Cheng Paper

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THE DETERMINANTS OF INTERNATIONAL TOURISM: EVIDENCE FROM EUROPEAN COUNTRIES AND CHINA'S PROVINCES

Abstract

This study focuses on the five significant determinants of tourism: carbon emissions, population, transportation infrastructure, energy consumption, and international trade (trade openness). Therefore, this study collects panel data from 12 western provinces in China and 18 countries in Europe. The analysis employs Pooled regression, fixed effects, random effects, and panel autoregressive distribution models. Through Jarque-Bera test and Hausman test, it is finally determined that the Pooled Mean group (PMG) model of panel ARDL is the best option. Hence, the study obtains the long-run impacts of each determinant on international tourism for general overall and individual countries and provinces. Based on these results, this study compares the difference between the impact of the same determinant in China and Europe.

Keywords: Tourism, Panel Data, ARDL, China, Europe
JEL Classification: Z32, C23, Q43, B17

Introduction

Tourism, the world's largest service sector industry, directly employs 292 million people globally (equating to around 1 in 10 jobs on the planet), and accounts for a total of 10.2 percent of world GDP (US$7.6 trillion) (Crotti & Misrahi, 2017). According to the concept of tourism multiplier proposed by Mathieson, A., & Wall (1982), tourism, as a comprehensive industry, involves multiple industries and sectors of the national economy and can positively affect economic growth and employment promotion.

When the impacts of tourism are studied (see the literature review), a critical question arises: what are the determinants of the development of tourism? What impact will the determinants have? These are the central questions of the current study. Evidence from experience and related literature proves unidirectional causality (or bidirectional causality) from carbon emissions, population, transportation infrastructure, energy consumption, and international trade (trade openness) to tourism. The study regards these five determinants as explanatory variables and inbound tourism receipts as the explanatory variable. The analysis employs different methods to analyse two panel data sets: one for Chinese provinces and another for European countries. Finally, the study compares the long-run or short-run impact of the determinants of the two areas on the international tourism industry.

This study aims to investigate some of the main determinants of tourism. To this end, the current study collected two data sets, one for Chinese provinces and another for European countries, from 1995 to 2019. In order to derive the impact of carbon emissions, population, transportation, energy consumption, and trade openness on inbound tourism, this study employs pooled regression, fixed effect, random effect regression, and Panel ARDL models, and finds the optimal method through Jarque-Bera test and Hausman test.

Most of the previous literature regards tourism as an explanatory variable, focusing on the impact of tourism, such as the impact of tourism on the economy (Ramadhaniah, 2020; Azizurrohman et al., 2021; A. Liu, 2022) and the impact on carbon emissions (Dogan & Aslan, 2017; Anser et al., 2020). Even if there is evidence that there is a unidirectional or bidirectional causality from determinants to tourism, there is still very little literature on this subject in depth. Especially concerning demographic factors, there is very little related literature on the impacts of population on international tourism. The innovation of the current study is to treat tourism as an explained variable and quantitatively analyse the specific impact of carbon emissions, population, transportation, energy consumption, and international trade on tourism through four quantitative methods. Another innovation is that the research objects of the study are the western provinces of China and European countries. Therefore, the most suitable panel ARDL model is obtained by testing four methods, and finally, the study compares the different influences of the determinants in the two regions.

This paper is mainly about the determinates of inbound tourism. Anser et al. (2020) provide evidence that carbon emissions reduce international tourism receipts. They used the differenced GMM estimator method to analyse large-scale panel data from 132 countries from 1995 to 2018. The results of ex-ante analysis show that when carbon emissions increase from 0.375 percent to 1.349 percent, international tourism receipts decrease from 19.546 percent to 16.854 percent. In addition Amzath & Laijun (2014) investigated the relationship between carbon emissions and the inbound tourism growth in Maldives through a combined model. The research investigates causality between carbon emissions and the three indicators of inbound tourism, and the result of Granger causality test proved that carbon emissions cause inbound tourism.

Based on the data envelopment analysis and the directional environmental distance function to build a decomposition model of tourism growth and tourism carbon emissions from the perspective of a low-carbon economy, Jianping et al. (2015) found that carbon emissions have a more pronounced positive effect on tourism industry because most regions mainly promote tourism economic growth at the expense of the ecological environment. TUGCU & TOPCU (2018) collected annual data from 1995 to 2010 and used the panel ARDL method to investigate the impact of different fuels' carbon emissions on tourism revenue in ten countries. Their research results revealed that total carbon dioxide emissions negatively affect tourism revenue in the short term. In addition, they also learned that gaseous fuel emissions have a positive effect, and liquid fuel and solid fuel (only in the short run) emissions are negatively correlated to tourism revenue.

Zhang et al. (2019) employed the autoregressive distribution lag model of time series, the model investigated the relationship between fossil fuels, dioxide carbon emissions, and inbound tourism in Thailand. The research results show that carbon emissions have a significant negative impact on Thailand's international tourism at a significance level of 10 percent in the long run. Nademi & Najibi (2011) collected panel data from 2000 to 2007 in 12 developed countries and analysed the effects of carbon emissions on international tourism. Through the panel EGLS model, the study results show that carbon emissions at a significant level of one percent have a strong negative effect on the international tourism industry. Shakouri et al. (2017) applied panel data from Asia-Pacific countries to test the environmental Kuznets curve hypo-study. The research revealed a unidirectional causality from CO2 (carbon dioxide) emissions to the number of tourists by the Granger causality test.

