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Analyzing the linkages of rural tourism, GDP, energy utilization, and environment: Exploring a sustainable path for China

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A R T I C L E I N F O

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A B S T R A C T

Rural tourism spurs economic growth and jobs but harms the Environment due to energy demands. The study accounts for energy use, globalization, and economic growth to assess and mitigate rural tourism's environmental impact. For data covering 2001Q1 to 2019Q4, GMM approaches are utilized to analyze the environmental implications of rural tourist enterprises. The findings suggest that rural tourism-related catering services increased substantial and positive overall environmental quality, except N2O. However, food and beverage services negatively influence greenhouse gas emissions and only PM2.5 in air pollution. Sightseeing hurts greenhouse gas emissions while having a positive impact on air pollution. Furthermore, traveling has a considerable negative influence on CO emissions in air pollutants. Energy use only has a substantial influence on CO_2 and CO, but GDP has a negative impact on N2O emissions. Globalization has a negative impact on CO_2 and air pollutants other than PM2.5. Catering services associated with rural tourism positively affect overall environmental quality, excluding N2O emissions. Rural tourism's food and beverage services harm greenhouse gas emissions (including CO_2) and air pollution (particularly PM2.5). Traveling has a significant negative impact on CO emissions, but sightseeing has a dual impact, both negative on greenhouse gas emissions and positive influence on air pollution. Furthermore, shopping and leisure have little impact on overall environmental quality in China. The crucial efforts' policy ramifications are addressed as well.

1. Introduction

In light of growing environmental concerns and an urgent worldwide need for sustainable solutions, this study tries to disentangle the complex link between rural tourism, energy consumption, economic development, and environmental quality in China. The rapid development of the rural tourist sector has accelerated economic progress and job creation, but it has also created considerable environmental issues owing to increased energy needs [1]. This research intends to give an in-depth study of how the rural tourist industry affects energy consumption, economic output, and environmental quality. The goal is to propose evidence-based methods and policy suggestions that pave the way for a more sustainable cohabitation of tourism-driven economic development and environmental conservation by exploring the subtle interaction of these elements.

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According to Ref. [2], rural tourism can be perceived as a phenomenon that arises from the desire to evade the urban setting and the necessity to reaffirm individual identities in response to increasing urbanization. According to some authors, a cluster of commercial enterprises generates revenue through the provision of commodities and amenities to visitors. So, in economic terms, RT may be considered business activities arranged by the tourism industry [3]. According to the China Bureau of Statistics, China received 144.9 million foreign tourists in 2019 [4]. China's tourism industry business offers a wide range of facilities for amusement, relaxation, fitness, shopping, commerce, games, drama, casinos, thematic parks, and cultural sites. According to Ref. [5], this has made China a popular tourist destination. Due to its high-quality tourism industry, China is a prominent tourist destination. The "Tourism Industry and Travel Competitiveness Index" ranks China 3rd in Asia-Pacific [6]. Australia leads, and Japan follows. Tourism industry contributed to job growth and economic surpluses [7]. China's tourism industry sector expanded rapidly after the 1978 reform. The domestic tourist market is vital to GDP [8]. The UNWTO reported 11.88 billion tourists in 2017, almost 1.6 times the world's population, generating $5.3 trillion. The tourism industry has been the fastest-growing sector of the world economy for eight years. In 2021, tourists spent 1,060,000 million Yuan in the travel subsector, ranking second in the tourism industry according to the NBS. Tourists spent 553,600, 209,100, and 172,900 Yuan on catering, sightseeing, and amusement. As China's consumption rises, the tourism industry is a major generator of consumption, employment, and economic growth.

However, economic growth necessitates the tourist industry's environmental responsibility. Due to its high environmental effect, the service sector tourism business is under scrutiny. Ref. [9] found that it boosts the global economy and promotes environmental sustainability research. According to Refs. [10,11], China emits the most GHG emissions due to its heavy usage of fossil fuels for electricity generation. Ref. [12] highlights the detrimental effects of climate change and the tourism effects on agricultural sectors. According to the latest figures, China's 2020 carbon dioxide emissions were 10.67 billion metric tons, 30.65% of the global total. This figure tops all nations.

Fig. 1 shows Chinese provinces' GHG gas emissions from oil, coal, and gas power in China's tourism industry. Traditional energy sources may harm the country's Environment. Previous research has shown that the tourism industry affects ecological sustainability [5].

According to Ref. [13], economic factors have a detrimental influence on pollution and the need for sustainable development. Ref. [14] argue that tourism industry growth in China reduces carbon dioxide emissions, improving the Environment. This means that further research is needed to discover how the tourism industry business affects climatic quality, particularly in China. Given these circumstances, empirical studies on the effects of the tourism industry on GHG gas emissions must consider economic expansion, energy use, and globalization. The sub-sector of the tourism industry exhibits distinct operational characteristics, energy use patterns, utilization intensities, activity performance methods, economic implications, and environmental impacts. The existing body of empirical research has yet to address the environmental impacts associated with these industries, particularly in China. Ref. [15] conducted a study to investigate the effects of tourism industry development on the environmental sustainability of highly frequented nations.

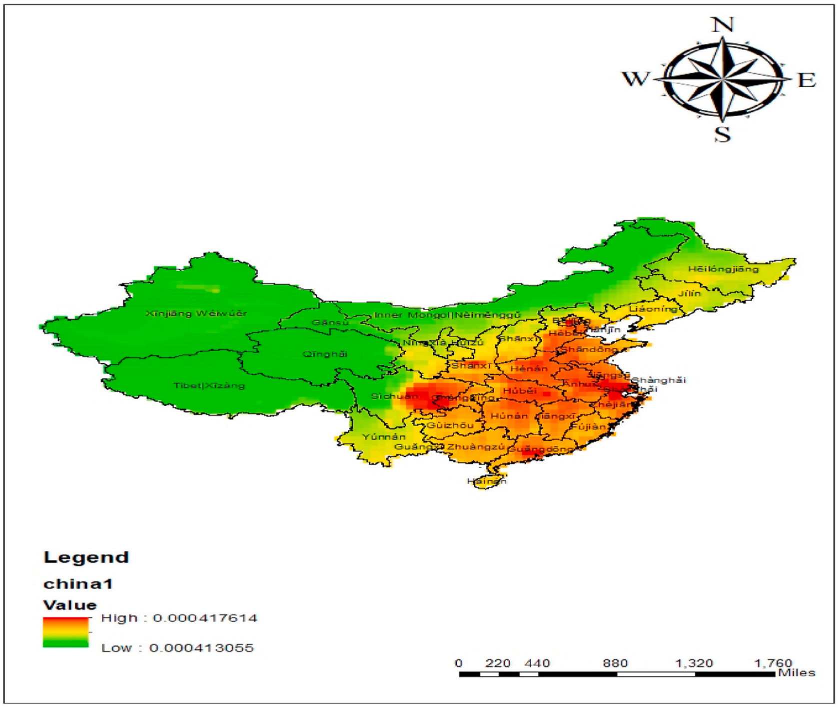

Fig. 1. CO_2 in Chinese provinces: Sources: Giovanni NASA.

The environmental impact of tourism industry-related enterprises has yet to be considered. Ref. [5] found that travel and hospitality energy use pollute the Environment. Transportation and daily operations require energy. Accommodation, transportation, eating, drinking, sports, and entertainment are major GHG gas and air polluters. These emissions come from air conditioning, ventilation, heating, cooking, lighting, trash disposal, and food making [16]. Tourism industry and environmental contamination have been studied extensively [17], but most researchers have examined tourism industry events and found mixed results. Thus, researchers should examine each sub-sector's environmental impacts rather than the tourism industry's overall impact. Tourism industry-related research also ignores additional GHG gases and air pollutants such as SO2, NH3, CO, N2O, and PM2.5. Ref. [18] note that changes in meteorological variables within particular sectors or businesses can long-term influence environmental aspects.

We understand the delicate interaction between Rural Tourism Infrastructure Development and Economic Factors and their aggregate influence on Greenhouse Gas (GHG) emissions and Air Pollutants to design effective solutions for reducing environmental damage and encouraging sustainable rural tourism. The objective is to assess the impact of rural tourism infrastructure development and economic factors on greenhouse gas emissions and air pollution. This study breaks new ground by looking at the environmental consequences of certain sub-sectors of China's tourist industry, as opposed to prior studies that considered the industry as a whole. We give detailed insights critical for targeted policies and sustainable development within the tourist industry by examining the environmental effects of four particular tourism sub-sectors. Furthermore, by including a complete set of greenhouse gases, climatic quality parameters, globalization, energy use, and economic growth, our analysis improves the evaluation of environmental effects, providing a holistic knowledge of the environmental landscape because assessing environmental impacts without these elements would be inappropriate [19].

2. Literature review

A substantial quantity of literature has explored the impact of technical innovation, natural resource usage, and financial development on environmental deterioration in depth. Many studies have used carbon dioxide (CO_2) emissions as a metric for ecological harm, yielding a variety of conclusions that can be used in policymaking [20,21]. However, a recent study has centered on using the ecological footprint to measure environmental degradation [1,22–24]. Ref. [25] investigates the complex link between oil rents, economic growth, and CO_2 emissions in 13 OPEC economies from 1970 to 2019. It reveals uneven impacts in certain nations and verifies the Environmental Kuznets Curve (EKC). The study emphasizes that oil rents affect CO_2 emissions differently among countries, emphasizing the necessity for specific environmental measures. Specific nations are advised to take strong environmental measures during rising oil prices to prevent negative environmental repercussions. Ref. [26] investigated Japan's financial development, economic globalization, growth, and ecological footprint. They discovered that while both globalization and financial development might raise the ecological footprint, certain globalization changes can reduce it. In general, their data support the environmental Kuznets curve hypothesis. Ref. [1] investigate how rural tourism experiences influence tourists' commitment to environmentally friendly consumption. The findings demonstrate that rural experiences positively affect memorable vacations and connections to the Environment, which drives aspirations for eco-friendly consumption after the trip. The study shows the importance of great rural experiences in promoting sustainable consumption and identifies significant mediators in this relationship. The correlation between the tourism industry and economic development has emerged as a prominent topic of discourse and a prevalent research trend in the tourism industry [27]. Previous research has extensively emphasized the critical function of the tourism industry in generating employment opportunities and fostering GDP. For example, [28] researched commonwealth countries, while [29] focused on the Asia-Pacific region.

Ref. [30] excessive fossil use in the tourism industry has increased CO_2, worsened global temperature, and harmed the Environment. Thus, to assess the tourism industry's GHG impact, one must first determine the tourism industry's CO_2. Ref. [31] used yearly data from 1995 to 2018 of EU countries and found that GDP and tourism industry raise carbon emissions. In four European countries, the tourism industry has little impact on the rest.

