Impact of eco-innovation and sustainable tourism growth on the environmental degradation: the case of China

Ka Yin Chau, Chen-Hsien Lin, Bushra Tufail, Trung Kien Tran, Le Van & Tran Thai Ha Nguyen

Published online: 03 Jan 2023.

Submit your article to this journal ↗

Article views: 804

View related articles ↗

View Crossmark data ↗

Routledge
Taylor & Francis Group

OPEN ACCESS   Check for updates

Impact of eco-innovation and sustainable tourism growth on the environmental degradation: the case of China

Ka Yin Chau[a,b], Chen-Hsien Lin[c], Bushra Tufail[d], Trung Kien Tran[e], Le Van[f] and Tran Thai Ha Nguyen[g]

[a]School of Management, Guangdong University of Science & Technology, Dongguan, Guangdong, China; [b]Faculty of Business, City University of Macau, Taipa, Macau, China; [c]Department of Hotel & MICE Management, Overseas Chinese University, Taichung, Taiwan; [d]Department of Public Administration, University of Karachi, Pakistan; [e]School of Public Finance, College of Economics, Law and Government, University of Economics Ho Chi Minh City, Ho Chi Minh City, Vietnam; [f]Faculty of Business Administration, Van Lang University, Ho Chi Minh City, Vietnam; [g]Faculty of Finance and Accounting, Saigon University, Ho Chi Minh City, Vietnam

ABSTRACT

Climate complexities and global warming have made sustainable development a customary topic in environmental literature. Since then, various diggings have been happening in academia. Amongst them tourism and eco-innovation receives the heap due to its contribution to economic development. The study, thereby, examines the impact of tourism, economic growth and eco-innovation on environmental degradation in China. The secondary data has been extracted from World Development Indicators (WDI) database from 1988 to 2020. The nexus among the variables have been examined using Nonlinear Autoregressive Distributed Lagged (NARDL) model. Findings reveal that international tourism receipts, expenditures and number of tourist arrival, GDP, national income and inflation are positively correlated with environmental degradation, while sustainability-oriented eco-innovation is related negatively in case of China. This study has provided help to the regulators while developing new policies regarding environmental degradation by controlling emissions from economic and tourism development and using sustainability-oriented eco-innovation.

1. Introduction

The environment is inextricably linked to the country's survival, development, prosperity, and country's future. The public personal lives, their social well-being, the country's financial development, and its economic progress are all influenced by the country's environmental quality (Sadiq, Ngo, et al., 2022; U. Shahzad, 2020). The environment in which human beings live, operate social activities and perform their jobs for livelihood has an impact on their physical and mental health, the quality of

CONTACT Le Van ✉ van.l@vlu.edu.vn

natural resources like water, soil, and minerals, and the health of living creatures on land, in the air, and underwater. When the living or work environment is free from pollution, it is clean and healthy; it maintains the people's health, keeps them fresh and energetic and assists them to lead a tranquil, quality life and be efficient in their social functions (Khattak et al., 2021; Lan et al., 2022; Umar et al., 2021). Economic development of any nation is supported by healthy and fresh persons who supply efficient labor, high intellect and effective management, as well as living and non-living natural resources and the nature of the work context. The quality environment assists in attaining a higher country's development not only in the present but also achieves the sustainable development for which it is required to assure the continued availability of energy and physical resources that are naturally found are created with the help of natural resources as well as efficient human resources (Liu, Yin, et al., 2022; Liu, Lan, et al., 2022; Mujan et al., 2019). If the natural environment is not clean and healthy, it becomes impossible to secure the natural resources and human capital for the future. A polluted environment not only affects the quality of resources but can diminish them completely, and it can also become a cause of many diseases among humans. There are many contaminating factors that come into existence naturally or as a result of human activities that can degrade environmental conditions (Kamarudin et al., 2021; Sarkodie & Strezov, 2018).

It has the belief of many that high emission of hazardous gases is responsible for increased global temperature. These anthropogenic emissions are not only hurting humans but also causing harm to ecosystem. The recent reports also illustrates that emissions cause by human activities such as deforestation activities, tourism, gas flaring are responsible for 95% global warming (Altıntaş & Kassouri, 2020; Chien, Hsu et al., 2022). Consequently, global temperatures are expected to climb dramatically. CO2 emissions and their repercussions, such as global warming, affect the ecosystem, weather system, quality of natural resources like foods, water, soil, minerals, and life on the earth (Avom et al., 2020; Haroon et al., 2021). As a result, a country's sustainable development becomes unlikely to achieve because a comfortable work context, fertile land, high-quality and abundant minerals, bio-productivity, pure water, and human resources are all necessary for sustainable economic development. Minimizing CO2 emissions can help to mitigate environmental degradation (Chien, 2022b; Mardani et al., 2019).

Tourism is one of the fast growing sectors in recent times, hence, considered a significant part of world economy. However, like others, it too has an adverse consequences when it comes to climate and environment. It is argued that tourism activities such as transportation and accommodation damages the environment drastically (Bhat, 2018; Ehsanullah et al., 2021). According to researchers, tourism collectively contributes 8% to GHG emissions and when it is not planned properly, it may cause huge and stubborn strain on environment in a longer run (Chien, Chau, et al., 2022; Wang & Wang, 2018). It is argued that there are countless reasons due to which tourism could impact environment negatively. This might cover no of tourists, different tourism activities, specific logistic services that are being offered during travelling etc. All in all, we can say that tourism growth and economic growth are two major causes of CO2 emissions and, consequently, the cause of environmental degradation for they cause an increase in economic human behaviors, as well as a variety

of social and domestic activities that make use of various technology and energy sources (Appiah, 2018; Chien, 2022a; Chien, Zhang, et al., 2022). However, economic factors such as sustainability-oriented eco-innovation can help to mitigate the detrimental effects of other economic activities such as CO2 emissions management.

Eco-innovation refers to a type of innovation that helps to achieve sustainable development with the reduction in the environmental impacts of our manufacturing processes, enhancing resistance to environmental challenges on the part of the change in nature, enhancing nature's ability to recover from environmental disasters, or ensuring optimal and responsible use of natural resources. Business processes, resources, technologies, and instruments are acquired, invented, and used in sustainability-oriented eco-innovation to reduce environmental pollution like CO emissions by employing renewable resources, reducing the fossil fuel and nuclear power consumption, or assuring energy sources' efficient use, or effective use of the things that are the source of CO2 emissions (Bai et al., 2022; Sun et al., 2021). That is why, in the economies where the businesses encourage the adoption of sustainability-oriented innovation, CO2 emissions are minimal.

The main focus of the study is on the impacts of tourism growth and economic growth factors like on environmental degradation in China. China is a fast-growing upper-middle-income economy that is newly industrialized. As per 2021 statistics, the country's nominal GDP is $16.6420 trillion, which accounts for an 8.5 per cent GDP growth rate. As per the nominal GDP, the country is the second-largest world economy (B. Wang & Wang, 2018). Whereas, as the GDP (PPP) puts it is the largest world economy. Agriculture among these economic sectors has the least negative environmental impacts. Rather, this sector is effective to protect environmental protection. However, industry and service based organization consume major chunk of energy and other resources which becomes the ultimate reason of polluted emissions (M. Ahmad et al., 2019).

In China, the major cause of environmental degradation is the country's population strength and dramatic expansion in the country's economy. The increasing population emits CO2 through respiration processes and their conduct regarding the domestic and economic decisions (Liu & Bae, 2018; Ojogiwa, 2021). Besides all other sectors, the rapid development in the tourism industry is increasing many environmental issues like declining air quality, increasing water pollution, increasing noise, and increasing biodiversity loss. Tourism not only causes pollution emissions but also makes other sectors to be a great source of pollution emissions (Jermsittiparsert, 2021; Ulucak, 2020). Among the world economies, China is considered the largest emitter of CO2 in the air, which represents it as the largest emitter of greenhouse gases. Because of this comparison, most people considers that the country is a major contribute carbon emissions. However, the situation is quite complicated if one ponders on the situation. According to deep observation, China alone has the capacity to destroy the globe. It has also revealed that the environmental condition of China is the worst ever been. The empirical analysis of M. Ahmad et al., (2018) proves that in terms of the overall greenhouse gas emission, China ranks first.

Well, the country has 48 places among the world economies in terms of per capita emissions, as it releases 7.10 tons of CO2. In this lieu, China is the 14th largest

country among the worst countries that are responsible for higher carbon emissions (Abdul Hamid et al., 2020; Ainou et al., 2022; Shahbaz et al., 2020). The environmental statistics have made it clear that China's CO2 emissions are 10.21 billion metric tons and the US CO2 emissions are 5.30 billion metric tons, which is about half of China's CO2 emissions. These environmental statistics also reveal that the country's emissions cover 28% of world CO2 emissions. This sets the position of the country as the greatest greenhouse gas emitter (Aslam et al., 2021; Ali et al., 2022). Because of the ongoing rise in CO2 emissions and their negative effects on environmental quality and economic development, it is critical to focus on and address this problem. China has producing CO2 emission more than the United States, India, Japan and Germany. Figure 1 illustrates the clear picture.