Sharma (2021) employs the panel quantile regression model to analyse the panel data of 200 countries or regions from 1995 to 2018. Studies have shown that greenhouse gases are negatively related to international tourism. In tourism-intensive countries, the negative effects of greenhouse gases are even more remarkable. Amin & Atique (2021) provided evidence that more tourism will lead to more carbon emissions. They analysed data from five countries in South Asia from 1995 to 2019, and the results revealed the unidirectional causality from tourism to carbon dioxide emissions. Dogan & Aslan (2017) reveal the relationships between energy consumption, CO2 emissions, and tourism for the countries included in Organization of Economic Cooperation and Development (OECD). Using the cross-sectional dependency, heterogeneity, and other robust panel methodologies, they find a long-run relationship between the variables. Additionally, they establish unidirectional causality from tourism to CO2 emissions using the Emirmahmutoglu-Kose panel Granger causality test.

The above literature shows that more tourism will lead to increased carbon dioxide emissions. As a greenhouse gas, CO2 has an impact on climate and environmental changes, which in turn will affect the tourism industry. Sajjad et al. (2014) found that climatic factors and air pollution have a negative impact on tourism indicators in the form of deforestation and depletion of natural resources. The tourism industry has been systematically eroded due to severe climate changes and increasing air pollution. There are many causal relationships among climate factors, air pollution and tourism indicators. Zhou et al. (2019) employed the gravity model to study the effect of air pollution on tourism in Beijing. They found that air pollution has a significant negative impact on tourism. Furthermore, the result reveals that the effect of air pollution on international tourism is more pronounced than domestic tourism. In other words, foreign tourists are more sensitive to air quality. However, Liu et al. (2019) used random effects and fixed effects models to analyse the panel data of 17 provinces in China. They found the opposite result, that is, domestic tourists are more sensitive to air quality than foreign tourists.

In addition, some scholars believe that there is no relationship between air pollution and tourism. Law & Cheung (2007) surveyed the opinions of 1,304 international tourists. They found that when international tourists come to Hong Kong make travel decisions, and air quality is not a key factor influencing tourists' behaviour. But after they completed their trip to Hong Kong, they realized the seriousness of outdoor air quality in Hong Kong. As a result, the investigators expressed their willingness to pay certain taxes and fees to subsidize the local government to improve the air quality. Chen et al. (2017) studied tourists' monthly time series data in Taiwan from January 2004 to December 2011. They found that the impact of air pollution and rainfall on tourism demand largely depends on the various stages of the business cycle.

Bernini & Cracolici (2015) used the Hurdle model to verify that the influence of population factors such as age and groups on tourism decision-making and tourism expenditure is statistically significant. Through the analysis of data on Italian household expenditures from 1997 to 2007, empirical evidence shows that the population age factor has a positive effect on tourism intentions and a negative effect on tourism consumption expenditures. Faria (2008) analysed the relationship between the number of tourists and the population in the different game framework. The results show that the number of tourists increases with the increase in population. Hadzik et al. (2012) made a comparative analysis of the changing trends of hot spring visitor data and population data in Polish health resorts from 1995 to 2009. These population data involve the population of 15 age groups, the probability of death, the number of deaths and births per 1,000 people. By analysing the correlation between the scale of demand for medical tourism services and the time series of demographic factors, he used linear regression and multiple regression to study the impact of each individual factor. The results indicate that demographic changes may be a key factor that negatively affects the number of hot spring tourists in Poland.

Hui et al. (2018) focused on the impact of population size and structure on China's tourism industry. They collected two sets of indicator data of China’s tourism industry and population from 1995 to 2014 and used canonical correlation analysis methods. The results show that the changes in population size and structure are highly related to the development of tourism. There is a significant positive correlation between population size and tourism. In addition, the process of aging is also highly positively correlated with tourism. This is because the increase in population size provides more labour for the tourism industry, and the elderly are more inclined to travel. Moreover, they also emphasized that the impact of demographic factors on tourism is important and comprehensive. They suggested that the Granger causality test can be employed to further confirm the impacts of population on tourism.

Khadaroo & Seetanah (2007) investigated the impact of Mauritius Island's transportation infrastructure on tourist arrivals. Through the random effects panel model, the study obtained that the transportation infrastructure has a positive impact on arrivals at a 10 percent significance level. A one percent increase in transportation infrastructure capital variables will increase tourist arrivals by 0.36 percent. Wang et al. (2017) found that high-speed rail strengthened the spatial connection of the Beijing-Shanghai metropolitan area, expanded its tourism target range, and promoted the optimization of the large-scale regional tourism spatial structure of the metropolitan area. They employ GIS analysis method to investigate the effect of high-speed railway accessibility in 338 cities. They found that the transportation infrastructure of high-speed rail has a significant positive correlation with the field strength value of tourist destinations. Getahun (2016) pointed out that in Lake Tana, Northwest Ethiopia, transportation infrastructure and tourism are highly internally related. In particular, the road network and passenger arrivals show a clear positive correlation.

Wang et al. (2017) used the principle of traffic accessibility and related mathematical statistics to compare and analyse the impact of infrastructure transportation construction on the development of tourism economy in five cities in Yunnan from 2015 to 2019. The results show that the tourism economy of the study area has increased in proportion to the investment in Yunnan transportation in recent years, but the growth rate is slower, and the overall level is low. The progress of transportation construction in the study area and the tourism economy are unbalanced and mismatched. The local area gradually formed a transportation network and tourism circle cantered on Kunming. In general, the traffic accessibility of the study area has improved from 2015 to 2019. Among them, Honghe City has the fastest development, which is the most suitable for the driving effect of the tourism economy. Mazrekaj (2020) made a simulation of Kosovo's tourist flow through Trans CAD software and compared it with other European countries. They pointed out that road infrastructure is a prerequisite for the development of tourism and finally predicted that Kosovo would need 778,923 buses and 7,767,338 cars every year to ensure the supplying of the local tourism industry.