Ref. [32] used moment quantile regression to examine the unequal effect of tourist development on CO_2 in the top 10 GDP nations from 1995 to 2018. They found that the tourism industry increases CO_2.

Ref. [33] confirms that Turkey's tourism industry business causes CO_2 and air pollution. Ref. [34] the tourism industry improves the economy but degrades the Environment using 1995–2014 BRICS data. The tourism industry increased CO_2 in Iceland, worsening climatic quality, according to Ref. [35]. Ref. [36] used quantile ARDL to quantify the tourism industry's negative environmental impact. Few academics believe tourist expansion improves climatic quality and reduces CO_2. Ref. [37] found that the tourism industry reduces EU CO_2. According to Ref. [38], Asian GDP can generate CO_2 and tourism industry earnings without harming the Environment. TI pollutes 8% of the world [39].

China's empirical investigations support this idea; for example, [40] reviewed the tourism industry's impact on China's ecology. The tourism industry and related activities in China increase energy use, which pollutes the Environment. Ref. [41] similarly found a negative relationship between tourism industry development and climatic quality in China. Ref. [42] employed the generalized nested spatial (GNS) approach in 2005–2017 Chinese data. Tourism industry influx directly affects PM2.5, forming a U-shaped relationship.

Ref. [43] employed the coupling coordination approach to Chinese data and found that air quality development fluctuated more than tourism industry inflow. They also said that coordination gaps diminish across regions. Ref. [14] found similar results by coupling the tourism industry and climatic quality in Chongqing, China, from 2000 to 2017. Tourism industry development improves China's climatic quality [44]. Ref. [45] also stated that tourism industry development promotes climatic quality in China. The study found that China's tourism sector reduces CO_2 and boosts economic growth. From 2006 to 2017, [46] utilized the panel vector-autoregressive model to investigate the tourism industry's impact on Chinese areas' climatic quality. The data show that the international and domestic tourism industry harms the ecosystem. Ref. [5] used quantile ARDL to find that the tourism industry negatively affected environmental indices from 1995 to 2018.

Furthermore, globalization is commonly regarded as a significant factor in the expansion of economies, the increase in tourism industry, and the degradation of the Environment [47]. They have posited that globalization engenders economic expansion, technology dissemination, market liberalization, and heightened energy use, as evidenced in the context of OECD nations. Globalization has enabled the specialization and movement of tourism services such as food, entertainment, culture, recreation, natural resources, and travel [48].

Most research has focused on the inclusive tourism industry and ignored sectoral environmental costs related to tourism industry-related travel, accommodation, food, entertainment services, and sports. Most empirical literature measured climatic quality using CO_2 emission, which needs to be more accurate. China's rising tourism industry growth makes these literature gaps more essential. We examined tourist subsectors' environmental impacts to address this gap. Ref. [49] documented that more than 14,000 research works on the tourism industry-environment linkages demonstrate no environmental impacts at the sectoral tourism industry level. However, [50] found that cafeterias and lodges emit CO_2 and degrade air quality. Victoria Falls' tourism industry facilities release the most greenhouse emissions from hotels [51]. Ref. [52] also found that beverage and food industries use CO_2 and SO2, which harm the climate and human health. Ref. [53] explores environmental challenges in China due to rapid economic growth. Because of China's widespread pollution, resource depletion, and ecological imbalances, a better understanding of the relationship between economic development and environmental sustainability is required. The discovery demonstrates that eco-innovation dramatically minimizes environmental degradation at multiple levels. However, increased private-sector finance and reliance on natural resources deteriorate

Table 1
Overview of the empirical literature.

Author (Year)	Country	Time	Econometric Model	Result
[54]	N-11 countries	1990–2018	CS-ARDL method	NAT↑HC↑URB↑IQ↑ GIN↓EN
[55]	N-11 countries	1990–2018	CS-ARDL method	DIG↑NR↓LCF
[56]	E-7 countries	2000–2021	MQR method	FDI↑GDP↑GI↑ ED↑CO_2
[57]	119 developed and developing countries	2002–2018	ARDL methodology	EC↑FD↑GLB↓FDI↑NR↓HDI↓
[58]	EU nations	1980–2018	CS-ARDL	EU↓GDP↓EN
[59]	OPEC countries	1975–2018	CCEMG and AMG methodologies	EU↓EN
[60]	E7 countries	1995–2016	CCEMG and AMG methodologies	EKC↑ IQ↑ST↑ TI↓EN
[61]	BRICS nations	1990–2018	NARDL method	FDI↑NR↑RE↓EN
[59]	A panel of 125 countries	1990–2018	GMM method	FDI↑EN
[62]	Top-seven green economies	1995–2018	QQ regression approach	EU↑EN
[63]	63 emerging and developed economies	1990–2020	CCEMG and AMG methodologies	GE↑non-RE↓FD↓EN
[64]	E7 countries	1995–2016	CCEMG AMG and DK panel methodologies	RE↑ EKC↑ Non-FFC↓ IQ↓ CO_2
[65]	Poland country	1990–1998	LIML method	GDP↑TI
[7]	China	1993–2019	bottom-up approach	DT↑GDP↑
[66]	The panel of 22 emerging economies	1984–2016	CS-ARDL	GDP↑TI ↓NR↓CO_2
[67]	ASEAN countries	1996–2016	Driscoll-Kraay (DK) panel regression model	T ↑NR↓CO_2
[68]	Panel data on 96 nations	1996–2018	STIRPAT	TI ↓CO_2
[69]	G-7	1990–2017	CS-ARDL	EI ↑ED ↓ CO_2
[70]	China	1970–2016	ARDL approach	EF↑GDP
[71]	BRICS nation	1996–2016	Panel Estimation Method	FD↑TO↑EN
[72]	Turkey	1986–2018	QARDL method	FD↑EN
[73]	G-7 nations	1970–2015	STIRPAT	EKC↑ GDP↑RE↑ CO_2
[74]	Top 20 oil refining economies	2007–2016	Dumitrescu and Hurlin (DH) panel causality	EI ↑CO_2
[75]	Pakistan	1970–2014	ARDL approach	GDP↑NR↓EN
[76]	59 Belt and Road countries	1990–2016	DK panel regression model	FD↑GDP↓EN
[77]	11 newly industrialized economies	1977–2013	Panel Estimation Method	GDP↑EC↑EN
[78]	Pakistan	1971–2016	ARDL method	EC↑ED↑TFDI↑ GDP↓IN↓ CO_2
[78]	The panel of 65 BRI countries	1981–2016	Panel cointegration	FD↑RE↑EC↓GDP↓

Note: Abbreviations are Technological Innovation (TI), Ecological innovation (EI), Total openness (TO), Common correlated effects mean group (CCEMG) estimator, The Augmented mean group (AMG) estimator, Limited Information Maximum Likelihood (LIML) method, Belt and Road Initiative (BRI), Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model, Natural resources (NR), Ecological environment (EN), Energy use (EU), Renewable energy (RE), Environmental Kuznets Curve (EKC), Fossil-Fuel Consumption (FFC), Institutional Quality (IQ), Sustainable Tourism (ST), Tourism industry (TI), Autoregressive distributed lag (ARDL), non-linear autoregressive distributed lag (NARDL), Foreign Direct Investments (FDI), Quantile-on-Quantile (QQ) regression approach, Environmental taxes (ET), Domestic Tourism (DT) CO_2, Improvements in natural resources (NAT), human development (HC), urbanization (URB), Improvement in Load Capacity Factor (LCF), digitalization (DIG), Momentum quantile regression (MQR) approach, Education (ED), Green Energy (GE), Human Development Index (HDI).

environmental conditions. The report emphasizes the relevance of environmentally friendly technologies and sustainable behaviors in combating global warming and advancing China's sustainable development. Table 1 shows the summary of the empirical literature.

From the above discussion, it is evident that different countries conducted studies and investigated the impact of tourism on environmental quality. This study fills the gap in research by focusing on the environmental implications of various sub-sectors of China's tourist industry, a break from past holistic methods. It underlines the importance of conducting a thorough assessment considering greenhouse gases, climatic factors, globalization, energy consumption, and economic growth to lead targeted policies and sustainable development in the sector.

3. Methodology

3.1. Theoretical framework and data

As previously mentioned, the study's overarching goal is to identify energy consumption, economic growth, and globalization as moderators in assessing the environmental impacts of rural tourism industry sub-sectors in China. We divided the rural tourism sector into the six sub-sectors of Table 1 by the Chinese Ministry of Culture and Tourism. The environmental quality in the host country is affected in different ways by each of these sectors. Hotels, inns, B&Bs, boarding houses, entertainment campuses, etc., are just some lodging options the ACO industry offers rural vacationers. According to Ref. [46], these rural tourism-related activities. They necessitated energy use, increasing greenhouse gas emissions. Restaurants, food trucks, fast food joints, bars, and other related businesses comprise the Food and Beverage industry. A higher level of SO2 and CO_2 is consumed by the FB sectors, as demonstrated empirically by Ref. [52]. During their time in the host country, rural tourists participate in the TVL sector using the country's airports, railroads, highways, and waterways. When the number of visitors to a country rises, the demand for transportation, hotel services, technological advancements, and infrastructure also rises, as shown by Ref. [79]. Tourists will spend 1,060,000 million Yuan on travel-related activities in 2020, making it the second largest sub-sector of the tourism industry after catering (553,600 million Yuan), sightseeing (209,100 million Yuan), and entertainment (172,900 million Yuan) [4]. The SE industry caters to vacationers searching for retail therapy and other forms of amusement, including casinos, amusement parks, nightclubs, and parks.

Pollutants released as a result of these activities affect the Environment, as [80] stated. While tourism spending in rural areas benefits the economy, the associated activities have environmental consequences for the host country due to their role in generating greenhouse gas emissions and air pollution [49]. In response to the above claims, we included the various tourism-related sectors in our environmental impact analysis. Various proxies were used to determine the effect that various segments of the rural tourism industry have on environmental quality, and the study opted to use the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model. Stochastic IPAT was first proposed by Ref. [81] as a function of technological advancement, economic prosperity, and population size. However, [82] have extended the IPAT model in a stochastic form and begun work on the STIRPAT variant due to several limitations. The STIRPAT model, in contrast to IPAT, provides estimates of the independent environmental impacts of technological progress, economic prosperity, and population growth and can be identified as. equation (1) is expressed as:

$$I_{it} = aP_{it}^{b} + A_{it}^{c} + T_{it}^{d} + \mu_{it} \tag{1}$$

As a result of its high collinearity with GDP, we eliminated population from our STIRPAT model and replaced it with GDP as a key control factor, which has a profound effect on environmental quality [64,83]. Therefore, this issue was sidestepped by using GDP alone as a control variable. The globalization (GLB) factor is also substituted for the technology (TECH) factor in the STIRPAT model. Global learning by doing, or GLB, is a major contributor to international knowledge sharing; greater GLB indicates greater technical efficiency and is strongly correlated with environmental sustainability [47,58]. To take environmental quality (EQ) into account, we relied on two environmental indicators: emissions of greenhouse gases (GHG) and air pollutants (AP). The parameters for greenhouse gas emissions and air pollutants are listed in Table 1; the regression is performed with each environmental indicator in isolation. Variable K in the equation represents a set of controls that, like those in Ref. [19], account for economic growth, energy consumption, and globalization (2).