Thus, the present study is aimed at analyzing the impacts of tourism and economic growth on environmental degradation. In previous studies, the impacts of tourism and economic growth on environmental degradation have been examined, but it has been done separately. For example, Lei et al. (2022) has examined only the impacts of tourism growth on environmental quality and pays no attention to overall economic growth in their investigation. The present article accumulates the effect of tourism growth and economic growth on environmental degradation. 2) CO2 emissions are the most dangerous greenhouse gas emission, and that is why they could be the most appropriate indicator of environmental degradation. The study considers CO2 emissions as a proxy of environmental degradation for analyzing the impacts of tourism and economic growth on environmental degradation is a great addition to environment-related literature. 3) This study examines how much the selected factors contribute to CO2 emissions and environmental degradation for an extended period of time in China, while in the previous literature, a little attention has been given to impacts of these variables on environmental degradation in China and in a limited period of time. So, the present study is a great contribution to the literature.

This paper is comprised of give parts: After the introductory part, the later part deals with the literature review where the theme of study is discussed in the light of past studies arguments. The next part explains the methodology part. After finding the results are compared with outcomes of past studies, and thereby, the study is supported. Near the end, the study implications are explained and followed by the study conclusion and implications.
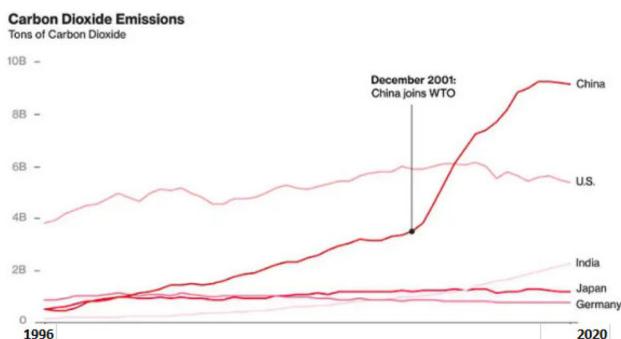

Figure 1. CO2 emission in China, US, India, Japan and Germany.
Source: WDI.

2. Literature review

The air, water, soil, minerals, energy sources, food and non-food crops, woods, and living resources which all are elements of the environment, are necessary for the country's overall development. A clean and healthy environment enhances the quality of these resources and triggers the country's development. Contrary to this, the environment, which is facing pollution in large amounts, has low quality of natural resources, both living and non-living and damages the health of humans. Thus, environmental degradation becomes a hurdle to the country's development (Hartani et al., 2021; Rehman et al., 2021). CO_2 emissions are one of the most dangerous factors that could destroy the environment. Tourism and economic growth cause an increase in human-based activities that releases CO_2 emissions and environmental degradation. However, if economic growth is driven by sustainability-oriented eco-innovation, it has a little negative impact on the environment because CO_2 emissions are low. Many authors have investigated the relationship between tourism and economic growth with environmental degradation in the previous literature. In the following, the present article looks at the past author's views about the relation of economic and tourism growth with environmental degradation (Tan et al., 2021; Zhao et al., 2021; Zhao et al., 2022).

Sarpong et al. (2020), investigates the relation between international tourism receipts, tourism arrivals, energy consumption, environmental quality, and quality of life. Employing a panel of eight Southern African countries for the time period of 1995–to 2017, the authors made a debate about the relationship between international tourism receipts, tourism arrivals, energy consumption, environmental quality, and quality of life. The results showed that the nature of the relationship between international tourism receipts and environmental quality depends on the use of those receipts. If the receipts from international tourism are utilized to use non-renewable energy, keeping under consideration the need for agility and responsiveness in the tourism practices, the CO_2 emissions are high and environmental quality degrades. While the use of those receipts in applying renewable energy and the technologies specific to renewable energy reduces CO_2 emissions and environmental degradation (Sadiq, Amayri, et al., 2022; Wirsbinna & Grega, 2021). The study by Wu and Wu (2018) identifies the relationship between international tourism receipts with economic development and environmental degradation. The data from 31 major regions in China for the time of 1995-to 2015 and a bootstrap panel Granger causality test were applied to examine the relationship between international tourism receipts with economic development and environmental degradation. The results reveal that the said constructs enhances the earnings of both the government and private entities. They can take the initiatives for economic development, and the practices for the economic development result in greenhouse gas like CO_2 emissions and become a major cause of environmental degradation.

In a study about tourism development and CO_2 emission, Koçak et al. (2020) examines the impacts of international tourism expenditures on CO_2 emissions. The panel data about the factors and their relationships were taken from the most visited countries over the period 1995-2014. The continuously updated fully modified (CUP-FM) and the continuously updated bias-corrected (CUP-BC) estimators were

conducted for analysis. When the tourism firms make expenditures for excessive transportation, information, and communication system in order to facilitate international tours, it increases the CO_2 emissions from the tourism industry and degrades the environmental quality. Haseeb and Azam (2021), also examines the international tourism expenditures on environmental degradation. Authors have examined that international tourism expenditures, both inbound and outbound, are a way of maintaining tourism practices both within and beyond the country. Consistent use of transportation technology for international tourism results in smoke and heat in the atmosphere, lowering environmental quality. As a result, the available environment makes it difficult for natural resources to thrive and living beings to breathe. Anser et al. (2021), present their views about the nexus between international tourism expenditures and environmental degradation with the mediator of ICTs with the evidence from Saudi Arabia. The study implies that tourism includes the activities like use of infrastructure, other electric or mechanical appliances, technologies used for information and communication, the use of recreational technologies, and transportation. The increased international tourism expenditures increase these tourism practices and result in large CO_2 emissions and environmental degradation (Sadiq, Ou, et al., 2022; Shibli et al., 2021).

The study conducted by Ali et al. (2020) analyzes the relation of structural change, international tourists' arrivals, economic growth, and energy use to CO_2 emissions. Authors collected information for the empirical analysis of structural change, international tourists' arrivals, economic growth, and energy use impacts on CO_2 emissions from Pakistan during the time 1981–to 2017. For analysis, ARDL and VECM based Granger causality tests were applied. The study posits that the increase in the number of international tourists' arrivals gives rise to tourism growth and the growth of other industries as well. Consequently, when the energy consumption rises in the country, there is a large volume of CO_2 in the air, and the environment loses its stability. Gyamfi et al. (2022), determine the extent to which the international tourists' arrivals intensify CO_2 emissions into the air. The data for the relation between tourists' arrivals, economic growth, energy use and CO_2 emissions were acquired from G7 countries spanning the period from 1995 to 2018. The authors employed dynamic panel estimations like DOLS, FMOLS, and PMG-ARDL estimation techniques for establishing the relationship between the variables of study interest. The study posits that CO_2 is linked to economic activities and energy consumption. When in a result of increasing international tourists' arrivals, economic activities and energy consumption increases CO_2 emissions and causes environmental degradation.

A study was initiated by Magazzino et al. (2021) to analyze the impacts of renewable energy, coal consumption, and GDP on CO_2 emissions. The three countries, China, India, and the USA, were the focal center of that study for an investigation into the relationship between GDP, renewable energy, coal consumption, and CO_2 emissions. With the machine learning approach and Direction from the Dependency algorithm, the dependent and independent variables were selected, and the nature of relationships among these variables was predicted. The results revealed that GDP has both positive and negative impacts on CO_2 emissions. GDP positively contributes to CO_2 emissions if non-renewable energy is applied for agility in the production

processes. GDP prove to be a factor helpful in reducing CO_2 emissions whenever GDP growth enables to produce and utilize renewable and clean energy. In a literary article, Ameyaw and Yao (2018) identifies the nexus between GDP, CO_2 emissions and environmental degradation. Through a panel data model, the evidence was collected from five West African countries for the time 2007-to 2014. The increased resources consumption for the production of goods and services at a higher level enhances the amount of CO_2 emissions; thus, it degrades the environment. Gong et al. (2019), sorted out the data from the last 4 Five Year Plans during the time 1995-to 2015 for the analysis of GDP on CO_2 emissions and environmental degradation. The study reveals that With rising GDP and technical breakthroughs, the use of technology and energy sources expands, resulting in a potentially dangerous increase in CO_2 emissions that could cause environmental degradation.

Through empirical research, Barra and Zotti (2018) integrate the relationship between national income and environmental degradation. The GDP and CO_2 emissions were used as the proxies of national income and environmental degradation, respectively. For the research sample, 120 countries were surveyed for the period 2000–2009. For the identification of the relationship between national income and environmental degradation through a panel unit root test and two-step generalized method of moments (GMM) estimator. According to the study, when a country's national income is high, the country's production of products and services rises. When technologies that demand a lot of potential energy are employed to create quick and creative products or services that suit the needs of customers, environmental degradation is considerably high due to large CO_2 emissions. The global empirical research, Zhang et al. (2019) examined the influences of national income on CO_2 emissions from manufacturing and construction industries and environmental degradation. The 121 countries across the world serve as the sample for the research and provide information regarding the relation among under research variables for the period of 1960-to 2014. The research highlights that when the NNI is high, the construction and developmental practices are at their peak. Construction and manufacturing methods have been proven to enhance CO_2 emissions into the atmosphere and degrade the environmental situation. In a literary article, Dong et al. (2020) announces that when there is high NNI, the increased employment and incomes enhance the purchasing power of the general people. Thus, they are able to improve their living style by adopting innovative mechanical appliances, machines, and transport modes that rely on fuel from renewable and non-renewable energy sources. These adoptions cause the release of harmful substances, including CO_2 emissions and in this way, degrades the environmental conditions.