Işik et al. (2017) used the Emirmahmutoglu–Kose bootstrap Granger non-causality method to investigate the relationship between tourism receipts and energy consumption in the ten countries with most tourists. They found that in different countries, the results of the causality test are also different. In Spain, Turkey, Italy, the United States, and the United Kingdom, there is evidence of unidirectional causality from tourist arrivals to energy consumption. At the same time, in France, Germany, and Russia, there is no causal relationship between tourism revenue and energy consumption.

Nižić et al. (2016) found that the importance of energy to the tourism industry is undeniable as the increase in tourism activities is accompanied by an increase in the demand for energy for various functions. Becken et al. (2003) determined that transportation and accommodation are the main areas of energy consumption in the tourism industry. The energy supply in tourist areas is critical to the success of the tourism industry. (Amin, 2015) found that the price of oil is the main determinant of macroeconomic activities, and the tourism industry also heavily relies on oil for transportation and other tourism-related activities, such as accommodation and entertainment. As tourism prices remain high, the impact of oil price shocks will have a significant impact on the tourism industry. Dogan & Aslan (2017) used heterogeneous panel estimation technology to analyse the cross-section, and analysed the relationship between carbon emissions, real income, energy consumption, and tourism in the EU during the period 1995-2011. He believed that carbon dioxide emissions and There is a two-way causal relationship between energy consumption and actual income and carbon dioxide emissions.

Katircioglu (2014) revealed that the tourist arrivals in Turkey significantly increased long-run energy consumption based on a trivariate framework of tourism, energy consumption, and environmental degradation. Tang et al. (2016) applied the same method to investigate the relationship between tourism and energy consumption in India. The result also indicated that tourism in India significantly affects energy consumption in the long run. Katircioglu (2014) revealed that inbound arrivals are positively correlated with energy consumption in Cyprus in the long run, and the impact is statistically significant and inelastic. Solarin (2014) also verified a unidirectional causality between tourist arrivals to energy consumption in Malaysia in the long run.

Kulendran & Wilson (2000) took the lead in putting forward the hypo-study of "whether human tourism is related to international trade." The conclusion enhances that there is a relationship between energy consumption and tourism. Chaisumpunsakul & Pholphirul (2018) used data from Thailand and 207 trading partner countries and found that the degree of trade openness is positively correlated with international tourism demand. Chenhao et al. (2018) employed a single co-integration equation to analyse the number of Chinese tourist arrivals from five middle Asian countries from 2001 to 2015 and their statistical data on imports and exports to China. They conducted an empirical study on the equilibrium relationship between inbound Chinese tourists and import and export trade volume in five Central Asian countries. They performed the Granger causality test on the relationship. The study results revealed a long-run stable equilibrium relationship between China's inbound tourism and import and export trade with the five middle Asian countries. For Kazakhstan, there is unidirectional Granger causality from import trade to inbound tourism. For Turkmenistan and Tajikistan, the unidirectional Granger causality from import to inbound tourist arrivals is confirmed. For Kyrgyzstan and Uzbekistan, export trade is the unidirectional Granger causality of inbound tourism.

The relationship between inbound tourism and international trade of the five middle Asian countries is manifested in three types according to Chenhao et al. (2018), the first is the mutual promotion of international trade and tourism, mainly Kazakhstan. The second type is trade-promoting tourism, including Turkmenistan and Tajikistan, which is manifested as import trade promoting inbound tourism; Kyrgyzstan and Uzbekistan belong to the third type are displayed as export trade promoting the development of inbound tourism.
Shahbaz et al. (2017) collected Malaysian time series data from 1975 to 2013 and analysed the relationship between tourism and trade openness. The results of Granger causality test reveal the bidirectional causality between trade opening and tourism demand. It is also supported by Nahar et al. (2020) explained that higher trade value lead to expand tourism due to wider trade openness.

Research Method

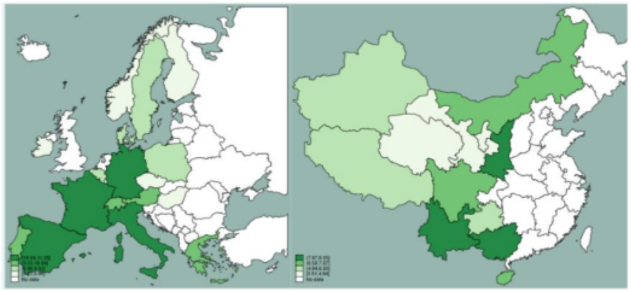
The data source at the country level applied in the current study is collected from the National Statistical Bureau of China, CEADs (Carbon Emission Accounts & Datasets) and the World Bank, and it covers the data on most of the required variables from 1995 to 2019. In addition, the present study applies a proxy of tourism development to investigate the determinants of the tourism industry in China and Europe (Brida et al., 2016). The current paper emphasizes the role of tourism receipts by following (Tang et al., 2016). Some studies also reveal that CO2 (carbon dioxide) emission per capita takes most greenhouse gasses released into the atmosphere, causing pollution (Saboori & Sulaiman, 2013; Chandran Govindaraju & Tang, 2013; and Zhang et al., 2019).

Data on Energy Consumption is collected in the shape of the amount of Fossil Fuel Energy (kg of fossil fuel per capita) and percent of total energy consumption (for European countries)(Pao & Tsai, 2010; Ismail & Mawar, 2012; Begum et al., 2015). This study also considers population as one of the factors affecting tourism (Faria, 2008; Zhang et al., 2019; Anser et al., 2020). The conclusion is that the population size is positively related to the development of tourism, and the population size has a positive impact on the development of tourism. Transportation is another crucial determinant that affects tourism. Some studies have revealed that transportation infrastructure will have a positive effect on tourism. Strengthening the construction of transportation infrastructure will promote the development of tourism (Xinchao, 2015; Zhiqiang, 2018; Qiang & Yabi., 2021).Therefore, this study also considers the transportation infrastructure of each region as an explanatory variable.