Therefore, taking into account the goals of our research to evaluate the effects of different segments of the rural tourism industry on environmental quality, we adopted the following model from Ref. [32]. Equation (2) is expressed as:

$$EQ = \beta_o + \beta_1 ACO_{it} + \beta_2 FB_{it} + \beta_3 TVL_{it} + \beta_4 SS_{it} + \beta_5 CAT_{it} + \beta_1 SE_{it} + \beta_1 K_{it} + \mu_{it}. \tag{2}$$

The term βo is constant, while βi is the coefficients of the explanatory variables, and i equals the number of parameters. Furthermore, consistent with [12,15,73], all the variables are transformed into log form to make them less skewed (normal) to obtain more valid results.

3.2. Data

Due to data constraints, the time series annual data from 2001 to 2019 has been converted into quarterly data. To accomplish this, we used a quadratic match-sum method to convert annual data to quarterly frequency. It has been incorporated into preexisting works. According to several scholarly studies [12,60,84–86] and is useful for transforming data from low to high frequency, which helps with both reducing point-to-point differences and adjusting seasonal fluctuations. The National Bureau of Statistics in China provides information on the value of foreign exchange earnings ($100 million) from rural tourism across all related sub-sectors. The information on greenhouse gas emissions and air pollutants was collected from the EDGAR database (Emission Database for Global Atmospheric Research). World Development Indicators and BP's energy statistics are mined for information on economic expansion and energy use, respectively. The KOF globalization index quantifies the degree to which a country has integrated into the global economy. Table 2 represents the detailed description and source of each variable used in this study. Additionally, the methodological framework utilized in this study is depicted in Fig. 2.

3.3. Estimation techniques

Ref. [87] developed a method for estimating dynamic panel data using GMM, which was used in this study. The approach was selected because it is suitable for dynamic panel data analysis where the number of cross-section observations (N = 24) exceeds the number of time series (T = 22) and because it corrects for small sample biases, controls for potential endogeneity in included regressors, limits over-identification, and controls for cross-sectional dependence. The Sargan Test (the secret results) was used to select the instruments. The GMM model's instruments were delayed in the explanatory variables. Due to its treatment of numerous additional econometric issues, such as serial correlation and multicollinearity, the GMM model is more appropriate than simple OLS or fixed effects when conducting a panel data analysis. The GMM model is still the best option, even when variables have measurement biases. It prevents problems from occurring that could otherwise be traced back to incorrectly specified explanatory variables or improperly calculated proxy variables. A few things must be in place before you can use the GMM technique, such as a diagnosis of endogeneity that inspired you to use the GMM model. Due to the possibility of endogeneity or a connection between the error term and explanatory variables, the Wald test is used in the present investigation. The null hypothesis that the instruments are reliable is accepted because the J-statistic is not statistically significant. The Wald test for identifying endogeneity has also been implemented. The alternative hypothesis that residual terms are correlated with explanatory variables and, thus, cause the endogeneity issue is supported by the significant value of residual terms.

3.4. Breakpoint unit root testing

Stationarity testing is required because of the many ecological, rural tourism, and macroeconomic variables used in the analysis. Therefore, we perform a stationarity diagnostic using a breakpoint unit root augmented Dickey–Fuller (ADF) test [88] and report our findings in Table 3. Rejecting the hypothesis that the series is stationary when the independent variables are dominant is appropriate. This test is superior to others since it can deal with more complex circumstances [12].

4. Empirical results and discussion

Ecological challenges in China are being evaluated by focusing on the impact of rural tourism and economic growth elements. Every parameter has been transformed into logarithms before to estimate to support the dataset's normality. Table 3 contains the variable's summary statistics.

Initially, breakpoint ADF unit root tests were conducted to determine the stationarity level of the variables since finding the stationarity qualities of the variables is essential in time-series analysis. In line with Table 4 findings, all parameters are stable at their

Table 2
List of research instruments.

#		Variables	Abbreviation	Resources
	Dependent variables	**GHG emissions (metric tons per capita)**		
1		Nitrous Oxide	N_2O	EDGAR
2		Methane	CH_4	EDGAR
3		Carbon Dioxide	CO_2	EDGAR
		Air pollutants (metric tons)		
1		Sulfur dioxide	SO_2	EDGAR
2		Carbon monoxide	CO	EDGAR
3		Nitrogen dioxide	NO_2	EDGAR
4		Particulate matter 2.5 (refers to fine particles with a diameter of 2.5 μm or smaller)	$PM_{2.5}$	EDGAR
	Independent variables	**Rural Tourism Infrastructure Development (Revenue in million USD)**		
1		Accommodation	ACO	NBC
2		Food and Beverages	FB	NBC
3		Traveling	TVL	NBC
4		Sightseeing	SS	NBC
5		Catering	CAT	NBC
6		Shopping and Entertainment	SE	NBC
		Economic Factors		
7		Energy consumption (Exajoules)	EC	BP
8		Globalization	GLB	WBI
9		GDP per capita annual growth	GDP	WBI

Note: National Bureau of Statistics China (NBSC); Emission Database for Global Atmospheric Research (EDGAR); World Development Indicators (WBI); BP energy statistics.

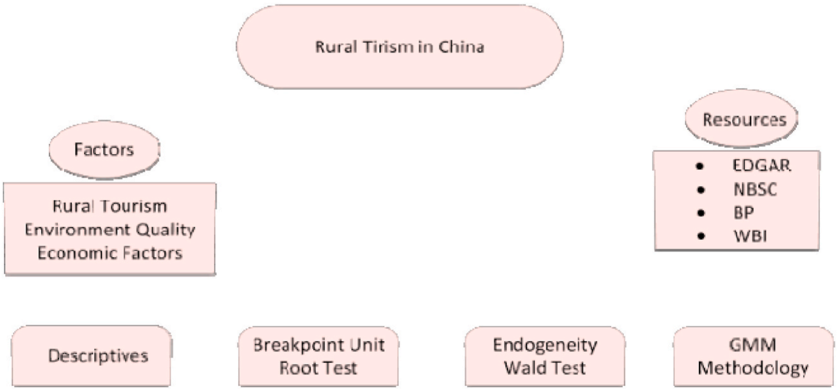

Fig. 2. Methodological farmwork.

Table 3
Summary statistics of climatological, Rural Tourism, and Economic factors.

Variables	Mean	Median	Std. Dev.	Jarque-Bera	Probability
LN_2O	−1.110	−1.103	0.056	2.220	0.330
LCO_2	1.788	1.923	0.317	11.677	0.003
LCH_4	0.100	0.131	0.087	13.384	0.001
LCO	18.533	18.555	0.098	6.380	0.041
LNO_2	16.811	16.955	0.284	9.506	0.009
$LPM_{2.5}$	16.113	16.160	0.142	8.773	0.012
LSO_2	17.105	17.147	0.172	9.797	0.007
LACO	8.675	8.555	0.620	3.997	0.136
LCAT	8.557	8.698	0.552	8.456	0.015
LFB	8.351	8.229	0.671	3.464	0.177
LSS	3.190	3.092	0.615	5.459	0.065
LTVL	9.593	9.480	0.734	4.958	0.084
LEC	4.554	4.647	0.348	9.532	0.009
LGDP	2.101	2.129	0.242	3.384	0.184
LGLB	4.112	4.132	0.056	18.901	0.000
LSE	9.547	9.600	0.586	2.618	0.270

Table 4
Trends of ADF unit root test.

Variables	Unite root at *I(0)*		Unite root at *I(1)*	
	T stat	Break year	*T* stat	Break year
LN_2O	−4.393*	2018 Q_4	−13.866***	2019 Q_1
LCO_2	−4.301*	2008 Q_4	–	–
LCH_4	−4.566**	2003 Q_4	–	–
LCO	−3.083	2007 Q_4	−10.751***	2008 Q_1
LNO_2	−4.361	2006 Q_4	−10.058***	2004 Q_1
$LPM_{2.5}$	−5.011*	2012 Q_4	–	–
LSO_2	−4.541**	2008 Q_4	–	–
LACO	−2.577	2014 Q_4	−11.863***	2015 Q_1
LCAT	−3.436	2004 Q_4	−10.091***	2004 Q_1
LFB	−2.622	2014 Q_4	−11.778***	2015 Q_1
LSS	−2.689	2006 Q_4	−11.608***	2007 Q_1
LTVL	−2.019	2013 Q_4	−14.712***	2015 Q_1
LEC	−4.042	2009 Q_4	−11.599***	2004 Q_1
LGDP	−3.131	2011 Q_4	−9.302***	2007 Q_1
LGLB	−4.126	2003 Q_4	−12.273***	2007 Q_4
LSE	−2.937	2014 Q_4	−12.055***	2015 Q_1

* Display that P-value <0.1 (10% level).
** Display that P-value <0.05 (5% level).
*** Display that P-value <0.01 (1% level).

first difference $I(1)$ or level $I(0)$. Under the unit root test findings, none of the factors are stationary at the second differential, satisfying the GMM model application's presumption. But with structural cracks, every element stays the same. Implementing ecological and economic legislation in certain sectors of the economy may be associated with specific violations.

In addition, the Wald test was used to diagnose endogeneity, and Table 5 shows the results. The Wald test's statistical results suggest that endogeneity problems exist. The significant value of residual terms lends credence to the alternative hypothesis that residual terms are linked to explanatory factors and thus generate the endogeneity problem.

The GMM approach is used for regression analysis to get parameter estimates, examine their statistically significant connection, and verify their validity. The AB model has been used in several previous studies with a similar vulnerability [89,90]. Seven environmental models are used to study the effects of rural tourism and economic factors on GHG emissions and air pollutants in the Chinese economy.

4.1. Greenhouse gas emission

$$LN_2O = 0.158LACO - 0.152LCAT - 0.101LFB - 0.059LSS - 0.078LTVL + 0.061LEC - 0.068LGDP + 0.884LGLB + 0.017LSE \quad (3)$$

Equation (3) depicts the influence of these figures on the greenhouse gas N_2O in the Chinese economy. The statistical coefficient value of 0.158 indicates that the ACO has little and beneficial influence on N_2O emissions. N_2O emissions are predicted to rise as the hospitality business expands. This might be due to higher energy use, heating and cooling systems emissions, and using fertilizers or other chemicals in horticulture and maintenance operations.