Through deep research, Musarat et al. (2021) integrate the relation of inflation rate with CO_2 emissions and the environment in a country with reference to the construction industry. The authors acquired data for research from the Government Department of Malaysia. The SPSS was applied for correlation coefficient performance so that the impacts of inflation on CO_2 emissions can be acquired. The research revealed that in the economy facing high inflation, the construction works are going on at the peak both at the private and state level, the use of the technologies during construction and the use of production technologies for the preparation of

construction material emit harmful gases like CO2. This harmful gas disturbs the quality of the atmosphere and causes environmental degradation. A study was made by Ullah et al. (2020) analyzes the impacts of GDP growth and inflation instability on environmental degradation. ARDL methodological approach was applied, and a quantitative research survey was conducted on the Pakistani economy over the time 1975 to 2018 so that the information for the GDP growth, inflation instability impacts on environmental degradation. The research says that the positive inflation shocks are helpful to control CO2 and N2O and protect the environment. But, the negative shocks of inflation instability positively influence CO2 and N2O and thus, deteriorates the environment. According to proclaim Shahbaz et al. (2021), the investment in developmental activities increases during inflation, boosts the productivity of many other industries and degrades the environment with CO2 emissions.

A study was presented by L. Wang et al. (2020) to identify the relation of innovation in renewable energy consumption and environmental context and export diversification to CO2 emissions and environmental quality. The study chose G7 economies like Germany, Italy, France, Japan, the United States, the United Kingdom, and Canada. The data regarding the association of eco-innovation and export diversification with CO2 emissions and environmental degradation were collected from these economies for the 28 years spanning stretching from 1990 to 2017. An analytical technique like a CS-ARDL was employed in this research to analyze the required relationship among the under-research factors for both the long and short-run. The results found a negative relationship between sustainability-oriented eco-innovation and environmental degradation. As the economy's predisposition to adopt eco-innovation grows, the amount of CO2 emissions can be more effective, and thus, environmental degradation can be minimized. Ding et al. (2021), wrote about the impacts of energy production and eco-innovation on consumption-based CO2 emissions. G7 countries for the period of 1990-2018, were the focal center for the collection of data regarding. Different econometric techniques like Westerlund panel co-integration test, slope homogeneity and cross-section dependence test, augmented mean group, cross-sectional autoregressive distributed lag, panel causality test, were employed for nexus analysis. As per the study findings eco-innovation has a negative relation with CO2 emissions for the use of unclean energy decreases leading to the ability to overcome CO2 emissions.

3. Research methodology

The paper examines the effect of tourism and economic growth, and sustainability-oriented eco-innovation on environmental degradation in China. The study has taken the international tourism receipts, expenditures and number of tourist arrival to measure tourism growth, while GDP, national income and inflation have been taken to measure economic growth, and high technology exports (% of manufactured exports) is the measurement of sustainability-oriented eco-innovation. The secondary data has been extracted from the WDI database from 1988 to 2020. The study used NARDL technique to assess the relationship. equation for the current article is given as under:

$$CO2_t = \alpha_0 + \beta_1 ITR_t + \beta_2 ITE_t + \beta_3 ITA_t + \beta_4 GDP_t + \beta_5 INF_t + \beta_6 NNI_t$$
$$+ \beta_7 EIN_t + e_t \qquad (1)$$

Where;
CO2 = Carbon Emission t = Time Period
ITR = International Tourism Receipts
ITE = International Tourism Expenditures
ITA = International number of Tourist Arrivals
GDP = Gross Domestic Product
INF = Inflation
NNI = Net National Income
EIN = Eco-innovation

The current study has investigated environmental degradation, which is measured as Carbon dioxide damage (% of GNI). Moreover, tourism and economic growth and sustainability-oriented eco-innovation have been taken as the independent variables. Table 1 provides the detailed of each variable sources and how they are measured in present study.

The current paper has run the descriptive statistics that provide the mean, minimum, number of observations used, maximum, and standard deviation. Moreover, the current paper has also run the year-wise descriptive statistics that show the details of all the constructs from 1988 to 2020. The study also applied the correlation matrix to test the directional linkage among constructs. The study also employed the PP and ADF tests for examined the unit root. The equation for the test is given as under:

$$d(Y_t) = \alpha_0 + \beta t + YY_{t-1} + d(Y_t(-1)) + \varepsilon_t \qquad (2)$$

The results of ADF and PP provide the justification for the application of the ARDL model in the study. The ARDL approach has four advantages. Firstly, the ARDL model could be applicable when the variables are stationary at I(0) and I(1) (M. Ahmad et al., 2018). Secondly, this approach is more straightforward as opposed to other co-integration approaches. This ARDL approach facilitates, once the lag order is identified, to inspect the association through the OLS method. Third, unlike other approaches for the co-integration test, the ARDL procedures do not necessarily need the pre-testing, such as the unit root test (S. J. H. Shahzad et al., 2017). Fourth, the ARDL approach is more efficient than other methods when the span of the sample period is smaller (Hoang, 2021). The ARDL equation is given below:

Table 1. Variables with measurements.

S#	Variables	Measurement	Sources
01	Carbon Emission	CO2 damages (% of GNI)	WDI
02	International Tourism Receipts	IT receipts (% of total exports)	WDI
03	International Tourism Expenditures	IT expenditures (% of total imports)	WDI
04	International number of Tourist Arrivals	International tourism, number of arrivals	WDI
05	Gross Domestic Product	GDP growth (annual %)	WDI
06	Inflation	Inflation, consumer price (% annual)	WDI
07	National Income	Adjusted net national income (annual % growth)	WDI
08	Eco-innovation	High technology exports (% of manufactured exports)	WDI

Source: Author's estimation.

$$\Delta CO2_t = \alpha_0 + \sum \delta_1 \Delta CO2_{t-1} + \sum \delta_2 \Delta ITR_{t-1} + \sum \delta_3 \Delta ITE_{t-1}$$
$$+ \sum \delta_4 \Delta LITA_{t-1} + \sum \delta_5 \Delta GDP_{t-1} + \sum \delta_6 \Delta INF_{t-1} + \sum \delta_7 \Delta NNI_{t-1}$$
$$+ \sum \delta_8 \Delta EIN_{t-1} + \varphi_1 CO2_{t-1} + \varphi_2 ITR_{t-1} + \varphi_3 ITE_{t-1} + \varphi_4 LITA_{t-1}$$
$$+ \varphi_5 GDP_{t-1} + \varphi_6 INF_{t-1} + \varphi_7 NNI_{t-1} + \varphi_8 EIN_{t-1} + \varepsilon_t$$

$$(3)$$

The current study has also examined the asymmetric nexus between inflation, national income and environmental degradation. Thus, the current study has developed the equation using these asymmetric nexuses as under:

$$CO2_t = \alpha_0 + \beta_1 ITR_t + \beta_2 ITE_t + \beta_3 LITA_t + \beta_4 GDP_t + \beta_5 INF_t^+ + \beta_6 INF_t^-$$
$$+ \beta_7 NNI_t^+ + \beta_8 NNI_t^- + e_t$$

$$(4)$$

The current study has also provided the individual equations for the asymmetric association among inflation, national income and environmental degradation given below:

$$INF^+ = \sum_{i=1}^{t} \Delta INF_i^+ = \sum_{i=1}^{t} \max(\Delta INF_i 0) \tag{5}$$

$$INF^- = \sum_{i=1}^{t} \Delta INF_i^- = \sum_{i=1}^{t} \min(\Delta INF_i 0) \tag{6}$$

$$NNI^+ = \sum_{i=1}^{t} \Delta NNI_i^+ = \sum_{i=1}^{t} \max(\Delta NNI_i 0) \tag{7}$$

$$NNI^- = \sum_{i=1}^{t} \Delta NNI_i^- = \sum_{i=1}^{t} \min(\Delta NNI_i 0) \tag{8}$$

Finally, the present article joined the ARDL model and asymmetric association among the variables and developed the NARDL equation as under:

$$\Delta CO2_t = \alpha_0 + \sum \delta_1 \Delta CO2_{t-1} + \sum \delta_2 \Delta ITR_{t-1} + \sum \delta_3 \Delta ITE_{t-1}$$
$$+ \sum \delta_4 \Delta LITA_{t-1} + \sum \delta_5 \Delta GDP_{t-1} + \sum \delta_6 \Delta EIN_{t-1}$$
$$+ \sum \delta_7 \Delta INF_{t-1}^+ + \sum \delta_8 \Delta INF_{t-1}^- + \sum \delta_9 \Delta NNI_{t-1}^+ + \sum \delta_{10} \Delta NNI_{t-1}^-$$
$$+ \varphi_1 CO2_{t-1} + \varphi_2 ITR_{t-1} + \varphi_3 ITE_{t-1} + \varphi_4 LITA_{t-1}$$
$$+ \varphi_5 GDP_{t-1} + \varphi_6 EIN_{t-1} + \varphi_7 INF_{t-1}^+ + \varphi_8 INF_{t-1}^- + \varphi_9 NNI_{t-1}^+$$
$$+ \varphi_{10} NNI_{t-1}^- + \varepsilon_t$$

$$(9)$$

4. Results of the study

Descriptives were applied to examine the mean values of variables along with minimum, maximum and standard deviation values. The study has used a total 33 observations because the data was collected from 1988 to 2020. As we can see in Table 2 that average value of carbon dioxide is 5.412% followed by ITR 9.563%, ITE 9.633%, ITA 9.53%, GDP, 9.031%, INF 4.89%, NNI 10.560%, EIN 30.53%.