For provinces in China, it is measured as the length of the highway in each region, and for European countries, it is measured as the percentage of value-added in transport equipment manufacturing. The study further investigates the involvement of international trade in the model as international trade is an essential determinant for tourist attraction in the region. Hence the paper takes trade openness as an explanatory variable in models supporting the work of Shahbaz et al. (2017). The current study converts all variables in the logarithmic form since the heteroscedasticity can be reduced due to the logarithmic transformation of the data by compressing the variable measurement scale (Gujarati, 2004). The variables are transformed to log form in the process of a model estimation to facilitate the unit root test and differences, according to Azlina & Mustapha, 2012). International tourism income is the explained variable of current study, which also reflects the development of the region's tourism industry. The source of data on tourism revenue in European countries is the World Bank. In contrast, the advent of tourism revenue in Chinese provinces is the National Bureau of Statistics of China (NBS).

Figure 1 shows the tourism revenue of European countries and Chinese provinces in 2019 (LNTR: the logarithmic form of tourism revenue). It can be seen from Figure 1 that for European countries, tourism income in the west is higher, mainly concentrated in Spain, France, Germany, and Ital. For provinces in China, this paper mainly focuses on the provinces of western China, among which are in the south. Provinces such as Yunnan, Guangxi and Guizhou, and Shaanxi in the north have more developed tourism, while Qinghai, Gansu, and Ningxia in the middle have much lower tourism income.

Comparing the European countries and China's provinces, European countries' international tourism revenue is significantly higher than that of China's western provinces. The value of LNTR in Europe ranges is from 8.22 to 11.28, while the value of LNTR in Chinese provinces ranges is from 3.51 to 8.55.



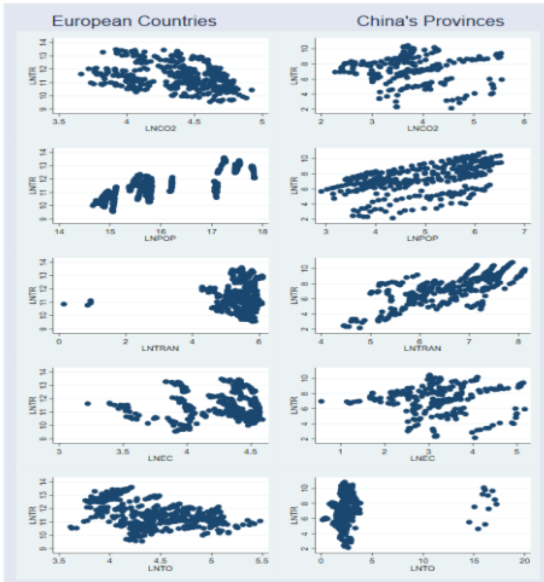
Note: the higher colour saturation represents the higher the international tourism receipts of the country (province). The data sources for Europe are from World Bank while the source for China is NBS.

Figure 1. LNTR of Europe countries and Chinese provinces in 2019

On the one hand, this is because the tourism industry of European countries is more internationally attractive. On the other hand, the tourism industry in western China is mainly for domestic tourists. In addition, Europe's carbon dioxide emissions data are collected from the World Bank, while China's carbon emissions data are derived from CEDAs. CEADs jointly compiled multi-scale carbon accounting lists and socio-economic and trade databases for China, developing countries, and regions with the joint support of many research institutions. The population data of European countries and Chinese provinces come from the World Bank and the National Bureau of Statistics of China, and the unit is the million people. Because of the different statistical data, the population data of Europe used in this paper is the population between 15 and 64 years old, while the population variable of Chinese provinces represents the total population. However, because the two models are separate, it does not affect the results.

Figure 2 is a logarithmic scatter plot of tourism revenue (LNTR) and explanatory variables in Europe and China. The first column shows the relationship between the explanatory variables and LNTR of European countries while the second column is for Chinese provinces. To keep two set in same scale and positive in logarithm form, the tourism receipts, carbon emission and transportation time 10 to keep positive. This would not affect the regression result since the empirical meaning of logarithm form in regression is percentage changes. We can see that the carbon dioxide emissions (LNCO2) of European countries is mainly concentrated in the range of 3.5 to 5. In contrast, the LNCO2 of Chinese provinces is scattered in the range of 2 to 6. This is due to the early maturity of industrial development in Europe and the small differences between countries, while the growth of China's carbon emissions from 1995 to the present is pronounced, and the differences between different provinces are also vast.

At the same time, we have noticed that European countries have obtained higher tourism income with lower per capita carbon emissions. The scatters plots of LNTR and population are also highlight of current study since there are seldom related literature on impact of population on international tourism receipts. It is obvious that LNTR increases while population increases in both European countries and China’s countries, which indicates a potential linear relationship between international tourism receipts and local population. In addition, China's trade openness value ranges are clustered in two regions, namely, range from 0 to 5 and 15 to 18. The relationship between LNTR and international trade (trade openness) needs to be explored in quantitative analysis and the results are presented in the following section.



Data sources: World Bank for Europe; CEDs & NBS for China.

Figure 2. Scatters Graphs of LNTR and Explanatory Variables

Compared with time-series data, panel data can better characterize the heterogeneity of European countries. For European countries, the paper relies on the panel data of a total of 450 observation samples in Europe from 1995 to 2019. For China's provinces, we use panel data of a total of 300 observation samples in China from 1995 to 2019.