The significant and negative influence on N_2O emissions is explained by the CAT (−0.152) and FB (−0.101) coefficient values. N_2O emissions are predicted to reduce by 0.1% as the catering business and food beverage grows. This might be attributed to attempts to implement sustainable farming practices, cleaner cooking methods, and a reduction in the use of nitrogen-based fertilizers in food production.

The SS and TVL sectors have a negligible and negative influence on N_2O. N_2O emissions are predicted to fall as the SS and TVL industries grow. Improved transport efficiency, decreased energy consumption, and fewer emissions from rural tourism-related activities could impact sightseeing results. The outcomes of traveling might be linked to improved technology for transportation, the use of cleaner fuels, and increased transportation efficiency.

According to the EC (0.061) statistic, increased energy consumption has an insignificant positive influence on N_2O emissions. N_2O emissions are predicted to rise as energy usage rises. This emphasizes the significance of shifting to cleaner, more sustainable energy sources to reduce N_2O emissions.

At the 10% significance level, the GDP coefficient value (−0.068) reveals a substantial negative association between GDP and N_2O emissions. N_2O emissions are predicted to fall by 0.06% if GDP rises by one unit. This implies that economic growth and better efficiency can decrease N_2O emissions. The findings are comparable to those of [58].

GLB and SE have an insignificant favorable effect on N_2O emissions. As this industry grows, N_2O emissions are predicted to rise by 0.08%–0.02%. This might be due to rising globalization-related economic activity, transportation needs, and agriculture practices. Increased energy usage in commercial buildings and transportation-related emissions linked with retail activities might impact this.

$$LNCO_2 = -0.008LACO + 0.118LCAT - 0.070LFB - 0.023LSS + 0.024TVL + 1.062LEC + 0.147LGDP - 0.988LGLB - 0.005LSE \quad (4)$$

The influence of these results on the greenhouse gas CO2 on China's economy is depicted in Equation (4).

According to the ACO (−0.008) statistic, the ACO sector negatively influences CO_2 emissions. CO_2 emissions are predicted to fall as the hospitality business expands. This might be attributed to increased energy efficiency, renewable energy sources, and sustainable construction practices.

The CAT industry has a significant positive influence on CO_2 emissions. If CO_2 increased by one unit, CAT increased by 0.11% at the 1% level. Increased energy use in food preparation and storage, transportation-related emissions, and waste management practices might all contribute to this.

The coefficient values of FB (−0.070) and SS (−0.023), respectively. The outcomes show how the FB and SS industries have a negative impact on CO_2 emissions. It suggests that as this sector grows, CO_2 emissions are expected to reduce by 0.07% and 0.02%,

Table 5
Endogeneity identification.

Testing of Null Hypothesis = C(n) = 0		
Variables	**F-statistics**	**Chi-square**
LN_2O	27112.21***	27112.21***
LCO_2	934322.6***	934322.6***
LCH_4	4677.948***	4677.948***
LCO	10,714,397***	1.07 e^{08}***
LNO_2	1,082,820***	10,828,199***
$LPM_{2.5}$	3,529,870***	35,298,677***
LSO_2	4,163,189***	41,631,893***

Note: n = 1, 2, 3, …, 10; *** explain the 1% level.

respectively. These outcomes are comparable to N_2O emissions in China's economy. Sustainable agriculture, decreased food waste, increased energy efficiency, and improved transportation contribute to good soil sustainability outcomes, including fewer emissions from rural tourism.

These TVL, EC, and GDP statistics demonstrate that there is a positive influence on CO_2 emissions. CO_2 emissions are predicted to rise as a result of these reasons. This might be owing to increased transportation activities, such as emissions from automobiles, aircraft, and ships that emit carbon dioxide, as a result of TVL. The significance of moving to greener and more sustainable energy sources to reduce CO_2 emissions is highlighted by EC results. The GDP results indicate that economic progress and rising consumption contribute to higher emissions unless efficient emission control strategies complement them. These findings are comparable with those obtained by Ref. [58] in the case of European nations.

The effects of GBL (−0.988) and SE (−0.005) appear to have significant adverse effects on CO_2 emissions. CO_2 emissions are predicted to fall dramatically as GLB rises. GLB results might be ascribed to tougher environmental legislation, the deployment of cleaner technology, and the relocation of industrial activity to lower-emissions zones. According to statistics, China is the greatest CO_2 emitter, accounting for 27% of worldwide emissions of greenhouse gases [46]. At the same time, enhanced energy efficiency in commercial buildings, lower emissions from mobility-related shopping activities, and the deployment of emission control measures all impact SE results. These findings are congruent with the results of [80] for the United States.

$$LCH_4 = -0.02LACO + 0.058LCAT - 0.053LFB - 0.099LSS + 0.080TVL + 0.099LEC - 0.039LGDP + 0.861LGLB + 0.014LSE \quad (5)$$

The influence of these figures on greenhouse gas CH_4 emissions on China's economy will be examined separately, as shown in Equation (5).

This ACO and GDP figure implies that these sectors have an insignificant negative influence on CH_4 emissions. CH_4 emissions are predicted to decrease as the lodging business expands. Like the CO_2 mission, ACO outcomes may result from improved energy efficiency, waste management practices, or adopting cleaner technologies within the sector. In contrast, GDP outcomes may result from economic development and improving living standards, which may lead to adopting cleaner technologies and practices that reduce methane emissions.

The CAT (0.058) and TVL (0.080) sector results demonstrate an extremely substantial and positive impact on CH_4 emissions. CH_4 emissions are expected to climb by 0.05% and 0.08%, respectively, as the CAT and TVL sectors expand. These sector effects and causes are the same as CO_2 emissions.

The regression coefficient values of FB (−0.053) and SS (−0.099) suggest that these sectors significantly and negatively influence CH_4 emissions, respectively. If one unit in these industries expands, CH_4 emissions would be reduced by 0.05% and 0.1%, respectively. The results, such as CO_2 emissions, are related. FB results may result from initiatives to reduce food waste, implement sustainable agriculture practices, or promote plant-based diets. Sustainable tourist practices, efficient transit alternatives, and conservation measures may all impact SS results.

The parameters EC (0.099), GLB (0.861), and SE (0.014) imply that increases in CH_4 emissions are not significant. These results are analogous to N_2O emission results. The EC findings emphasize the value of shifting to cleaner and renewable energy sources to reduce CH_4 emissions. GLB results might result from increasing commerce, transportation, and industrial activity related to globalization. Increasing energy usage, transportation needs, and emissions from retail and leisure destinations may also impact SE findings. Furthermore, waste is burnt to create energy, which releases CH_4 and is also released during the manufacturing of oil, coal, and gas [91].

The unidirectional causation between SE and N_2O, CO_2 and CH_4 confirms the SE sector's participation in releasing greenhouse gases. Because of the limited number of activities, the distance traveled, a relatively small proportion of people, the creation of new locations, food services, and garbage discharge, the SE sector generates very little carbon dioxide [7].

According to the "Energy Information Administration" (EIA), in the United States, meals and beverages, traveling, entertainment and sporting events, and other tourism-related services all demand a tremendous amount of energy to function daily, causing releases of greenhouse gases (EIA, 2019).

4.2. Air pollutant

$$LCO = 0.118\,LACO + 0.128\,LCAT + 0.005\,LFB + 0.124\,LSS - 0.039TVL + 0.324\,LEC + 0.007\,LGDP - 1.894\,LGLB + 0.027\,LSE \quad (6)$$

The influence of these statistics on the air pollutant CO on China's economy is seen in Equation (6).

The results of the ACO, CAT, SS, and EC variables indicate that these sectors have a highly significant and positive influence on CO emissions. CO emissions are estimated to rise by 0.11%, 0.12%, 0.12%, and 0.32% for each unit increase in these industries. ACO consequences might result from increased energy use in the sector's facilities, including heating and cooling. The sector's increasing food production, transportation, and waste output might all be related to CAT results. Increased transportation needs and energy consumption connected with tourism activities may impact SS outcomes. In contrast, EC outcomes emphasize the significance of shifting to cleaner and more sustainable energy sources to reduce CO emissions. The food and beverage industry consumes the most energy because of the high need for freezing and cooking [92].

The TVL (−0.039) and GLB (−1.894) statistic values indicate that these sectors significantly and adversely impact CO emissions. CO emissions are expected to drop by 0.04% and 1.89%, respectively, when TVL and GLB rise by one unit. TVL outcomes might be attributed to efforts to increase transportation efficiency, promote cleaner fuels, and lower vehicle emissions. Still, GLB could be attributed to changes in manufacturing practices, cleaner technologies, and stronger environmental laws.

The results for FB (0.005), GDP (0.007), and SE (0.027) show that these sectors have a negligible positive impact on CO emissions. It implies that CO emissions are anticipated to rise as this industry expands. Emissions from food processing, transportation, and cooking practices may contribute to FB consequences. GDP implies that economic progress and rising consumption increase emissions unless pollution control measures are implemented. Increased energy use, transit needs, and retail and leisure emissions could impact SE.

$$LNO_2 = -0.058LACO + 0.141LCAT - 0.042LFB + 0.068LSS + 0.078TVL + 0.343LEC + 0.195LGDP - 1.068LGLB - 0.012LSE \quad (7)$$

The influence of these figures on the air pollutant NO2 on China's economy is depicted in Equation (7).

The sectors significantly and negatively affect NO2 emissions, according to the ACO (−0.058) and GLB (−1.068) factors. NO2 emissions are expected to fall when the ACO and GLB sectors grow by one unit. The reasons for these findings are equivalent to those for CO emissions. GLB outcomes could be attributed to stricter environmental regulations, adopting cleaner technologies, and relocating industrial activities to lower-emissions regions. In contrast, ACO outcomes could be attributed to increased energy efficiency, using cleaner fuels, or implementing pollution control measures in buildings within the sector. According to Ref. [52], the results are comparable.

NO2 emissions are significantly influenced by the sector factors CAT (0.141), SS (0.068), and GDP (0.195). When these organizations develop on a unit basis, NO2 emissions are expected to rise by 0.141%, 0.068%, and 0.195%, respectively. The causes for CAT and SS are the same as for CO emissions. The GDP finding demonstrates that economic growth and growing consumption contribute to increased emissions unless effective pollution control measures accompany them. Ref. [58] analyzed the relationship between energy consumption and GDP in Europe and discovered that, although energy consumption is required for economic growth, so is growth.

The Fb and SE statistics reveal a negative influence on NO_2 emissions, while the TVL and EC statistics suggest a positive effect. The findings of FB and SE results are similar to CO emissions. TVL results may result from increasing transportation activities, such as using fossil fuels in automobiles, aircraft, and ships emitting NO_2. To reduce NO_2 emissions, SE findings emphasize the necessity of shifting to cleaner and more sustainable energy sources and deploying emission control technology.

$$LPM_{2.5} = 0.058LACO + 0.312LCAT - 0.118LFB + 0.233LSS + 0.168TVL - 0.171LEC + 0.004LGDP - 0.472LGLB - 0.029LSE \quad (8)$$

Equation (8) depicts the economic impact of these figures on the air pollution particle $PM_{2.5}$ in China.