Year-wise descriptives were also done in order to showcase the yearly details of each variable. Results reveal that in 1990, CO_2 was around 2.98%. According to results ITR was its at lowest in 1988 and highest in 2020 with 17.61% value. Also, in case of ITE, it was highest in 2020 and low in 1989. ITA had maximum value in 1989 which was $1.62\,e+08$ and minimum in 2013. Furthermore, GDP's maximum value happened to occur in 2016 and minimum in 1988. In case of INF, the highest value was 24.25% in 2008 and −14% in the year 2002. In case of NNI and EIN, maximum values were observed in 2016 and 2010 respectively. Figure 2 and Table 3 provides detailed picture of descriptives.

The study also applied the correlation matrix to test the directional linkage among constructs. The results revealed that international tourism receipts, expenditures and number of tourist arrival, GDP, national income and inflation have a significant and positive relationship with environmental degradation while EIN has a negative association with environmental degradation in China. These outcomes are mentioned in Table 4 and Figure 3.

The study also employed the PP and ADF tests for examined the unit root. The results exposed that the CO_2, ITR, and LITA have been stationary at the level. On the other hand, ITE, GDP, INF, NNI and EIN have been stationary at the first difference. These findings are given in Table 5.

The co-integration has been examined using the ARDL bound test, an essential part for applying the ARDL model. The results indicated that the 4.992 calculated f-statistics value is higher than the upper and lower bound values. This is the indication that co-integration exists. These outputs are mentioned in Table 6.

The NARDL results revealed that 'international tourism receipts, expenditures and number of tourist arrival, GDP, national income and inflation' have a significant and positive relationship with environmental degradation while EIN has a negative relationship with environmental degradation in China. In addition, the results also investigated that asymmetric relationships exist between inflation, national income and environmental degradation. These findings are given in Table 7.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
CO2	33	5.412	1.904	2.984	9.097
ITR	33	9.563	4.947	2.901	17.610
ITE	33	9.633	5.751	1.909	19.028
ITA	33	95387978	42584841	28672775	1.625e + 08
GDP	33	9.031	2.846	2.348	14.231
INF	33	4.898	6.344	−1.401	24.257
NNI	33	10.560	3.145	4.631	15.513
EIN	33	30.532	0.583	29.364	32.124

Source: Author's estimation.
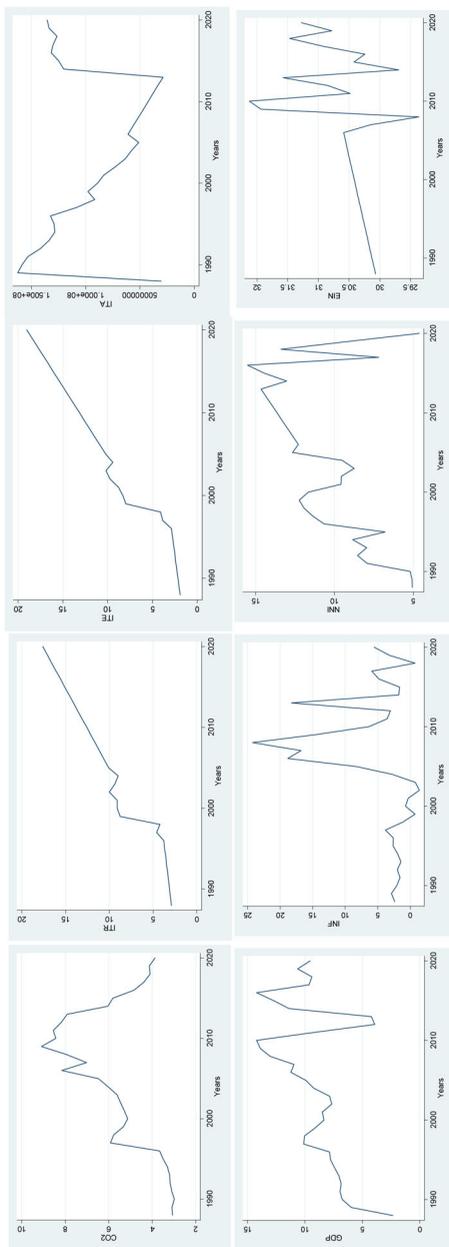
Figure 2. Descriptive statistics.
Source: Author's estimation.

Table 3. Descriptive statistics by years.

Years	CO2	ITR	ITE	ITA	GDP	INF	NNI	EIN
1988	3.073	2.901	1.909	30402000	2.348	2.419	5.073	30.071
1989	3.086	3.009	2.030	1.625e + 08	5.950	2.899	5.082	30.100
1990	2.984	3.119	2.150	1.586e + 08	6.750	2.075	5.200	30.129
1991	3.107	3.228	2.271	1.533e + 08	6.947	1.593	7.927	30.157
1992	3.176	3.337	2.391	1.418e + 08	6.849	2.000	8.538	30.186
1993	3.201	3.447	2.512	1.338e + 08	7.041	1.437	7.958	30.215
1994	3.302	3.556	2.632	1.285e + 08	7.426	1.922	8.849	30.244
1995	3.492	3.665	2.753	1.291e + 08	7.766	2.621	6.788	30.273
1996	3.659	3.774	2.873	1.324e + 08	7.864	2.620	10.661	30.301
1997	5.914	4.589	3.858	1.090e + 08	10.114	3.825	11.376	30.330
1998	5.775	4.195	4.076	91662000	10.038	1.128	11.938	30.359
1999	5.330	8.780	7.971	97908000	9.134	−0.732	12.239	30.388
2000	5.125	9.112	8.306	89013000	8.336	0.719	11.651	30.417
2001	5.283	9.113	8.792	83444000	8.490	0.348	9.591	30.445
2002	5.459	10.012	9.746	72796000	7.662	−1.401	9.559	30.474
2003	5.622	9.358	10.195	63478000	7.846	−0.773	8.751	30.503
2004	6.044	8.984	9.436	57588000	9.237	2.786	9.520	30.532
2005	6.476	10.066	10.220	51128000	9.923	8.313	12.66	30.561
2006	8.160	10.569	10.807	60970046	11.223	18.812	12.292	30.589
2007	7.024	11.072	11.395	56356150	10.954	16.791	12.631	30.151
2008	7.952	11.575	11.982	51742254	13.037	24.257	12.970	29.364
2009	9.097	12.078	12.569	47128358	13.884	14.610	13.308	31.938
2010	8.428	12.581	13.156	42514463	14.225	6.354	13.647	32.124
2011	8.554	13.084	13.743	37900567	9.263	3.557	13.985	30.484
2012	8.183	13.587	14.331	33286671	3.920	3.052	14.324	30.849
2013	7.909	14.090	14.918	28672775	4.206	18.246	14.663	31.574
2014	6.036	14.593	15.505	1.203e + 08	11.395	1.776	13.030	29.695
2015	5.818	15.095	16.092	1.249e + 08	12.721	1.649	14.456	30.422
2016	4.837	15.598	16.679	1.319e + 08	14.231	4.817	15.513	30.243
2017	4.377	16.101	17.267	1.300e + 08	9.651	5.925	7.195	30.907
2018	4.096	16.604	17.854	1.265e + 08	9.399	−0.728	13.385	31.467
2019	4.134	17.107	18.441	1.338e + 08	10.636	3.175	9.088	30.783
2020	3.877	17.610	19.028	1.354e + 08	9.551	5.554	4.631	31.274

Source: Author's estimation.

Table 4. Matrix of correlations.

Variables	CO2	ITR	ITE	GDP	INF	NNI	LITA	EIN
CO2	1.000							
ITR	0.480	1.000						
ITE	0.484	0.999	1.000					
GDP	0.436	0.484	0.486	1.000				
INF	0.595	0.260	0.263	0.319	1.000			
NNI	0.749	0.497	0.494	0.502	0.337	1.000		
LITA	0.750	−0.216	−0.220	0.095	−0.467	−0.427	1.000	
EIN	−0.352	−0.477	0.411	0.637	−0.712	0.553	0.328	1.00

Source: Author's estimation.