Table 1. Descriptive Statistics

		LNTR	LNCO2	LNPOP	LNTRAN	LNEC	LNTO
European Countries	Mean	9.21	2.05	2.22	5.40	4.27	4.45
	Median	9.12	2.08	1.94	5.48	4.38	4.40
	Maximum	11.31	2.62	4.02	6.10	4.59	5.48
	Minimum	7.25	1.36	0.85	0.14	3.22	3.61
	Std. Dev.	0.93	0.29	0.93	0.58	0.28	0.39
	Skewness	0.30	-0.28	0.65	-4.98	-1.26	0.31
	Kurtosis	2.33	2.01	2.06	40.57	3.96	2.29
	Jarque-Bera	15.2***	21.2***	48.1***	27000***	114.9***	16.8***
	Observation	449	392	450	424	378	450
Chinese Provinces	Mean	7.15	3.78	4.86	4.22	3.20	2.87
	Median	7.23	3.73	4.86	4.30	3.17	2.34
	Maximum	10.85	5.55	6.52	5.82	5.17	17.22
	Minimum	2.13	2.27	2.90	2.15	0.57	0.14
	Std. Dev.	1.85	0.75	0.94	0.88	0.85	2.77
	Skewness	-0.48	0.37	-0.03	-0.26	0.07	4.35
	Kurtosis	2.91	2.88	1.72	2.12	3.27	21.17
	Jarque-Bera	11.7***	5.4*	20.6***	13.3***	1.0	5075***
	Observation	300	227	300	300	250	300

Note: *, **, *** represent significance of the coefficients at the 10%, 5%, and 1% levels respectively. To ensure the logarithm form is positive, for China and Europe, the LNTR=ln(10*tourism receipts), and Carbon emission is calculated in same way.

Table 1 shows the descriptive statistics of each variable (all variables are converted to natural logarithms). For European countries, the skewness and kurtosis values indicate that the distribution of all variables is skewed, which is different from the normal distribution. Furthermore, the Jarque-Bera (JB) statistical test reveals that the unconditional distribution of all variables is non-normal. Therefore, the traditional OLS linear regression method may lead to biased estimation results. In other words, it is more suitable to use the panel ARDL method to study the heterogeneous effects of factors such as carbon emissions on the tourism industry. For China's provinces, the skewness and kurtosis values represent that the distribution of all variables is different from the normal distribution. Furthermore, the Jarque-Bera (JB) statistical test shows that except for energy consumption (LNEC), carbon dioxide emissions (LNCO2), other variables are significant at the 1% level, and LNCO2 is significant at the 10% level. Therefore, the panel ARDL method is also more suitable for the data of Chinese provinces.

Table 2 Correlation Matrix

		LNTR	LNCO2	LNPOP	LNTRAN	LNEC	LNTO
European Countries	LNTR	1					
	LNCO2	-0.33	1				
	LNPOP	0.79	-0.15	1			
	LNTRAN	0.08	-0.04	0.15	1		
	LNEC	0.09	0.40	0.22	-0.42	1	
	LNTO	-0.36	0.18	-0.48	0.04	0.07	1
Chinese Provinces	LNTR	1					
	LNCO2	-0.01	1				
	LNPOP	0.38	0.74	1			
	LNTRAN	0.67	0.27	0.46	1		
	LNEC	0.01	0.97	0.71	0.33	1	
	LNTO	0.12	0.15	0.26	0.08	0.15	1

Note: Data sources: World Bank for Europe; CEDs & NBS for China.

Table 2 reveals the correlation between variables to decide the proper method to be used in the next step. Table 2 goes further to indicate that for European countries, LNCO2 with LNTR, population (LNPOP) with LNCO2, transportation infrastructure (LNTRAN) with LNCO2, LNEC with LNTRAN, trade openness (LNTO) with LNTR and LNPOP are all negatively correlated. However, at the same time, it is positively correlated between LNPOP with LNTR, LNTRAN with LNTR and LNPOP, LNEC with LNTR, LNCO2, and LNPOP, LNTO with LNCO2, LNTRAN, and LNEC; For Chinese provinces, LNCO2 is also negatively correlated with LNTR, while the others are positively correlated. However, it is still plain that most of these variables are weakly correlated; the analysis is insightful into the appropriate methodology to adopt in the future.

This study first uses pooled regression, fixed effects, and random effects models and conducts the Hausmann test on fixed effects and random effects regression for panel data. First, we need to understand the concept of error components model:

$$y_{it} = x'_{it}\beta + z'_{i}\delta + u_i + \varepsilon_{it} \qquad (1)$$

Among them, z_i is the individual characteristics of time-invariant, such as gender. Moreover, x_{it} can change with individuals and is time-varying. The unobservable random variable u_i represents the intercept term of individual heterogeneity. Finally, ε_{it} represents the stochastic disturbance team that varies with the individual and time. If all individuals have the same regression equation, the pooled regression equation can be expressed as equation (2).

$$y_{it} = \alpha + x'_{it}\beta + z'_i\delta + \varepsilon_{it} \quad (2)$$

Because of the characteristics of panel data, although we can usually assume that the disturbance terms between different individuals are independent of each other, there is often autocorrelation among the disturbance term of the same individual in different year (annual data) or observed time. Therefore, this paper adopts clustering robust standard errors. Clustering is composed of all the observations of the particular individual in different time period. The observations of the same cluster are allowed to be correlated. On the contrary, there is no correlation between the observations of different clusters.