The ACO and GDP coefficients suggest that the sectors positively influence $PM_{2.5}$ emissions, whereas EC, SE, and GLB have a minor and negative impact on $PM_{2.5}$ emissions. Increased energy use, emissions from heating and cooling systems, and particle release from building materials and indoor activities all contribute to ACO results. The GDP results indicate that economic expansion and increasing consumption contribute to higher emissions unless efficient pollution control measures complement them.

To reduce $PM_{2.5}$ emissions, the EC findings emphasize the significance of shifting to cleaner and more sustainable energy sources and installing emission control systems. GLB results might be ascribed to tougher environmental legislation, the deployment of cleaner technology, and the relocation of industrial activity to lower-emissions zones. Improved energy efficiency in business buildings, lower vehicle emissions related to shopping activities, and the deployment of pollution control measures all impact SE results.

The $PM_{2.5}$ emissions are significantly influenced by the levels of CAT (0.312), SS (0.233), and TVL (0.168). With each unit growth in these enterprises, $PM_{2.5}$ emissions are predicted to climb. The CAT and SS facts findings are comparable to the prior ones. Increased transportation activities, such as particulate matter emissions from vehicles, aircraft, and ships, may be causing TVL outcomes.

The FB (−0.118) coefficient value shows that the food and beverage industry has negatively influenced $PM_{2.5}$ emissions. It implies that for every unit increase in this sector, $PM_{2.5}$ emissions are anticipated to fall by 0.11%. This might be attributed to attempts to embrace cleaner cooking methods, reduce emissions from food processing, and improve waste management practices.

$$LSO_2 = -0.048LACO + 0.341LCAT - 0.029\ LFB + 0.019\ LSS + 0.075TVL + 0.236LEC + 0.060LGDP - 2.473LGLB + 0.015\ LSE \quad (9)$$

Equation (9) depicts the influence of these data on the air pollutant SO_2 in the Chinese economy; let us examine each element separately:

The ACO (−0.048) and FB (−0.029) statistics indicate that the sectors have no significant impact on SO2 emissions. ACO results might result from increased energy efficiency, the use of cleaner fuels, or the implementation of pollution control measures in the sector's structures. The findings of FB are equivalent to those of NO_2.

The sectors of SS (0.019), EC (0.236), GDP (0.060), and SE (0.015) have an insignificant and positive influence on SO2 emissions. Increased transportation needs and energy consumption linked with tourism activities, which may entail using sulfur-containing fuels, might impact SS results. The SE, GDP, and EC outputs all have the same findings.

The parameters CAT (0.341) and TVL (0.075) significantly influence SO2 emissions. SO2 emissions are predicted to rise by 0.34% and 0.075%, respectively, when the catering and transport industries expand by one unit. The CAT results reveal the same findings, whereas the TVL results indicate the same CO and $PM_{2.5}$ findings.

GLB (−2.473) has a significant negative impact on SO2 emissions. SO2 emissions are expected to fall dramatically as the globe gets more linked. Environmental legislation, the adoption of cleaner technology, and the migration of industrial activity to lower-emission locations may all have contributed to this trend.

Numerous empirical research studies [7,91] support our conclusions that overall tourist development and some TI sub-sectors have a detrimental influence on the quality of the Environment. According to recent research, despite substantial efforts to minimize greenhouse gas and pollutant emissions, 97 million people in various nations still live in locations with high pollution levels. These emissions were responsible for ozone, smog, and impaired visibility. Consequently, our findings were similar to those of the IEA and the EPA, demonstrating that China's tourist business is just as liable for adverse environmental effects as other industries.

The presented findings provide crucial insights into the environmental implications of rural tourism-related activities, concentrating in particular on key factors. Understanding these implications is crucial for developing effective solutions to mitigate the negative environmental effects and improve the tourism industry's sustainability. According to the research, rural tourism-related catering services greatly improve all environmental quality factors aside from N2O emissions. However, the N2O emissions are of

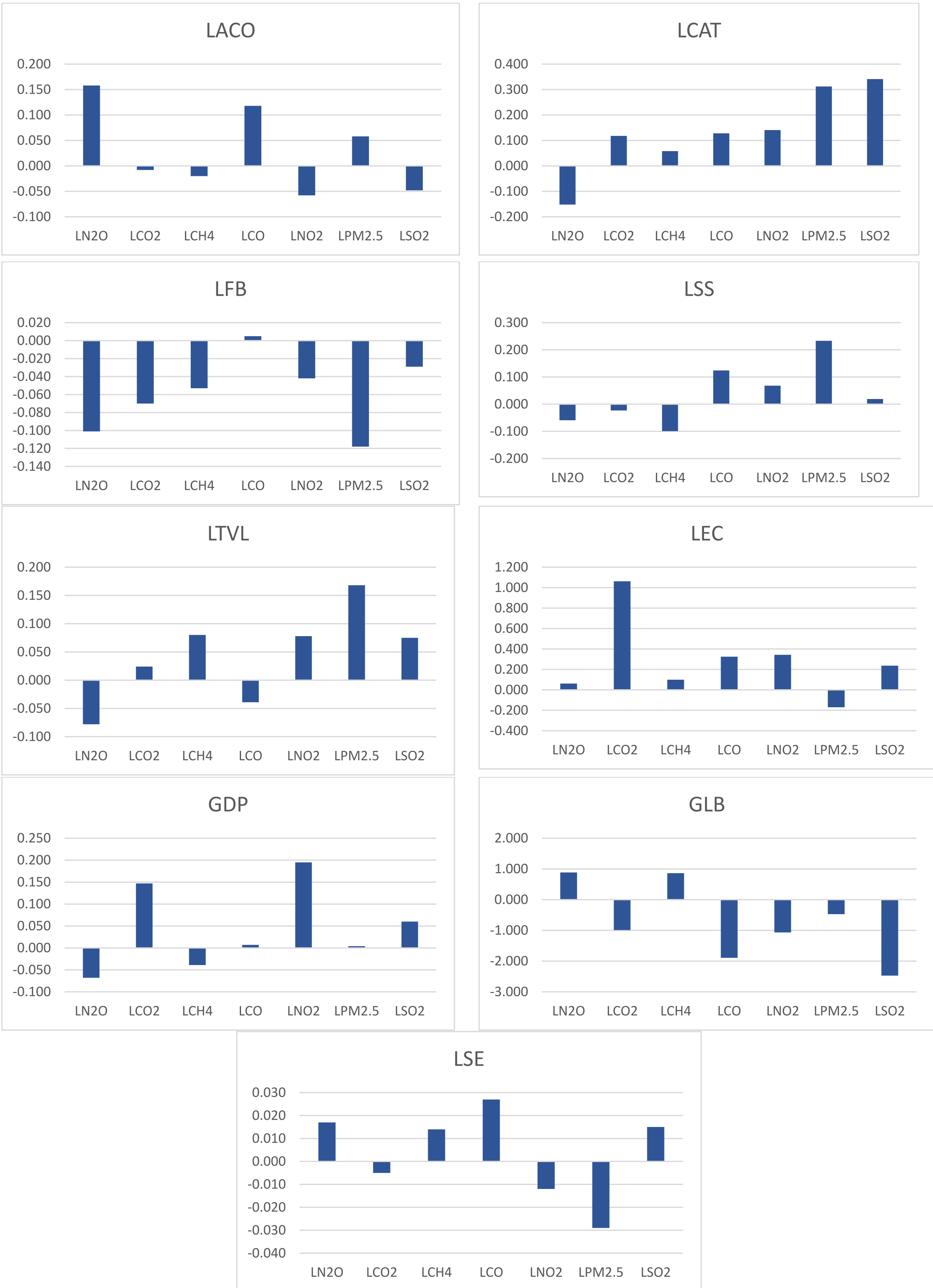

Fig. 3. Graphical presentation of results.

concern, highlighting the need to enhance the sustainability of catering methods. One answer might be to promote waste reduction and sustainable sourcing in the catering industry, encourage using locally produced, organic foods, and reduce food waste via effective management techniques. By lowering the environmental impact of catering services, these solutions would help improve environmental quality.

The necessity for sustainable practices in this industry is highlighted by the detrimental effects that food and beverage services have on air pollution and greenhouse gas emissions, namely PM2.5. Potential solutions include promoting environmentally friendly manufacturing methods, lowering food waste via effective supply chains and responsible consumer behavior, and implementing energy-efficient cooking and refrigeration technology. These actions may significantly decrease the sector's emissions and air pollution, which aligns with environmental sustainability objectives.

Sightseeing, although helpful for tourism, has been demonstrated to influence air pollution and negatively impact greenhouse gas emissions positively. It's crucial to balance sightseeing's benefits and environmental issues. Environmental harm may be reduced by implementing ecotourism policies and encouraging low-impact tourist activities. Additionally, promoting public transportation for sightseeing excursions and investing in it may greatly lessen the environmental impact of this kind of tourism.

The critical role that transportation plays in reducing CO emissions emphasizes the urgent need for environmentally friendly transportation solutions. Effective solutions include promoting electric or hybrid vehicles, improving public transportation infrastructure, and promoting active commuting methods like bicycling and walking. These methods may significantly reduce the carbon emissions brought on by travel, leading to cleaner and healthier ecosystems.

The research emphasizes how globalization hurts air pollutants like CO2 and air pollutants (excluding PM2.5). Collaboration on a worldwide scale, as well as legislative changes, are needed to solve this problem. Adopting renewable energy worldwide and implementing international agreements and legislation to restrict emissions are essential answers. These steps may encourage international collaboration for a sustainable future while reducing the negative environmental repercussions of globalization.

It is necessary to take a multifaceted strategy to solve the environmental difficulties caused by the activities associated with rural tourism. This approach should include sustainable practices, technical breakthroughs, legislative interventions, and global collaboration. By implementing these ideas, the tourist sector can lessen its impact on the Environment, protect natural resources, and contribute to a more sustainable and environmentally friendly future. Fig. 3 shows the graphical presentation results (see Table 6).

5. Conclusion and policy recommendations

Pollution of the natural environment is a major threat to human health. Environmental degradation issues, such as global warming, melting snow, rising ocean temperatures, rising sea levels, increased greenhouse gas emissions, and air pollution, have prompted researchers to look for answers across disciplines. The TI's potential as a growth and job creation driver has only become apparent recently. China has seen the largest increase in greenhouse gas emissions and is now the leader in this category, leading to serious problems with air pollution. However, due to reform and opening-up, China's tourism industry has flourished in recent years, making increasingly important social and economic contributions. The rural tourism industry also contributes significantly to pollution because of its high energy consumption. Therefore, we must conduct a thorough study of the environmental impacts of the rural tourism industry, as this connection is essential for government and related institutions to consider when crafting policies to ensure continued and greener growth. The goal of this study was to use the GMM regression technique to determine how much of an impact rural tourism has on China's greenhouse gas emissions and air pollution.