5. Discussions

The results stated that international tourism receipts have a positive link to environmental degradation. These results are supported by Nathaniel et al. (2021), which shows that when the tourism industry is making progress and successfully achieving receipts from international sources through selling tourism tickets, their financial capacity increases, and they can spend on increasing tourism practices. The increase in tourism practices which include the use of energy for operating different small or large machines and technologies causes environmental degradation with an increase in the abominating
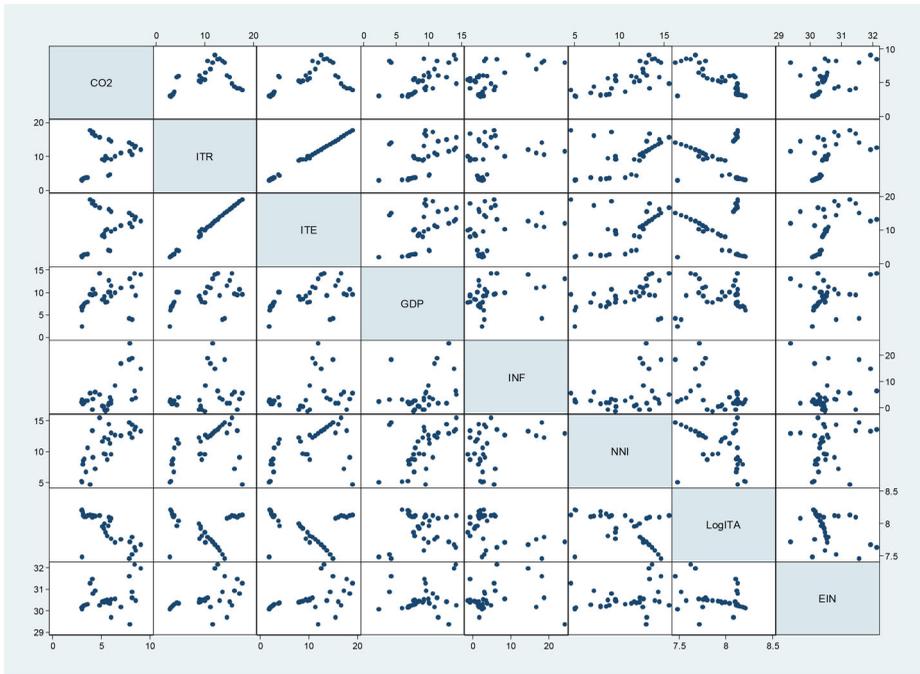
Figure 3. Correlation matrix.
Source: Author's estimation.

Table 5. Unit root test.

| | ADF | | PP | |
Series	Level	First difference	Level	First difference
CO2	−2.092***	−4.011***	−2.099***	−5.001***
ITR	−3.020***	−5.904***	−4.018	−7.091***
ITE	−1.219	−4.520***	−1.123	−5.073***
GDP	−1.882	−5.762***	−1.152	−4.099***
INF	−1.019	−5.901***	−1.460	−4.925***
NNI	−1.088	−5.099***	−3.092***	−7.214***
LITA	−3.100***	−5.410***	−4.662***	−8.091***
EIN	−0.281	−5.812***	−0.527	−5.627***

Source: Author's estimation.

Table 6. Bound test of nonlinear ARDL.

	F-statistics	Lower bound	Upper bound	Decision
Linear ARDL	0.77	3.09	3.98	No Co-integration
Asymmetric ARDL	4.992	3.21	3.99	Co-integration

Source: Author's estimation.

gases. These results agree with Danish and Wang (2018), which examines the association between tourism receipts and environmental degradation. This study reveals that with the increase in the number of receipts from carrying on the tourism projects for international tourists, the firms can have the receipts with increased value. In this case, they become able to apply innovation in the tourism services they are providing. This innovation in the form of new technologies adoption, though it gives rise to the tourism

Table 7. Nonlinear ARDL Results.

Variables	Coefficients	Std. Err.	t-statistics
C	2.982	1.109	2.689
CO2 (-1)	2.028	0.876	2.315
ITR (-1)	0.294	0.093	3.161
ITE (-1)	0.557	0.199	2.799
LITA (-1)	1.934	0.923	2.095
GDP (-1)	0.855	0.391	2.187
EIN (-1)	−1.721	0.528	−3.259
INF-P (-1)	1.767	0.532	3.321
INF-N (-1)	0.775	0.210	3.690
NNI-P (-1)	0.202	0.099	2.040
NNI-N (-1)	0.902	0.291	3.099
Adj. R Square	0.543		
F-statistics	51.098		
Prob.(F-statistics)	0.002		

Source: Author's estimation.

industry, also causes harmful gases which can destroy the ozone layer, overly warm up the earth, and thereby degrades the environmental situation.

The study results indicated that international tourism expenditures have a positive link to environmental degradation. These results match with Balsalobre-Lorente et al. (2020), which shows that the expenditures on international tourism, both inbound and outbound tourism, are the way of continuing the tourism practices both within and outside the country. The consistent use of transportation technologies for international tourism purposes causes smoke and heat in the atmosphere and degrades the environmental quality. So, the environment available is of the kind that it becomes difficult for the natural resources to flourish and living creatures to breathe. These results also agree with Gulistan et al. (2020), which highlights that the international tourism firms make expenditures on the infrastructure like buildings or road construction and the adoption of tourism information and communication system which assist in remaining in contact with stakeholders, advertise tourism practices, attract the tourists, and provide them with a plate-form to get together. These expenditures increase the use of construction or ICT technologies and cause greenhouse gas emissions to destroy the environment. These results are supported by Katircioglu et al. (2018), which highlights that the increase in the expenditures on international tourism, like the adoption of swift and comfortable modes of transportation, enhances the use of energy and leads the industry to environmental pollution.

The results stated that international tourist arrivals have a positive impact linked to environmental degradation. These results agree with F. Ahmad et al. (2019), which states that one of the great sources of environmental pollution is the existence of human beings as the respiration in the living beings emits harmful gases in the air. So, when the international tourists' arrivals become more frequent than earlier, the population number increases in the country, and a large amount of CO2 emissions distracts the environmental elements from performing their functions duly. That is why an increasing number of foreign tourists enhances the environmental degradation in one region. These results relate to Sharif et al. (2020), whose focus is on the relation of global tourists arrivals with environmental degradation. The study posits that there is a need to create accommodation facilities, transportation facilities, food, and entertainment activities, whenever there is an increase in the number of tourists

from other neighboring countries. The expansion of technological practices in order to meet the demands of foreign tourists cause greenhouse gas emissions. This disturbs the weather pattern and geographical characteristics, and as a result, the environmental degradation puts the country on trial.

The results revealed that GDP and environmental degradation share positive connection. Results support the evidences of Mardones and del Rio (2019) . In this study, the authors are of the view that the increase in the country's growth with the high GDP growth enhances the production in all the economic sectors. The production of the goods and services on one side is essential to the country's well-being, while on the other hand, it is a threat to public well-being and the country's sustainable development for it causes greenhouse gas emissions, chemicals creation, and creation of harmful substances through wastes. The results are also in line with Pandey and Rastogi (2019), which states that in the case of high GDP, the production level in the economy is high. In production processes, different manual and electronic machines are used. The nature of the machines is dependent on the nature of goods and services being produced; the nature of the machines determines the use of energy and emissions of pollution. The heavy machines cause much environmental degradation. These results are also supported by Ergun and Rivas (2020), which analyzes how much environmental degradation is caused by GDP growth. The study implies that the use of plants and different technologies that are based on fuel consumption is the biggest source of greenhouse gas emissions. So, the increased production, which requires technologies and energy, enhances environmental degradation.

The results stated that inflation has a positive link to environmental degradation. These results are in line with Baloch et al. (2020), which shows that it is commonly known that when there is an upward movement in the prices of different commodities, the production of those commodities increases in the economy as they could bring more profits and the increased production with high technology and mechanical processes adversely affect the environmental quality. Hence, inflation in the country deteriorates the environment. Results agree with Deka et al. (2022), which shows that the increase in financial resources with the government as a result of inflation in the country strengthens the government's position to set the future economic plans and make them implemented. In this process, many resources produced and provided by the firms are utilized. When the increased demands of resources end with the greater production level, the environmental condition degrades due to increased greenhouse gas emissions. These results are also in line with Islam et al. (2021), which posits that when there is high inflation in the country, the production level goes high, and the use of any source of energy degrades the environment.

Similarly, NNI and environmental degradation also share positive connection. Hence supports Ozcan et al. (2020) study, which highlights that in countries with high NNI, the direct and indirect revenues of the government are high, and this provides financial power to the government. When the government having high financial power takes steps for the development of the country, like development in education, medical, and city infrastructure, the production of relevant goods and services increases. When there is an addition in the production practices, the emissions of wastes and other harmful substances are also at a larger scale, and eventually, the

environmental condition degrades. These results are in line with Raza et al. (2019), which examines the influences of NNI impacts on environmental quality. The increased NNI, with an increase in the employment ratio and promotion in the income level, enhances the procurement and use of mechanical home appliances and social technologies for facilitating their personal lives. The increased use of mechanical appliances and technologies creates CO_2 emissions and roadblocks to environmental quality. Hence, the increased NNI causes environmental degradation.