The basic assumption of pooled regression is that there is no individual effect. Individual effects exist in only two forms: fixed effects or random effects. For the fixed effects model, taking the average of both sides of equation (1) over time, we can obtain:

$$\bar{y}_{it} = \bar{x}'_{it}\beta + z'_i\delta + \bar{\varepsilon}_{it} \quad (3)$$

By subtracting equation (3) from equation (1), we can obtain the dispersion form of the original model. This conversion is called mean-differencing or time demeaning. FE regression is obtained as following:

$$\tilde{y}_{it} = \tilde{x}'_{it}\beta + \tilde{\varepsilon}_{it} \quad (4)$$

For equation (1), the random-effects model assumes that u_i is not related to the explanatory variables x_{it} and z_i.

The panel ARDL model regards all variables as endogenous variables and assumes that there is a linear causal relationship between the variables. Moreover, by constructing a lag term, the panel ARDL model is converted to a panel ECM model, which can effectively estimate the long-term and short-term effects of variables and the short-term to long-term adjustment speed. In order to study the short-run and long-run relationship between tourism and determinants, based on the panel ARDL model proposed by Pesaran & Shin (1997), this paper constructs the test model for this chapter:

$$Q_{LNTR}(\tau_k|\alpha_i, x_{it}, \xi_t) = \alpha_i + \beta_{1\tau}LNCO_{2it} + \beta_{2\tau}LNPOP_{it} + \beta_{3\tau}LNTRAN_{it} + \beta_{4\tau}LNEC_{it} + \beta_{5\tau}LNTO_{it} + \xi_t \quad (5)$$

The definition of the variables in equation (5) is consistent with Table A.1., t represents the year. *i* represents a country in the European model, and its value range is i = 1, 2...,18; while in the Chinese model, *i* represents a province, and its value range is *i*=1, 2...,12. According to Pesaran (2021), a panel autoregressive distributed lag model with long-term relationship coefficients can be represented as equation (6), which contains the short-run and long-run coefficients, moreover, there is also the error correction term to measure the adjustment speed from the short run to long run in this form.

$$\begin{aligned}\Delta LNTR_{it} = {} & \beta_0 + \sum_{i=1}^{n}\alpha_{i1}\,\Delta LNTR_{t-i} + \sum_{i=1}^{n}\gamma_{2i}\,\Delta LNTR_{i,t-i} + \sum_{i=1}^{n}\sigma_3\,\Delta LNCO_{2i,t-i} + \sum_{i=1}^{n}\theta_4\,\Delta LNPOP_{i,t-i} \\ & + \sum_{i=1}^{n}\tau_5\,\Delta LNTRAN_{i,t-i} + \sum_{i=1}^{n}\varphi_6\,\Delta LNEC_{i,t-i} + \sum_{i=1}^{n}\omega_7\,\Delta LNTO_{it} + \beta_{1\tau}LNCO_{2it} + \beta_{2\tau}LNPOP_{it} \\ & + \beta_{3\tau}LNTRAN_{it} + \beta_{4\tau}LNEC_{it} + \beta_{5\tau}LNTO_{it} + \delta EC_{i,t-1} + \mu_{it} \quad (6)\end{aligned}$$

Thus, β_i measures the long-term impact of explanatory variables on the tourism industry, $EC_{i,t-1}$ represents error correction, μ_{it} is the error term, and the α, γ, σ, θ, τ, ϕ and ω rest are the coefficients of short-term impact. When the coefficients in the estimation results are significant, it can be considered that there is a short-term or long-term dynamic relationship between the variables.

The advantages of the ARDL model are as follows: (1) It is unnecessary to test whether the variable is single first-order integrality in advance, which is the biggest advantage of the ARDL method. Traditional methods almost require that all variables entering the model have single first-order integrality, that is, I(1). The ARDL method does not have strict requirements on the stability of the data, no matter whether the data is I(1) or I(0), and whether there is a cointegration relationship between them, this method can be used (Pesaran & Shin, 1997). In other words, it is not necessary to consider whether the time series entering the model is pure I(0) or pure I(1) or a mixture of I(0) and I(1). Then (2) there is no need to consider whether the variable is endogenous. Pesaran et al. (1996) believes that cointegration vector autoregressive analysis involves many endogenous and exogenous variable selections, determination of lag order, determination of trend terms, and intercept terms so that the study's conclusions are very uncertain. The robustness of the model is not high. The ARDL method will not affect the estimation of the model even when the explanatory variable is endogenous, and the estimation result is more robust. The last is (3) simultaneously reflect the short-run and long-run relationship (Narayan & Narayan, 2006). The ARDL method can derive a ECM (dynamic error correction model) through a simple linear transformation (Banerjee & Newman, 1993), integrating short-term and long-term dynamics. This paper applies Mean Group (MG) and Pooled Mean Group (PMG) to estimate the equation, and the final model is determined by Hausmann's test.

Result and Discussion

Pooled Regression, Fixed and Random Effect Model

This paper first uses pooled regression, fixed effects, and random effects regression to investigate the impact of each explanatory variable on the tourism industry. To verify the most acceptable of the three models, this study first compares pooled regression and fixed-effects models by F-test and then compares fixed-effects and random-effects by Hausman test.