The study's preliminary results suggest that the catering, food and beverages, and GDP sectors significantly negatively affect N2O emissions. This suggests that as these sectors experience growth, there is a corresponding decrease in N2O emissions. At the same time, other factors are enhancing the N2O in China's economy. The accommodation, food and beverages, shopping and entertainment, and sightseeing sectors negatively impact CO2 emissions. It implies that measures promoting sustainable practices, energy efficiency, and environmentally friendly policies within these sectors can reduce CO2 emissions in China's economy.

Moreover, the other sectors of rural traveling and economic factors have indicated that changes or growth in these sectors may

Table 6
Rural tourism and economic factors impact climatological factors.

Variables	Coefficients						
	LN_2O	**LCO_2**	**LCH_4**	**LCO**	**LNO_2**	**$LPM_{2.5}$**	**LSO_2**
LACO	0.158	−0.008	−0.020	0.118*	−0.058*	0.058	−0.048
LCAT	−0.152**	0.118***	0.058***	0.128*	0.141*	0.312***	0.341***
LFB	−0.101***	−0.070***	−0.053***	0.005	−0.042	−0.118**	−0.029
LSS	−0.059	−0.023**	−0.099***	0.124***	0.068***	0.233*	0.019
LTVL	−0.078	0.024**	0.080***	−0.039***	0.078	0.168*	0.075**
LEC	0.061	1.062***	0.099	0.324***	0.343	−0.171	0.236
LGDP	−0.068*	0.147***	−0.039	0.007	0.195*	0.004	0.060
LGLB	0.884	−0.988***	0.861	−1.894***	−1.068*	−0.472	−2.473**
LSE	0.017	−0.005	0.014	0.027	−0.012	−0.029	0.015
Adjusted R^2	0.677	0.928	0.891	0.973	0.783	0.940	0.809
Prob (J-statistic)	0.143	0.322	0.205	0.122	0.301	0.101	0.210

Note: ***, ** & * equals to significant at 1%, 5% & 10% level.

increase CO2 emissions. Accommodation, food and beverages, sightseeing, and GDP negatively impact CH4 emissions. It highlights the potential for sustainable practices, resource efficiency, and environmentally friendly policies within these sectors to contribute to CH4 emission reduction. At the same time, other factors have implied that changes or growth in these sectors may result in increased CH4 emissions.

Factors such as accommodation, catering, sightseeing, food and beverages, energy consumption, shopping and entertainment, and GDP exhibit that as these factors experience growth or changes, there is a corresponding increase in CO emissions. At the same time, other parameters demonstrate that changes or growth in these factors are associated with decreased CO emissions. Reducing carbon dioxide emissions can be aided by encouraging eco-friendly modes of transportation like public transportation and electric cars and enacting environmentally responsible globalization policies. NO2 emissions are negatively affected by globalization and the accommodation, food and beverage, shopping, and entertainment industries. The opposite is true regarding other factors' impact on NO2 emissions. PM2 is positively affected by factors like GDP, tourism, travel, and hospitality.PM2.5 emissions are negatively impacted by economic five emissions in China and other factors. Accommodation, food and beverage, and globalization are all factors that contribute to increased SO2 emissions. On the flip side, some external factors positively affect SO2 emissions.

The results suggest that in China, accommodation, shopping, and entertainment have a negligible impact on GHG emissions, including SO_2. Food and beverages are also minor in air pollutants, except for $PM_{2.5}$. However, energy consumption contributes insignificantly to CO_2 and CO emissions, indicating a substantial link between energy use and environmental pollutants. However, it is important to investigate these relationships using more specific data and rigorous statistical analyses to confirm or refute the lack of a significant relationship.

A major change toward market-based environmental rules and initiatives is required to meet China's goals of reaching carbon neutrality by 2060 and peaking CO2 emissions by 2030. The present centralized control system needs to meet pollution reduction aims. Market-based strategies like carbon pricing and emissions trading systems must be adopted if greenhouse gas emissions are to be reduced significantly.

The efficacy of carbon pricing, which penalizes companies financially for each metric ton of carbon dioxide equivalent they produce, has been shown to reduce emissions. A large decrease in greenhouse gas emissions may be achieved in China by implementing a carbon price scheme suited to emitters' needs. This strategy encourages firms to invest in cutting-edge technology and more environmentally friendly procedures while simultaneously generating income for the government.

Additionally, implementing an emissions trading system that rewards participating companies with annual carbon credits may encourage emission reductions and advance sustainable business practices. The effectiveness of these strategies not only supports environmental objectives but also strengthens China's standing in the fight against climate change globally.

Future-proofing rules and regulations are essential for promoting environmentally responsible rural tourist activities, protecting natural resources, and reducing adverse environmental effects. Key policies include waste management rules to reduce environmental pollution, zoning ordinances that support eco-friendly tourist infrastructure, and financial incentives for companies to embrace sustainable practices. China can foster an atmosphere for sustainable development while actively participating in efforts to mitigate climate change by integrating governmental frameworks with market-driven processes.

This research highlights the significance of sustainable practices in the catering, food and beverage, tourist, and transportation sectors to prevent detrimental environmental consequences. It highlights the environmental implications of many components of rural tourism. These results advance our theoretical knowledge of sustainable tourism and provide policymakers with more information to craft policies that support economic development and environmental protection.

A sub-sectoral approach is warranted to address the environmental impacts of rural tourism, which have yet to be addressed in previous research. However, no study is exhaustive, and we compiled information from numerous departments and agencies. While we looked at the various sub-sectors of rural tourism, we should have accounted for the industry's many important stakeholders in infrastructure building, natural resource management, and socioeconomics. Future studies may include these areas and use a nonparametric approach or Quantile ARDL to analyze the same data for a more in-depth evaluation.

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Data availability statement

Data is available on World bank (http://www.stats.gov.cn/english/).

CRediT authorship contribution statement

Xiangyang Wu: Funding acquisition, Data curation, Conceptualization. **Yu Si:** Resources, Project administration, Methodology, Investigation. **Usman Mehmood:** Writing - review & editing, Writing - original draft, Validation, Supervision, Software.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] J. Chen, Y. Huang, E.Q. Wu, R. Ip, K. Wang, How does rural tourism experience affect green consumption in terms of memorable rural-based tourism experiences, connectedness to nature and environmental awareness? J. Hospit. Tourism Manag. 54 (Mar. 2023) 166–177, https://doi.org/10.1016/j.jhtm.2022.12.006.

[2] M. Kaaristo, Value of Silence: Mediating Aural Environments in Estonian Rural Tourism, vol. 12, 2014, pp. 267–279, https://doi.org/10.1080/14766825.2014.939366, no. 3.

[3] P.D. Rosalina, K. Dupre, Y. Wang, Rural tourism: a systematic literature review on definitions and challenges, J. Hospit. Tourism Manag. 47 (Jun. 2021) 134–149, https://doi.org/10.1016/j.jhtm.2021.03.001.

[4] NBS, "National Bureau of Statistics China."..

[5] S. Zhu, Y. Luo, N. Aziz, A. Jamal, Q. Zhang, Environmental Impact of the Tourism Industry in China: Analyses Based on Multiple Environmental Factors Using Novel Quantile Autoregressive Distributed Lag Model, vol. 35, 2021, pp. 3663–3689, https://doi.org/10.1080/1331677X.2021.2002707, no. 1.

[6] L.U. Calderwood, M. Soshkin, The Travel and Tourism Competitiveness Report 2019, World Economic Forum, 2019.

[7] Y. Wang, L. Wang, H. Liu, Y. Wang, The robust causal relationships among domestic tourism demand, carbon emissions, and economic growth in China, Sage Open 11 (4) (Oct. 2021), 215824402110544, https://doi.org/10.1177/21582440211054478.

[8] B. He, L. Li, J. Wang, J. Li, L. Zhu, Investigating the Influence of Tourism on Economic Growth and Carbon Emissions: Evidence from Hainan Island, China, 2022, https://doi.org/10.1080/1528008X.2022.2029666.

[9] A. Rauf, et al., Do tourism development, energy consumption and transportation demolish sustainable environments? Evidence from Chinese provinces, Sustainability 13 (22) (2021), https://doi.org/10.3390/SU132212361.

[10] H. Bai, M. Irfan, Y. Hao, How does industrial transfer affect environmental quality? Evidence from China, J. Asian Econ. 82 (2022), https://doi.org/10.1016/j.asieco.2022.101530.

[11] J. Liang, M. Irfan, M. Ikram, D. Zimon, Evaluating natural resources volatility in an emerging economy: the influence of solar energy development barriers, Resour. Pol. 78 (2022), https://doi.org/10.1016/j.resourpol.2022.102858.

[12] U. Waris, S. Tariq, U. Mehmood, Z. ul-Haq, Exploring potential impacts of climatic variability on production of maize in Pakistan using ARDL approach, Acta Geophys. (May 2023), https://doi.org/10.1007/s11600-023-01118-0.

[13] S.Q. Ali Shah, et al., What is the role of remittance and education for environmental pollution? - analyzing in the presence of financial inclusion and natural resource extraction, Heliyon 9 (6) (2023), e17133, https://doi.org/10.1016/j.heliyon.2023.e17133.

[14] F. Zhang, et al., Coupling coordination and obstacle factors between tourism and the ecological environment in Chongqing, China: a multi-model comparison, Asia Pac. J. Tourism Res. 26 (7) (2021) 811–828, https://doi.org/10.1080/10941665.2021.1925715.

[15] M.A. Ansari, M.A. Villanthenkodath, Does tourism development promote ecological footprint? A nonlinear ARDL approach, Anatolia 33 (4) (Oct. 2022) 614–626, https://doi.org/10.1080/13032917.2021.1985542.

[16] C. Xiong, Q. Xu, M. Liu, V. Chang, Factors affecting student satisfaction in e-learning, Int. J. Bus. Syst. Res. 1 (1) (2022) 1, https://doi.org/10.1504/IJBSR.2022.10031981.

[17] M. Irfan, M. Abdur Rehman, X. Liu, A. Razzaq, Interlinkages between mineral resources, financial markets, and sustainable energy sources: evidence from minerals exporting countries, Resour. Pol. 79 (Dec. 2022), 103088, https://doi.org/10.1016/j.resourpol.2022.103088.

[18] U. Waris, S. Sarif, S.A. Batool, Exploring association and forecasting of evapotranspiration based on meteorological factors over megacity Lahore (Pakistan) and central place of Indo-Gangetic Basin, Environ. Dev. Sustain. (2023), https://doi.org/10.1007/s10668-023-03471-y.