Eco-innovation was found to be negative when it comes to environmental degradation. These results agree with Fethi and Rahuma (2019), which examines the role of sustainability-oriented eco-innovation in environmental degradation. This study posits that the usage of energy-efficient technologies stems from the embrace of eco-innovation. When businesses use energy-efficient technologies, they minimize their energy consumption to the greatest extent possible while simultaneously reducing their negative environmental implications. Reduced energy consumption ends in reducing CO_2 emissions and saves the environment from getting degraded. Eco-innovation, therefore, has a negative relationship with environmental degradation. These results are also supported by Tao, Umar et al. (2021), according to which When it comes to corporate operations like production, communication, and marketing, eco-innovation uses resources (physical and technological resources) and processes that use less energy than traditionally utilized resources and procedures. The energy used in less amount allows a decrease in CO_2 emissions, resulting in a cleaner environment and a more sustainable economy.

6. Conclusions

It has been the general problem for all the countries that as the economies have been making progress in technologies, mechanical processes, and other resources, and globalization has become common, the environmental issues have been getting increased. The environment that is important to human survival and economic progress in the future, needs protection from degradation. The authors of the present study considered this issue and took a step to investigate the causes of environmental degradation. They were to throw light on tourism and economic growth as the causes of environmental degradation and analyze the impacts various factors of tourism growth such as international tourism receipts, international tourism expenditures, arrivals of international tourists along with economic growth factors such as GDP, inflation, NNI, and sustainability-oriented eco-innovation on environmental degradation. The evidence for the variables and their relationship were collected in quantitative form from China. The results based on the empirical investigation showed a positive among variables except eco-innovation. The results indicated that the increase in the receipts from international tourism practices improves the financial position of state-owned and private authorities within the country and, when directly or indirectly leads to an increase in production level, causes CO_2 emissions and environmental degradation. The results denoted that international tourism expenditures increase the tourism practices that are linked to many economic sectors. Increased use of technologies, energy, chemical, medicines enhance the CO_2 emissions and degrades the

environmental quality. When tourists from foreign countries make their arrival frequent, they exist by themselves, and the increase in the use of basic or recreational needs enhances CO2 emissions and environmental degradation. The results also revealed that the increase in the GDP and NNI stimulate economic activities like manufacturing, trading, aid to trade activities, and services production. This results in environmental deterioration. The inflation also, with the increase in production and consumption level, generates higher carbon emissions. The results showed that eco-innovation has a negative relationship with environmental degradation. The innovation in the different business areas for the purpose of reducing environmental impacts of the business practices, reduces the CO2 and environmental degradation.

7. Implications

Both sort of implications can be drawn from the present article. First and foremost, it is a great addition to the environmental literature as it purely focuses on the environment related activities. On the basis of conclusion, multiple policies can be proposed in order to reduce carbon emission. Under the evidences, China should enhance its real income so that its environmental standards can be improved. In this regard, green energy policy could be a great initiative as it has a potential to create environmental sustainability. Furthermore, increasing technological service to facilitate international tourist could also be an excellent approach to mitigate carbon emissions

The present study is also unique in a way that it examined the collective analysis of tourism and economic growth impacts on environmental degradation. The present study, which initiates in this regard, is a great extension of the theory on environmental quality. This study guides many responsible entities, the state authorities, environmental regulators, and economists, on how they can control CO2 emissions and environmental quality. This study has provided help to the regulators while developing new policies regarding environmental degradation by controlling emissions from economic and tourism development. The study provides a guideline that the tourism industry must be grown, but through effective policies, the negative environmental impacts of international tourism receipts, international tourism expenditures, arrivals of international tourists can be minimized. Similarly, the present article also suggests that with effective economic management, the adverse environmental impacts of increasing GDP, inflation, and NNI can be controlled. The study suggested that the government and environmental regulators should implement the policies for encouraging eco-innovation so that CO2 emissions can be reduced, and environmental conditions do not degrade.

8. Limitations

The present study has many limitations despite the theoretical contributions. These limitations must be removed with some suitable additions. The present study examines the impacts of only tourism and economic growth on CO2 emissions and environmental degradation. Some of the major causes of CO2 emissions and environmental degradation are population growth, energy production and

consumption, technological advancements etc., but there is no attention to these essential sources of carbon emissions. This confines the scope of the study and raises the need for investigation of the impacts of these factors on CO2 emissions and environmental degradation. In this study, CO2 emissions have been used as the predictor of environmental degradation, but it is admissible that all the greenhouse gases are environmentally deteriorating and require discussion. So, it is also the duty of other authors to pay focus on all the greenhouse gases while analyzing the impact of study variables on environmental degradation.

Funding

ORCID

Chen-Hsien Lin 🆔 http://orcid.org/0000-0002-1768-503X
Trung Kien Tran 🆔 http://orcid.org/0000-0002-1205-3746
Tran Thai Ha Nguyen 🆔 http://orcid.org/0000-0003-2598-3720

References

Abdul Hamid, B., Azmi, W., & Ali, M. (2020). Bank risk and financial development: Evidence from dual banking countries. *Emerging Markets Finance and Trade*, *56*(2), 286–304. https://doi.org/10.1080/1540496X.2019.1669445

Ahmad, F., Draz, M. U., Su, L., & Rauf, A. (2019). Taking the bad with the good: The nexus between tourism and environmental degradation in the lower middle-income Southeast Asian economies. *Journal of Cleaner Production*, *233*, 1240–1249. https://doi.org/10.1016/j.jclepro.2019.06.138

Ahmad, M., Khan, Z., Ur Rahman, Z., & Khan, S. (2018). Does financial development asymmetrically affect CO2 emissions in China? An application of the nonlinear autoregressive distributed lag (NARDL) model. *Carbon Management*, *9*(6), 631–644. https://doi.org/10.1080/17583004.2018.1529998

Ahmad, M., Ul Haq, Z., Khan, Z., Khattak, S. I., Ur Rahman, Z., & Khan, S. (2019). Does the inflow of remittances cause environmental degradation? Empirical evidence from China. *Economic Research-Ekonomska Istraživanja*, *32*(1), 2099–2121. https://doi.org/10.1080/1331677X.2019.1642783

Ainou, F. Z., Ali, M., & Sadiq, M. (2022). Green energy security assessment in Morocco: Green finance as a step toward sustainable energy transition. *Environmental Science and Pollution Research*, https://doi.org/10.1007/s11356-022-19153-7

Ali, M., Ibrahim, M. H., & Shah, M. E. (2022). Impact of non-intermediation activities of banks on economic growth and volatility: An evidence from OIC. *The Singapore Economic Review*, *67*(01), 333–348. https://doi.org/10.1142/S0217590820420023

Ali, W., Sadiq, F., Kumail, T., Li, H., Zahid, M., & Sohag, K. (2020). A cointegration analysis of structural change, international tourism and energy consumption on CO2 emission in Pakistan. *Current Issues in Tourism*, *23*(23), 3001–3015. https://doi.org/10.1080/13683500.2020.1804338

Altıntaş, H., & Kassouri, Y. (2020). Is the environmental Kuznets Curve in Europe related to the per-capita ecological footprint or CO2 emissions? *Ecological Indicators*, *113*, 106187. https://doi.org/10.1016/j.ecolind.2020.106187

Ameyaw, B., & Yao, L. (2018). Analyzing the impact of GDP on CO2 emissions and forecasting Africa's total CO2 emissions with non-assumption driven bidirectional long short-term memory. *Sustainability*, *10*(9), 3110–3128. https://doi.org/10.3390/su10093110

Anser, M. K., Khan, M. A., Nassani, A. A., Askar, S. E., Abro, M. M. Q., Zaman, K., & Kabbani, A. (2021). The mediating role of ICTs in the relationship between international tourism and environmental degradation: Fit as a fiddle. *Environmental Science and Pollution Research International*, *28*(45), 63769–63783. https://doi.org/10.1007/s11356-020-10954-2

Appiah, M. O. (2018). Investigating the multivariate Granger causality between energy consumption, economic growth and CO2 emissions in Ghana. *Energy Policy*, *112*, 198–208. https://doi.org/10.1016/j.enpol.2017.10.017

Aslam, B., Hu, J., Majeed, M. T., Andlib, Z., & Ullah, S. (2021). Asymmetric macroeconomic determinants of CO2 emission in China and policy approaches. *Environmental Science and Pollution Research International*, *28*(31), 41923–41936. https://doi.org/10.1007/s11356-021-13743-7

Avom, D., Nkengfack, H., Fotio, H. K., & Totouom, A. (2020). ICT and environmental quality in Sub-Saharan Africa: Effects and transmission channels. *Technological Forecasting and Social Change*, *155*, 120028–120137. https://doi.org/10.1016/j.techfore.2020.120028

Bai, X., Wang, K. T., Tran, T. K., Sadiq, M., Trung, L. M., & Khudoykulov, K. (2022). Measuring China's green economic recovery and energy environment sustainability: Econometric analysis of sustainable development goals. *Economic Analysis and Policy*, *75*, 768–779. https://doi.org/10.1016/j.eap.2022.07.005

Baloch, M. A., Khan, S. U.-D., & Z. Ş., Danish. (2020). Poverty and vulnerability of environmental degradation in Sub-Saharan African countries: What causes what? *Structural Change and Economic Dynamics*, *54*, 143–149., https://doi.org/10.1016/j.strueco.2020.04.007