Table 3. The Results of Pooled, Random Effect (RE) and Fixed Effect (FE) Regression

	Variables	**Pooled**		**RE**		**FE**	
		Coefficients	P value	Coefficients	P value	Coefficients	P value
European Countries	LNCO2	- 0.67	0.14	0.25	0.15	0.67***	0.00
	LNPOP	0.81***	0.00	1.58***	0.00	3.89***	0.00
	LNTRAN	-0.14	0.55	0.04	0.33	0.08*	0.07
	LNEC	-0.12	0.80	-1.71***	0.00	-2.58***	0.00
	LNTO	0.16	0.39	1.13***	0.00	0.90***	0.00
	Constant	-9.25	0.40	7.18***	0.00	5.83***	0.00
	R squared	0.67		0.55		0.61	
	F test	---	---	---	---	75.82***	0.00
Chinese Provinces	LNCO2	-1.01	0.45	-0.17	0.44	-0.05	0.81
	LNPOP	1.09**	0.04	0.92***	0.00	1.00***	0.00
	LNTRAN	1.25***	0.00	-0.27*	0.08	-0.52***	0.00
	LNEC	-0.29	0.75	0.32	0.12	0.30	0.13
	LNTO	0.02	0.31	-0.01	0.52	-0.01	0.44
	Constant	1.31	0.44	3.51***	0.00	3.83***	0.00
	R squared	0.59	---	---	---	---	---
	F test	---	---	---	---	29.89***	0.00
Dependent variable		LNTR		Observations for European countries			450
				Observations for Chinese Provinces			300

Note: *, **, *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels respectively

Table 3 shows the parameters and p-values of the three models. Through the F test, we find that in the two subjects of European countries and Chinese provinces, the F test shows that the null hypo-study is rejected; that is, the null hypo-study that pooled regression is acceptable is rejected. In other words, both in China and Europe, fixed effects are better than pooled regression. This paper further employs the LSDV method to investigate it, the results are attached in appendix (Table A2), since the most of the individual dummy variables are significant at the one percent level. We can reject the null hypo-study and believe that there is an individual effect, the conclusion is consistent with the F test. Hence, the FE method is the better option than pooled regression.

This study further compares fixed effects and random effects. Through Hausmann's test, we found that the p-value of Hausmann's test is less than 0.01 under the data of China and Europe. Therefore, the null hypo-study is strongly rejected, and the fixed effects model should be adopted. In China's fixed effects model, the coefficients of LNPOP and LNTRAN are significant at the one percent level, and the coefficients of other variables are not significant. One percent population increase will bring about one percent increase in international tourism revenue, and one percent increase in the length of traffic roads will reduce international tourism revenue by 0.52 percent. In the above Table 1 mentioned Jarque-Bera test, all data are not normally distributed. Therefore, using the Panel ARDL model is a better option.

Panel Autoregressive Distributed Lag Model

a. Cross-sectional dependence (CD) test and unit root test

Due to the characteristics of panel data, a common cause may affect all individuals, which may lead to Cross-sectional Dependence. When there is cross-section correlation, the traditional panel unit root test will be invalid. Therefore, before the unit root test of the variables, this paper first conducts the CD Test panel independence test, and the results are shown in Table 4.

Table 4. Results of CD test

		CD Test	P value
European Countries	LNTR	53.87***	0.00
	LNCO2	37.55***	0.00
	LNPOP	14.18***	0.00
	LNTRAN	15.40***	0.00
	LNEC	36.87***	0.00
	LNTO	47.63***	0.00
Chinese Provinces	LNTR	30.03***	0.00
	LNCO2	29.90***	0.00
	LNPOP	40.46***	0.00
	LNTRAN	37.71***	0.00
	LNEC	33.31***	0.00
	LNTO	39.95***	0.00

Note: *, **, *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels respectively. Null hypo-study of CD test: panel independence exists.

Table 4 reveals that the variables are all strongly significant at the one percent level through the CD test, thus rejecting the null hypo-study. Therefore, the panel data used in this paper does not have panel independence, so the unit root test is performed on the variables. Commonly used basic unit root testing methods such as IPS and Fisher assumed that the cross-section is irrelevant, but according to the results of the CD test, the assumption that the cross-section is not relevant is rejected. Therefore, current study employs the second-generation unit root test method, which is the Cross-section Augmented Dickey-Fuller (CADF) method. The paper still applies the IPS and Fisher method as the reference for the CADF unit root test. The results are shown in Table 5.

Table 5. Results of Unit Root Test

		Level			First difference		
		IPS	FISHER	CADF	IPS	FISHER	CADF
European Countries	LNTR	2.31	-8.02***	-2.15**	-10.98***	-11.86***	-5.69***
	LNCO2	4.68	-7.52***	-3.52***	-7.31***	-12.11***	-7.86***
	LNPOP	-2.21**	-5.24***	-1.49*	-2.43***	-7.56***	-2.87***
	LNTRAN	0.44	-4.90***	2.32	-9.79***	-12.88***	-7.30***
	LNEC	6.75	-3.89***	0.28	-6.49***	-11.85***	-6.20***
	LNTO	-1.70**	-7.76***	0.44	-12.09***	-12.24***	-5.11***
Chinese Provinces	LNTR	3.57	-5.32***	-1.17	-9.03***	-11.40***	-6.19***
	LNCO2	2.36	-5.13***	-4.30***	-3.91***	-9.87***	-6.25***
	LNPOP	3.68	-4.48***	-0.63	-3.08***	-9.29***	-3.68***
	LNTRAN	2.06	-5.81***	-1.59*	-6.16***	-9.57***	-4.85***
	LNEC	3.65	-3.03***	-6.00***	-2.89***	-9.14***	-4.86***
	LNTO	-7.20	-4.24***	2.98	-14.28***	-10.81***	-5.00***

Note: *, **, *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels respectively.