[19] A. Sharif, D.I. Godil, B. Xu, A. Sinha, S.A. Rehman Khan, K. Jermsittiparsert, Revisiting the role of tourism and globalization in environmental degradation in China: fresh insights from the quantile ARDL approach, J. Clean. Prod. 272 (Nov. 2020), 122906, https://doi.org/10.1016/j.jclepro.2020.122906.

[20] Z. Wang, F. Yin, Y. Zhang, X. Zhang, An empirical research on the influencing factors of regional CO2 emissions: evidence from Beijing city, China, Appl. Energy 100 (Dec. 2012) 277–284, https://doi.org/10.1016/j.apenergy.2012.05.038.

[21] M. Shahbaz, S.A. Solarin, H. Mahmood, M. Arouri, Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis, Econ. Modell. 35 (Sep. 2013) 145–152, https://doi.org/10.1016/j.econmod.2013.06.037.

[22] T. Hassan, H. Song, Y. Khan, D. Kirikkaleli, Energy efficiency a source of low carbon energy sources? Evidence from 16 high-income OECD economies, Energy 243 (Mar. 2022), 123063, https://doi.org/10.1016/j.energy.2021.123063.

[23] N.M. Suki, N.M. Suki, A. Sharif, S. Afshan, K. Jermsittiparsert, The role of technology innovation and renewable energy in reducing environmental degradation in Malaysia: a step towards sustainable environment, Renew. Energy 182 (Jan. 2022) 245–253, https://doi.org/10.1016/j.renene.2021.10.007.

[24] A. Sharif, M.S. Meo, M.A.F. Chowdhury, K. Sohag, Role of solar energy in reducing ecological footprints: an empirical analysis, J. Clean. Prod. 292 (Apr. 2021), 126028, https://doi.org/10.1016/j.jclepro.2021.126028.

[25] H. Mahmood, N. Saqib, Oil rents, economic growth, and CO2 emissions in 13 OPEC member economies: asymmetry analyses, Front. Environ. Sci. 10 (Oct) (2022), https://doi.org/10.3389/fenvs.2022.1025756.

[26] Z. Ahmed, B. Zhang, M. Cary, Linking economic globalization, economic growth, financial development, and ecological footprint: evidence from symmetric and asymmetric ARDL, Ecol. Indicat. 121 (Feb. 2021), 107060, https://doi.org/10.1016/j.ecolind.2020.107060.

[27] J. Fang, G. Gozgor, S.R. Paramati, W. Wu, The impact of tourism growth on income inequality: evidence from developing and developed economies, Tourism Econ. 27 (8) (Dec. 2021) 1669–1691, https://doi.org/10.1177/1354816620934908.

[28] S. Khan, M. Azam, I. Ozturk, S.F. Saleem, Analysing Association in Environmental Pollution, Tourism and Economic Growth: Empirical Evidence from the Commonwealth of Independent States, vol. 57, Nov. 2021, pp. 1544–1561, https://doi.org/10.1177/00219096211058881, no. 8.

[29] S. Çiftçioğlu, A. Sokhanvar, Can Specialization in Tourism Enhance the Process of Sustainable Economic Development and Investment in East Asia and the Pacific?, vol. 23, 2021, pp. 1006–1029, https://doi.org/10.1080/15256480.2021.1905581, no. 5.

[30] M. Usman, S. Anwar, M.R. Yaseen, M.S.A. Makhdum, R. Kousar, A. Jahanger, Unveiling the dynamic relationship between agriculture value addition, energy utilization, tourism and environmental degradation in South Asia, J. Publ. Aff. 22 (4) (Nov. 2022), e2712, https://doi.org/10.1002/PA.2712.

[31] F. Fatai Adedoyin, P.O. Agboola, I. Ozturk, F.V. Bekun, M.O. Agboola, Environmental consequences of economic complexities in the EU amidst a booming tourism industry: accounting for the role of brexit and other crisis events, J. Clean. Prod. 305 (Jul. 2021), 127117, https://doi.org/10.1016/J.JCLEPRO.2021.127117.

[32] A. Razzaq, T. Fatima, M. Murshed, Asymmetric effects of tourism development and green innovation on economic growth and carbon emissions in top 10 GDP countries, J. Environ. Plann. Manag. 66 (3) (Feb. 2023) 471–500, https://doi.org/10.1080/09640568.2021.1990029.

[33] Y. Sun, O.A. Duru, A. Razzaq, M.S. Dinca, The asymmetric effect eco-innovation and tourism towards carbon neutrality target in Turkey, J. Environ. Manag. 299 (2021), 113653, https://doi.org/10.1016/J.JENVMAN.2021.113653.

[34] Danish, Z. Wang, Dynamic relationship between tourism, economic growth, and environmental quality, J. Sustain. Tourism 26 (11) (Nov. 2018) 1928–1943, https://doi.org/10.1080/09669582.2018.1526293.

[35] N.M. Saviolidis, D. Cook, B. Davíðsdóttir, L. Jóhannsdóttir, S. Ólafsson, Challenges of national measurement of environmental sustainability in tourism, Current Research in Environmental Sustainability 3 (2021), 100079, https://doi.org/10.1016/j.crsust.2021.100079.

[36] Z. Zhan, L. Ali, S. Sarwat, D.I. Godil, G. Dinca, M.K. Anser, A step towards environmental mitigation: do tourism, renewable energy and institutions really matter? A QARDL approach, Sci. Total Environ. 778 (2021), https://doi.org/10.1016/j.scitotenv.2021.146209.

[37] H. Shi, X. Li, H. Zhang, X. Liu, T. Li, Z. Zhong, Global difference in the relationships between tourism, economic growth, CO2 emissions, and primary energy consumption, Curr. Issues Tourism 23 (9) (May 2020) 1122–1137, https://doi.org/10.1080/13683500.2019.1588864.

[38] S. Zhang, X. Liu, The roles of international tourism and renewable energy in environment: new evidence from Asian countries, Renew. Energy 139 (Aug. 2019) 385–394, https://doi.org/10.1016/j.renene.2019.02.046.

[39] J. Gao, L. Zhang, Exploring the dynamic linkages between tourism growth and environmental pollution: new evidence from the Mediterranean countries, Curr. Issues Tourism 24 (1) (2021) 49–65, https://doi.org/10.1080/13683500.2019.1688767.

[40] L. Zhong, J. Deng, Z. Song, P. Ding, Research on environmental impacts of tourism in China: progress and prospect, J. Environ. Manag. 92 (11) (Nov. 2011) 2972–2983, https://doi.org/10.1016/j.jenvman.2011.07.011.

[41] Z. Tang, C.B. Shi, Z. Liu, Sustainable development of tourism industry in China under the low-carbon economy, Energy Proc. 5 (2011) 1303–1307, https://doi.org/10.1016/j.egypro.2011.03.226.

[42] J. Zeng, Y. Wen, C. Bi, R. Feiock, Effect of tourism development on urban air pollution in China: the moderating role of tourism infrastructure, J. Clean. Prod. 280 (Jan. 2021), https://doi.org/10.1016/j.jclepro.2020.124397.

[43] Y. Geng, R. Wang, Z. Wei, Q. Zhai, Temporal-spatial measurement and prediction between air environment and inbound tourism: case of China, J. Clean. Prod. 287 (Mar. 2021), https://doi.org/10.1016/j.jclepro.2020.125486.

[44] P. Wu, P. Shi, An estimation of energy consumption and CO2 emissions in tourism sector of China, J. Geogr. Sci. 21 (4) (Aug. 2011) 733–745, https://doi.org/10.1007/S11442-011-0876-Z.

[45] A. Razzaq, A. Sharif, P. Ahmad, K. Jermsittiparsert, Asymmetric role of tourism development and technology innovation on carbon dioxide emission reduction in the Chinese economy: fresh insights from QARDL approach, Sustain. Dev. 29 (1) (Jan. 2021) 176–193, https://doi.org/10.1002/SD.2139.

[46] Y. Teng, A. Cox, I. Chatziantoniou, Environmental degradation, economic growth and tourism development in Chinese regions, Environ. Sci. Pollut. Control Ser. 28 (26) (2021) 33781–33793, https://doi.org/10.1007/s11356-021-12567-9.

[47] S. Ullah, K. Ali, S.A. Shah, M. Ehsan, Environmental concerns of financial inclusion and economic policy uncertainty in the era of globalization: evidence from low & high globalized OECD economies, Environ. Sci. Pollut. Control Ser. 29 (24) (May 2022) 36773–36787, https://doi.org/10.1007/s11356-022-18758-2.

[48] H. Song, G. Li, Z. Cao, Tourism and economic globalization: an emerging research agenda, J. Trav. Res. 57 (8) (Nov. 2018) 999–1011, https://doi.org/10.1177/0047287517734943.

[49] E. Németh-Durkó, Determinants of carbon emissions in a European emerging country: evidence from ARDL cointegration and Granger causality analysis, Int. J. Sustain. Dev. World Ecol. 28 (5) (2021) 417–428, https://doi.org/10.1080/13504509.2020.1839808.

[50] H. Wang, et al., Emissions of volatile organic compounds (VOCs) from cooking and their speciation: a case study for Shanghai with implications for China, Sci. Total Environ. 621 (Apr. 2018) 1300–1309, https://doi.org/10.1016/j.scitotenv.2017.10.098.

[51] K. Dube, G. Nhamo, Greenhouse gas emissions and sustainability in victoria falls: focus on hotels, tour operators and related attractions, African Geograph. Rev. 40 (2) (2021) 125–140, https://doi.org/10.1080/19376812.2020.1777437.

[52] B.K. Sovacool, M. Bazilian, S. Griffiths, J. Kim, A. Foley, D. Rooney, Decarbonizing the food and beverages industry: a critical and systematic review of developments, sociotechnical systems and policy options, Renew. Sustain. Energy Rev. 143 (Jun. 2021), 110856, https://doi.org/10.1016/j.rser.2021.110856.

[53] S. Afshan, T. Yaqoob, The potency of eco-innovation, natural resource and financial development on ecological footprint: a quantile-ARDL-based evidence from China, Environ. Sci. Pollut. Control Ser. 29 (33) (2022) 50675–50685, https://doi.org/10.1007/s11356-022-19471-w.

[54] Y. Sun, W. Tian, U. Mehmood, X. Zhang, S. Tariq, How do natural resources, urbanization, and institutional quality meet with ecological footprints in the presence of income inequality and human capital in the next eleven countries? Resour. Pol. 85 (Aug. 2023), 104007 https://doi.org/10.1016/j.resourpol.2023.104007.

[55] X. Li, Y. Sun, J. Dai, U. Mehmood, How do natural resources and economic growth impact load capacity factor in selected Next-11 countries? Assessing the role of digitalization and government stability, Environ. Sci. Pollut. Control Ser. 30 (36) (2023) 85670–85684, https://doi.org/10.1007/s11356-023-28414-y.