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 International*, *27*(7), 7130–7144. https://doi.org/10.1007/s11356-019-07372-4

Barra, C., & Zotti, R. (2018). Investigating the non-linearity between national income and environmental pollution: International evidence of Kuznets curve. *Environmental Economics and Policy Studies*, *20*(1), 179–210. https://doi.org/10.1007/s10018-017-0189-2

Bhat, J. A. (2018). Renewable and non-renewable energy consumption—Impact on economic growth and CO2 emissions in five emerging market economies. *Environmental Science and Pollution Research International*, *25*(35), 35515–35530. https://doi.org/10.1007/s11356-018-3523-8

Chien, F. (2022a). How renewable energy and non-renewable energy affect environmental excellence in N-11 economies? *Renewable Energy*. *196*, 526–534. https://doi.org/10.1016/j.renene.2022.07.013

Chien, F., Zhang, Y., Sharif, A., Sadiq, M., & Hieu, M. V. (2022). Does air pollution affect the tourism industry in the USA? Evidence from the quantile autoregressive distributed lagged approach. *Tourism Economics*, 135481662210970. https://doi.org/10.1177/13548166221097021

Chien, F., Chau, K. Y., Sadiq, M., & Hsu, C. C. (2022). The impact of economic and non-economic determinants on the natural resources commodity prices volatility in China. *Resources Policy*, *78*, 102863. https://doi.org/10.1016/j.resourpol.2022.102863

Chien, F. (2022b). The mediating role of energy efficiency on the relationship between sharing economy benefits and sustainable development goals (Case Of China). *Journal of Innovation & Knowledge*, *7*(4), 100270. https://doi.org/10.1016/j.jik.2022.100270

Chien, F., Hsu, C. C., Sibghatullah, A., Hieu, V. M., Phan, T. T. H., & Hoang Tien, N. (2022). The role of technological innovation and cleaner energy towards the environment in ASEAN countries: Proposing a policy for sustainable development goals. *Economic Research-Ekonomska Istraživanja*, *35*(1), 4677–4692. https://doi.org/10.1080/1331677X.2021.2016463

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

Deka, A., Cavusoglu, B., & Dube, S. (2022). Does renewable energy use enhance exchange rate appreciation and stable rate of inflation? *Environmental Science and Pollution Research International*, *29*(10), 14185–14194. https://doi.org/10.1007/s11356-021-16758-2

Ding, Q., Khattak, S. I., & Ahmad, M. (2021). Towards sustainable production and consumption: Assessing the impact of energy productivity and eco-innovation on consumption-based carbon dioxide emissions (CCO2) in G-7 nations. *Sustainable Production and Consumption*, *27*, 254–268. https://doi.org/10.1016/j.spc.2020.11.004

Dong, K., Hochman, G., & Timilsina, G. R. (2020). Do drivers of CO2 emission growth alter overtime and by the stage of economic development? *Energy Policy*, *140*, 111420. https://doi.org/10.1016/j.enpol.2020.111420

Ehsanullah, S., Tran, Q. H., Sadiq, M., Bashir, S., Mohsin, M., & Iram, R. (2021). How energy insecurity leads to energy poverty? Do environmental consideration and climate change concerns matters. *Environmental Science and Pollution Research International*, *28*(39), 55041–55052.

Ergun, S. J., & Rivas, M. F. (2020). Testing the environmental Kuznets curve hypothesis in Uruguay using ecological footprint as a measure of environmental degradation. *International Journal of Energy Economics and Policy*, *10*(4), 473–485. https://doi.org/10.32479/ijeep.9361

Fethi, S., & Rahuma, A. (2019). 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. *Environmental Science and Pollution Research*, *26*(29), 30145–30153.

Gong, B., Zheng, X., Guo, Q., & Ordieres-Meré, J. (2019). Discovering the patterns of energy consumption, GDP, and CO2 emissions in China using the cluster method. *Energy*, *166*, 1149–1167. https://doi.org/10.1016/j.energy.2018.10.143

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

Gyamfi, B. A., Bein, M. A., Adedoyin, F. F., & Bekun, F. V. (2022). To what extent are pollutant emission intensified by international tourist arrivals? Starling evidence from G7 Countries. *Environment, Development and Sustainability*, *24*(6), 7896–7917. https://doi.org/10.1007/s10668-021-01765-7

Haroon, O., Ali, M., Khan, A., Khattak, M. A., & Rizvi, S. A. R. (2021). Financial market risks during the COVID-19 Pandemic. *Emerging Markets Finance and Trade*, *57*(8), 2407–2414. https://doi.org/10.1080/1540496X.2021.1873765

Haseeb, M., & Azam, M. (2021). Dynamic nexus among tourism, corruption, democracy and environmental degradation: A panel data investigation. *Environment, Development and Sustainability*, *23*(4), 5557–5575. https://doi.org/10.1007/s10668-020-00832-9

Hartani, N. H., Haron, N., & Tajuddin, N. I. I. (2021). The impact of strategic alignment on the sustainable competitive advantages: Mediating role of it implementation success and it managerial resource. *International Journal of eBusiness and eGovernment Studies*, *13*(1), 78–96.

Hoang, T. M. (2021). Asymmetric effects of oil price shock on stock markets in Vietnam: An empirical investigation based on SVAR model and NARDL model. *The Journal of Asian Finance, Economics and Business*, *8*(6), 553–565.

Islam, M. M., Alharthi, M., & Murad, M. W. (2021). The effects of carbon emissions, rainfall, temperature, inflation, population, and unemployment on economic growth in Saudi Arabia: An ARDL investigation. *Plos One*, *16*(4), e0248743–263. https://doi.org/10.1371/journal.pone.0248743

Jermsittiparsert, K. (2021). Linkage between energy consumption, natural environment pollution, and public health dynamics in ASEAN. *International Journal of Economics and Finance Studies*, *13*(2), 1–21.

Kamarudin, F., Anwar, N. A. M., Chien, F., & Sadiq, M. (2021). Efficiency of microfinance institutions and economic freedom nexus: Empirical evidence from four selected ASIAN countries. *Transformations in Business & Economics*, 20(2b), 845–868.

Katircioglu, S., Gokmenoglu, K. K., & Eren, B. M. (2018). Testing the role of tourism development in ecological footprint quality: Evidence from top 10 tourist destinations. *Environmental Science and Pollution Research International*, 25(33), 33611–33619. https://doi.org/10.1007/s11356-018-3324-0

Khattak, M. A., Ali, M., & Rizvi, S. A. R. (2021). Predicting the European stock market during COVID-19: A machine learning approach. *MethodsX*, 8, 101198. https://doi.org/10.1016/j.mex.2020.101198

Koçak, E., Ulucak, R., & Ulucak, Z. Ş. (2020). The impact of tourism developments on CO_2 emissions: An advanced panel data estimation. *Tourism Management Perspectives*, 33, 100611–100118. https://doi.org/10.1016/j.tmp.2019.100611

Lan, J., Khan, S. U., Sadiq, M., Chien, F., & Baloch, Z. A. (2022). Evaluating energy poverty and its effects using multi-dimensional based DEA-like mathematical composite indicator approach: Findings from Asia. *Energy Policy*, 165, 112933. https://doi.org/10.1016/j.enpol.2022.112933

Lei, W., Xie, Y., Hafeez, M., & Ullah, S. (2022). Assessing the dynamic linkage between energy efficiency, renewable energy consumption, and CO_2 emissions in China. *Environmental Science and Pollution Research International*, 29(13), 19540–19552. https://doi.org/10.1007/s11356-021-17145-7

Liu, X., & Bae, J. (2018). Urbanization and industrialization impact of CO_2 emissions in China. *Journal of Cleaner Production*, 172, 178–186. https://doi.org/10.1016/j.jclepro.2017.10.156

Liu, Z., Yin, T., Surya Putra, A. R., & Sadiq, M. (2022). Public spending as a new determinate of sustainable development goal and green economic recovery: Policy perspective analysis in the Post-Covid ERA. *Climate Change Economics*, 13(03) https://doi.org/10.1142/S2010007822400073

Liu, Z., Lan, J., Chien, F., Sadiq, M., & Nawaz, M. A. (2022). Role of tourism development in environmental degradation: A step towards emission reduction. *Journal of Environmental Management*, 303, 114078. https://doi.org/10.1016/j.jenvman.2021.114078

Magazzino, C., Mele, M., & Schneider, N. (2021). A machine learning approach on the relationship among solar and wind energy production, coal consumption, GDP, and CO_2 emissions. *Renewable Energy*. 167, 99–115. https://doi.org/10.1016/j.renene.2020.11.050

Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., & Khoshnoudi, M. (2019). Carbon dioxide (CO_2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. *The Science of the Total Environment*, 649, 31–49. https://doi.org/10.1016/j.scitotenv.2018.08.229

Mardones, C., & del Rio, R. (2019). Correction of Chilean GDP for natural capital depreciation and environmental degradation caused by copper mining. *Resources Policy*, 60, 143–152. https://doi.org/10.1016/j.resourpol.2018.12.010

Mujan, I., Anđelković, A. S., Munćan, V., Kljajić, M., & Ružić, D. (2019). Influence of indoor environmental quality on human health and productivity – A review. *Journal of Cleaner Production*, 217, 646–657. https://doi.org/10.1016/j.jclepro.2019.01.307

Musarat, M. A., Alaloul, W. S., Liew, M., Maqsoom, A., & Qureshi, A. H. (2021). The effect of inflation rate on CO_2 emission: A framework for Malaysian construction industry. *Sustainability*, 13(3), 1562–1579. https://doi.org/10.3390/su13031562

Nathaniel, S. P., Barua, S., & Ahmed, Z. (2021). What drives ecological footprint in top ten tourist destinations? Evidence from advanced panel techniques. *Environmental Science and Pollution Research International*, 28(28), 38322–38331. https://doi.org/10.1007/s11356-021-13389-5

Ojogiwa, O. T. (2021). The crux of strategic leadership for a transformed public sector management in Nigeria. *International Journal of Business and Management Studies*, 13(1), 83–96.

