economic-Impact

Xiao, Z. (2009). Quantile cointegrating regression. *Journal of econometrics*, *150*(2), 248–260.

Xie, C., & Zheng, X. (2001). An analysis of the destruction to the tourist ecosystem by holiday tour peaks and its countermeasure. *Tourism Science*, *3*, 33–35. (in Chinese)

Xu, S.-C., Miao, Y.-M., Gao, C., Long, R.-Y., Chen, H., Zhao, B., & Wang, S.-X. (2019). Regional differences in impacts of economic growth and urbanization on air pollutants in China based on provincial panel estimation. *Journal of Cleaner Production*, *208*, 340–352. https://doi.org/10.1016/j.jclepro.2018.10.114

Yeoman, I., Lennon, J. J., Blake, A., Galt, M., Greenwood, C., & Beattie, U. M. (2007). Oil depletion: What does this mean for Scottish tourism? *Tourism Management*, *28*(5), 1354–1365. https://doi.org/10.1016/j.tourman.2006.09.014

Zhang, L., & Jing, G. (2016). Exploring the effects of international tourism on China's economic growth, energy consumption and environmental pollution: Evidence from a regional panel analysis. *Renewable and Sustainable Energy Reviews*, *53*(2016), 225–234. https://doi.org/10.1016/j.rser.2015.08.040

Zhang, Q., Yang, J., Sun, Z., & Wu, F. (2017a). Analyzing the impact factors of energy-related CO2 emissions in China: What can spatial panel regressions tell us? *Journal of Cleaner Production*, *161*, 1085–1093. https://doi.org/10.1016/j.jclepro.2017.05.071

Zhang, S., & Liu, X. (2019). The roles of international tourism and renewable energy in environment: New evidence from Asian countries. *Renewable Energy*, *139*, 385–394. https://doi.org/10.1016/j.renene.2019.02.046

Zhang, S., Liu, X., & Bae, J. (2017b). Does trade openness affect CO2 emissions: Evidence from ten newly industrialized countries? *Environmental Science and Pollution Research International*, *24*(21), 17616–17625. https://doi.org/10.1007/s11356-017-9392-8

Zhao, J., & Shu-Min, L. (2018). The Impact of tourism development on the environment in China. *Acta Scientifica Malaysia*, *2*(1), 1–4. https://doi.org/10.26480/asm.01.2018.01.04

Zivot, E., & Andrews, D. W. K. (1992). Further evidence on the great crash, the oil price shock, and the unit root hypothesis. *Journal of Business & Economic Statistics*, *10*(3), 251–270. https://doi.org/10.2307/1391541