[56] P. Xu, J. Zhang, U. Mehmood, How do green Investments, foreign direct investment, and renewable energy impact CO2 emissions? Measuring the role of education in E-7 nations, Sustainability 15 (19) (Sep. 2023), 14052, https://doi.org/10.3390/su151914052.

[57] I. Uddin, A. Ullah, N. Saqib, R. Kousar, M. Usman, Heterogeneous role of energy utilization, financial development, and economic development in ecological footprint: how far away are developing economies from developed ones, Environ. Sci. Pollut. Control Ser. 30 (20) (Mar. 2023) 58378–58398, https://doi.org/10.1007/s11356-023-26584-3.

[58] Z. Zhen, S. Ullah, Z. Shaowen, M. Irfan, How do renewable energy consumption, financial development, and technical efficiency change cause ecological sustainability in European Union countries? Energy Environ. (Jun. 2022), 0958305X2211099 https://doi.org/10.1177/0958305X221109949.

[59] M. Azam, A. Raza, Does foreign direct investment limit trade-adjusted carbon emissions: fresh evidence from global data, Environ. Sci. Pollut. Control Ser. 29 (25) (May 2022) 37827–37841, https://doi.org/10.1007/S11356-021-18088-9.

[60] F.V. Bekun, F.F. Adedoyin, M.U. Etokakpan, B.A. Gyamfi, Exploring the tourism-CO emissions-real income nexus in E7 countries: accounting for the role of institutional quality, J. Policy Res. Tour. Leis. Events 14 (1) (Jan. 2022) 1–19, https://doi.org/10.1080/19407963.2021.2017725.

[61] A.E. Caglar, B. Guloglu, A. Gedikli, Moving towards sustainable environmental development for BRICS: investigating the asymmetric effect of natural resources on CO 2, Sustain. Dev. 30 (5) (Oct. 2022) 1313–1325, https://doi.org/10.1002/sd.2318.

[62] S. Ullah, R. Luo, T.S. Adebayo, M.T. Kartal, Dynamics between environmental taxes and ecological sustainability: evidence from top-seven green economies by novel quantile approaches, Sustain. Dev. (2022), https://doi.org/10.1002/SD.2423.

[63] N. Saqib, Green energy, non-renewable energy, financial development and economic growth with carbon footprint: heterogeneous panel evidence from cross-country, Econ. Res.-Ekonomska Istraživanja 35 (1) (Dec. 2022) 6945–6964, https://doi.org/10.1080/1331677X.2022.2054454.

[64] F.V. Bekun, B.A. Gyamfi, S.T. Onifade, M.O. Agboola, Beyond the environmental Kuznets Curve in E7 economies: accounting for the combined impacts of institutional quality and renewables, J. Clean. Prod. 314 (Sep. 2021), 127924, https://doi.org/10.1016/j.jclepro.2021.127924.

[65] R. Croes, J. Ridderstaat, M. Bąk, P. Zientara, Tourism specialization, economic growth, human development and transition economies: the case of Poland, Tourism Manag. 82 (Feb. 2021), 104181, https://doi.org/10.1016/J.TOURMAN.2020.104181.

[66] M. Ahmad, P. Jiang, A. Majeed, M. Umar, Z. Khan, S. Muhammad, The dynamic impact of natural resources, technological innovations and economic growth on ecological footprint: an advanced panel data estimation, Resour. Pol. 69 (Dec. 2020), 101817, https://doi.org/10.1016/j.resourpol.2020.101817.

[67] N. Kongbuamai, Q. Bui, H.M.A.U. Yousaf, Y. Liu, The impact of tourism and natural resources on the ecological footprint: a case study of ASEAN countries, Environ. Sci. Pollut. Control Ser. 27 (16) (Jun. 2020) 19251–19264, https://doi.org/10.1007/s11356-020-08582-x.

[68] Y. Chen, C.-C. Lee, Does technological innovation reduce CO2 emissions?Cross-country evidence, J. Clean. Prod. 263 (2020), 121550, https://doi.org/10.1016/j.jclepro.2020.121550.

[69] L. Wang, H.-L. Chang, S.K.A. Rizvi, A. Sari, Are eco-innovation and export diversification mutually exclusive to control carbon emissions in G-7 countries? J. Environ. Manag. 270 (Sep. 2020), 110829 https://doi.org/10.1016/j.jenvman.2020.110829.

[70] Z. Ahmed, M.M. Asghar, M.N. Malik, K. Nawaz, Moving towards a sustainable environment: the dynamic linkage between natural resources, human capital, urbanization, economic growth, and ecological footprint in China, Resour. Pol. 67 (Aug. 2020), 101677, https://doi.org/10.1016/j.resourpol.2020.101677.

[71] M. Aydin, Y.E. Turan, The influence of financial openness, trade openness, and energy intensity on ecological footprint: revisiting the environmental Kuznets curve hypothesis for BRICS countries, Environ. Sci. Pollut. Control Ser. 27 (34) (2020) 43233–43245, https://doi.org/10.1007/s11356-020-10238-9.

[72] D.I. Godil, A. Sharif, S. Rafique, K. Jermsittiparsert, The asymmetric effect of tourism, financial development, and globalization on ecological footprint in Turkey, Environ. Sci. Pollut. Control Ser. 27 (32) (Nov. 2020) 40109–40120, https://doi.org/10.1007/s11356-020-09937-0.

[73] M. Liu, X. Ren, C. Cheng, Z. Wang, The role of globalization in CO2 emissions: a semi-parametric panel data analysis for G7, Sci. Total Environ. 718 (May 2020), 137379, https://doi.org/10.1016/j.scitotenv.2020.137379.

[74] S. Fethi, A. Rahuma, The role of eco-innovation on CO2 emission reduction in an extended version of the environmental Kuznets curve: evidence from the top 20 refined oil exporting countries, Environ. Sci. Pollut. Control Ser. 26 (29) (Oct. 2019) 30145–30153, https://doi.org/10.1007/s11356-019-05951-z.

[75] S.T. Hassan, E. Xia, N.H. Khan, S.M.A. Shah, Economic growth, natural resources, and ecological footprints: evidence from Pakistan, Environ. Sci. Pollut. Control Ser. 26 (3) (Jan. 2019) 2929–2938, https://doi.org/10.1007/s11356-018-3803-3.

[76] M.A. Baloch, J. Zhang, K. Iqbal, Z. Iqbal, The effect of financial development on ecological footprint in BRI countries: evidence from panel data estimation, Environ. Sci. Pollut. Control Ser. 26 (6) (2019) 6199–6208, https://doi.org/10.1007/s11356-018-3992-9.

[77] M.A. Destek, S.A. Sarkodie, Investigation of environmental Kuznets curve for ecological footprint: the role of energy and financial development, Sci. Total Environ. 650 (Feb. 2019) 2483–2489, https://doi.org/10.1016/j.scitotenv.2018.10.017.

[78] M.K. Khan, J.-Z. Teng, M.I. Khan, M.O. Khan, Impact of globalization, economic factors and energy consumption on CO2 emissions in Pakistan, Sci. Total Environ. 688 (Oct. 2019) 424–436, https://doi.org/10.1016/j.scitotenv.2019.06.065.

[79] Y. Zhou, T.G. Mistry, W.G. Kim, C. Cobanoglu, Workplace mistreatment in the hospitality and tourism industry: a systematic literature review and future research suggestions, J. Hospit. Tourism Manag. 49 (Dec. 2021) 309–320, https://doi.org/10.1016/j.jhtm.2021.09.024.

[80] C. Xiong, A. Khan, S. Bibi, H. Hayat, S. Jiang, Tourism subindustry level environmental impacts in the US, Curr. Issues Tourism 26 (6) (Mar. 2023) 903–921, https://doi.org/10.1080/13683500.2022.2043835.

[81] P.R. Ehrlich, J.P. Holdren, Impact of population growth, Science (1979) 171 (3977) (Mar. 1971) 1212–1217, https://doi.org/10.1126/science.171.3977.1212.

[82] R. York, E.A. Rosa, T. Dietz, STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts, Ecol. Econ. 46 (3) (Oct. 2003) 351–365, https://doi.org/10.1016/S0921-8009(03)00188-5.

[83] A.E. Caglar, M.W. Zafar, F.V. Bekun, M. Mert, Determinants of CO2 emissions in the BRICS economies: the role of partnerships investment in energy and economic complexity, Sustain. Energy Technol. Assessments 51 (Jun. 2022), 101907, https://doi.org/10.1016/j.seta.2021.101907.

[84] M. Shahbaz, C. Raghutla, M. Song, H. Zameer, Z. Jiao, Public-private partnerships investment in energy as new determinant of CO2 emissions: the role of technological innovations in China, Energy Econ. 86 (Feb. 2020), 104664, https://doi.org/10.1016/j.eneco.2020.104664.

[85] B. Pan, T.S. Adebayo, R.L. Ibrahim, M.A.S. Al-Faryan, Does nuclear energy consumption mitigate carbon emissions in leading countries by nuclear power consumption? Evidence from quantile causality approach, Energy Environ. (2022), 0958305X2211129, https://doi.org/10.1177/0958305X221112910.

[86] T.S. Adebayo, Environmental consequences of fossil fuel in Spain amidst renewable energy consumption: a new insights from the wavelet-based Granger causality approach, Int. J. Sustain. Dev. World Ecol. 29 (7) (Oct. 2022) 579–592, https://doi.org/10.1080/13504509.2022.2054877.

[87] M. Arellano, O. Bover, Another look at the instrumental variable estimation of error-components models, J. Econom. 68 (1) (1995) 29–51, https://doi.org/10.1016/0304-4076(94)01642-D.

[88] E. Zivot, D.W.K. Andrews, Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis, J. Bus. Econ. Stat. 20 (1) (Jan. 1992) 25–44, https://doi.org/10.1198/073500102753410372.

[89] U. Farooq, J. Ahmed, S. Khan, Do the macroeconomic factors influence the firm's investment decisions? A generalized method of moments approach, Int. J. Finance Econ. 26 (1) (Jan. 2021) 790–801, https://doi.org/10.1002/ijfe.1820.

[90] N.P. Canh, C. Schinckus, S.D. Thanh, The natural resources rents: is economic complexity a solution for resource curse? Resour. Pol. 69 (2020), 101800 https://doi.org/10.1016/j.resourpol.2020.101800.

[91] R. Arbolino, R. Boffardi, L. De Simone, G. Ioppolo, Multi-objective optimization technique: a novel approach in tourism sustainability planning, J. Environ. Manag. 285 (May 2021), 112016, https://doi.org/10.1016/j.jenvman.2021.112016.

[92] L.H.U.W. Abeydeera, G. Karunasena, Greenhouse gas emission reporting mechanism for hotel industry: a case of Sri Lanka, Int. J. Environ. Sci. Nat. Resour. 20 (4) (2019), https://doi.org/10.19080/IJESNR.2019.20.556042.