Ozcan, B., Tzeremes, P. G., & Tzeremes, N. G. (2020). Energy consumption, economic growth and environmental degradation in OECD countries. *Economic Modelling*, *84*, 203–213. https://doi.org/10.1016/j.econmod.2019.04.010

Pandey, K. K., & Rastogi, H. (2019). Effect of energy consumption & economic growth on environmental degradation in India: A time series modelling. *Energy Procedia*. *158*, 4232–4237. https://doi.org/10.1016/j.egypro.2019.01.804

Raza, S. A., Shah, N., & Sharif, A. (2019). Time frequency relationship between energy consumption, economic growth and environmental degradation in the United States: Evidence from transportation sector. *Energy*, *173*, 706–720. https://doi.org/10.1016/j.energy.2019.01.077

Rehman, A., Ma, H., Chishti, M. Z., Ozturk, I., Irfan, M., & Ahmad, M. (2021). Asymmetric investigation to track the effect of urbanization, energy utilization, fossil fuel energy and CO2 emission on economic efficiency in China: Another outlook. *Environmental Science and Pollution Research International*, *28*(14), 17319–17330. https://doi.org/10.1007/s11356-020-12186-w

Sadiq, M., Ngo, T. Q., Pantamee, A. A., Khudoykulov, K., Ngan, T. T., & Tan, L. L. (2022). The role of environmental social and governance in achieving sustainable development goals: Evidence from ASEAN countries. *Economic Research-Ekonomska Istraživanja*, 1–21. https://doi.org/10.1080/1331677X.2022.2072357

Sadiq, M., Amayri, M. A., Paramaiah, C., Mai, N. H., Ngo, T. Q., & Phan, T. T. H. (2022). How green finance and financial development promote green economic growth: Deployment of clean energy sources in South Asia. *Environmental Science and Pollution Research*, *29*(43), 65521–65534. https://doi.org/10.1007/s11356-022-19947-9

Sadiq, M., Ou, J. P., Duong, K. D., Van, L., Ngo, T. Q., & Bui, T. X. (2022). The influence of economic factors on the sustainable energy consumption: Evidence from China. *Economic Research-Ekonomska Istraživanja*, 1–23. https://doi.org/10.1080/1331677X.2022.2093244

Sarkodie, S. A., & Strezov, V. (2018). Assessment of contribution of Australia's energy production to CO2 emissions and environmental degradation using statistical dynamic approach. *The Science of the Total Environment*, *639*, 888–899. https://doi.org/10.1016/j.scitotenv.2018.05.204

Sarpong, S. Y., Bein, M. A., Gyamfi, B. A., & Sarkodie, S. A. (2020). The impact of tourism arrivals, tourism receipts and renewable energy consumption on quality of life: A panel study of Southern African region. *Heliyon*, *6*(11), e05351–549. https://doi.org/10.1016/j.heliyon.2020.e05351

Shahbaz, M., Raghutla, C., Song, M., Zameer, H., & Jiao, Z. (2020). Public-private partnerships investment in energy as new determinant of CO2 emissions: The role of technological innovations in China. *Energy Economics*, *86*, 104664–101059. https://doi.org/10.1016/j.eneco.2020.104664

Shahbaz, M., Sharma, R., Sinha, A., & Jiao, Z. (2021). Analyzing nonlinear impact of economic growth drivers on CO2 emissions: Designing an SDG framework for India. *Energy Policy*, *148*, 111965–111134. https://doi.org/10.1108/CG-01-2020-0047

Shahzad, S. J. H., Nor, S. M., Ferrer, R., & Hammoudeh, S. (2017). Asymmetric determinants of CDS spreads: US industry-level evidence through the NARDL approach. *Economic Modelling*, *60*, 211–230. https://doi.org/10.1016/j.econmod.2016.09.003

Shahzad, U. (2020). Environmental taxes, energy consumption, and environmental quality: Theoretical survey with policy implications. *Environmental Science and Pollution Research International*, *27*(20), 24848–24862. https://doi.org/10.1007/s11356-020-08349-4

Sharif, A., Godil, D. I., Xu, B., Sinha, A., Khan, S. A. R., & Jermsittiparsert, K. (2020). Revisiting the role of tourism and globalization in environmental degradation in China: Fresh insights from the quantile ARDL approach. *Journal of Cleaner Production*, *272*, 122906–121245. https://doi.org/10.1016/j.jclepro.2020.122906

Shibli, R., Saifan, S., Ab Yajid, M. S., & Khatibi, A. (2021). Mediating role of entrepreneurial marketing between green marketing and green management in predicting sustainable performance in Malaysia's organic agriculture sector. *AgBioForum*, *23*(2), 37–49.

Sun, Y., Duru, O. A., Razzaq, A., & Dinca, M. S. (2021). The asymmetric effect eco-innovation and tourism towards carbon neutrality target in Turkey. *Journal of Environmental Management*, *299*, 113653–111149. https://doi.org/10.1016/j.jenvman.2021.113653

Tan, L. P., Sadiq, M., Aldeehani, T. M., Ehsanullah, S., Mutira, P., & Vu, H. M. (2021). How COVID-19 induced panic on stock price and green finance markets: Global economic recovery nexus from volatility dynamics. *Environmental Science and Pollution Research*, *29*(18), 26322–26335. https://doi.org/10.1007/s11356-021-17774-y

Ullah, S., Apergis, N., Usman, A., & Chishti, M. Z. (2020). Asymmetric effects of inflation instability and GDP growth volatility on environmental quality in Pakistan. *Environmental Science and Pollution Research International*, *27*(25), 31892–31904. https://doi.org/10.1007/s11356-020-09258-2

Ulucak, R. (2020). Linking biomass energy and CO2 emissions in China using dynamic autoregressive-distributed lag simulations. *Journal of Cleaner Production*, *250*, 119533–119132. https://doi.org/10.1016/j.jclepro.2019.119533

Umar, M., Ji, X., Kirikkaleli, D., & Alola, A. A. (2021). The imperativeness of environmental quality in the United States transportation sector amidst biomass-fossil energy consumption and growth. *Journal of Cleaner Production*, *285*, 124863–121264. https://doi.org/10.1016/j.jclepro.2020.124863

Wang, B., & Wang, Z. (2018). Imported technology and CO2 emission in China: Collecting evidence through bound testing and VECM approach. *Renewable and Sustainable Energy Reviews*, *82*, 4204–4214. https://doi.org/10.1016/j.rser.2017.11.002

Wang, L., Chang, H.-L., Rizvi, S. K. A., & Sari, A. (2020). Are eco-innovation and export diversification mutually exclusive to control carbon emissions in G-7 countries? *Journal of Environmental Management*, *270*, 110829–111125. https://doi.org/10.1016/j.jenvman.2020.110829

Wang, M. C., & Wang, C. S. (2018). Tourism, the environment, and energy policies. *Tourism Economics*, *24*(7), 821–838. https://doi.org/10.1177/1354816618781458

Wirsbinna, A., & Grega, L. (2021). Assessment of economic benefits of smart city initiatives. *Cuadernos de Economía*, *44*(126), 45–56.

Wu, T.-P., & Wu, H.-C. (2018). The influence of international tourism receipts on economic development: Evidence from China's 31 major regions. *Journal of Travel Research*, *57*(7), 871–882. https://doi.org/10.1177/0047287517722231

Zhang, Y., Chen, X., Wu, Y., Shuai, C., & Shen, L. (2019). The environmental Kuznets curve of CO2 emissions in the manufacturing and construction industries: A global empirical analysis. *Environmental Impact Assessment Review*, *79*, 106303–101078. https://doi.org/10.1016/j.eiar.2019.106303

Zhao, L., Zhang, Y., Sadiq, M., Hieu, V. M., & Ngo, T. Q. (2021). Testing green fiscal policies for green investment, innovation and green productivity amid the COVID-19 era. *Economic Change and Restructuring*, https://doi.org/10.1007/s10644-021-09367-z

Zhao, L., Chau, K. Y., Tran, T. K., Sadiq, M., Xuyen, N. T. M., & Phan, T. T. H. (2022). Enhancing green economic recovery through green bonds financing and energy efficiency investments. *Economic Analysis and Policy*, *76*, 488–501. https://doi.org/10.1016/j.eap.2022.08.019