From the table 5, we can conclude that all five determinants and tourism receipts are stationary at 1 percent significant level in first difference term since the p value of CADF test in first difference form are all smaller than 0.01. Even looking through the traditional unit root test method such as IPS and Fisher methods, the results are consistent with CADF from the perspective of first differences term. It also reveals that LNTR, LNCO2, LNPOP in Europe and LNCO2, LNTRAN and LNEC in China rejected the null hypo-study within 10 percent significant level in level term. Hence all variables are I(0) or I(1) and it is plausible to estimate the panel ARDL model.

b. Co-integration test

The common method for variables with unit roots is to make a first-order difference, hence current study obtains stationary series. However, the meaning of the variables after the first difference is different from the original sequence. At this time, we still hope to use the original sequence for regression. The Table 6 presents the result of Pedroni and Kao co-integration test, since the most statistics are significant at one percent level, we can reject the null hypo-study of no co-integration. Furthermore, the paper applied the Kao co-integration test and obtained the same output, which is that the null hypo-study is rejected. So, we can conclude there is a significant cointegration relationship between variables.

Table 6. Results Of Pedroni and Kao Co-Integration Test

		Statistics	P value
European Countries	Pedroni Modified Phillips–Perron	3.63***	0.00
	Pedroni Phillips–Perron	-1.68**	0.04
	Pedroni ADF	-1.17	0.12
	Kao test	-3.97***	0.00
Chinese Provinces	Pedroni Modified Phillips–Perron	2.74***	0.00
	Pedroni Phillips–Perron	-1.76**	0.04
	Pedroni ADF	-2.16**	0.02
	Kao test	3.08***	0.00

Note: *, **, *** represent significance of statistics value at the 10 percent, 5 percent, and 1 percent levels respectively. Null hypo-study of co-integration: cointegration relationship does not exist.

On the assumption of long-run homogeneity, the Pedroni or Kao Co-integration test can be skipped. Co-integration is ascertained from the statistical significance of the long-run coefficients and the error correction term. In the other words, co-integration presents itself as the joint significance of the level equation.

c. Optimal lags selection

In order to obtain the best lags structure, this paper runs the ARDL model on the time series of each country (or province) and then counts the frequency of the lag term of each variable in each country (or province), and finally chooses the lags with the highest frequency is the final result. Table 7 gives the results of selecting the optimal lag structure. The maximum lags setting in this paper is two because a more extensive lag will cause collinearity problems and make it impossible to run the ARDL model for some countries (or provinces).

From Table 7, we can see that the optimal lag of European countries' data is (2 2 1 2 2 1). For variables such as LNTR, the frequency of lag 0 is 0, lag 1 is 8, and lag 2 is 10. Therefore, we should choose lag two which is with the highest frequency, as the lag of LNTR. In addition, the sum of frequencies is 18, which is the same as the number of countries, which also verifies that each country runs the ARDL model individually. For Chinese provinces, the optimal lag structure is (1 1 2 2 1 0). We noticed that the sum of frequencies is 9, and the number of provinces is 12. The reason is that the panel is unbalanced. The missing data of some provinces and collinearity cause no results in the remaining three provinces, but the panel ARDL model can still work; the optimal lag structure is adequate.

Table 7. Optimal lags for European Countries and China's Provinces

		Lag 0 frequency	Lag 1 frequency	Lag 2 frequency	Results
European Countries	LNTR	0	8	10	2
	LNCO2	2	7	9	2
	LNPOP	5	13	0	1
	LNTRAN	3	5	10	2
	LNEC	3	4	11	2
	LNTO	7	11	0	1
Chinese Provinces	LNTR	0	6	3	1
	LNCO2	3	6	0	1
	LNPOP	3	1	5	2
	LNTRAN	2	0	7	2
	LNEC	4	5	0	1
	LNTO	6	3	0	0

Note: the method is to run ARDL model for each individual and then select the most common lags for each variable.

d. Panel ARDL: MG and PMG

The mean group (MG) estimates N time series equations and average the coefficients and the pooled mean group (PMG) uses a combination of pooling and average of coefficients. First of all, we applied international tourism receipts as dependent variables and carbon emission, population, energy consumption, transport and trade openness as explanatory variables. The PMG estimation method can be applied to estimate the variables with cointegration relationship under the premise of satisfying the existence of cointegration relationship. The PMG method can estimate the relationship between the cointegration variables and gives an error correction coefficient, which confirms the existence of a long-term relationship. Moreover, only when the error correction coefficient is significantly negative can we consider the relationship is significant and efficient.

Table 8. Results of MG and PMG Models for European Countries

	Variables	MG		PMG	
		Coefficients	p-value	Coefficients	p-value
Long-run	lnCO2	2.640*	0.063	2.026***	0.000
	lnPOP	6.708	0.108	4.047***	0.000
	lnTran	-0.458	0.419	-0.642***	0.000
	lnEC	-9.098**	0.027	-4.098***	0.000
	lnTO	0.116	0.810	1.811***	0.000
Short-run	ECM	-0.583***	0.000	-0.295***	0.000
	ΔlnCO2	-0.506	0.260	0.006	0.976
	ΔlnPOP	-5.405	0.420	-3.552	0.325
	ΔlnTran	0.004	0.979	0.101	0.475
	ΔlnEC	0.316	0.850	-0.281	0.685
	ΔlnTO	0.108	0.517	-0.068	0.568
	_cons	-1.024*	0.915	2.718***	0.000
Hausman test		Chi2:	5.40	Prob>Chi2	0.37
Dependent variable		LNTR		Observations	450

Note: *, **, *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels respectively

Hausman test is the judgment standard for selecting PMG estimator and MG estimator for panel ARDL analysis. According to the results of the Hausman test in Table 8, this paper believes that the PMG estimator is a more appropriate estimator for the model compared to the MG estimator. We can first see that in both MG and PMG, the coefficients of ECM are significantly negative, which reveals that there is a significant long-term relationship between variables in European countries. From Table 8, we can see the results of PMG estimation. In the short-term relationship, the coefficients of the variables are not significant at least at the 10 percent level, but the coefficients of all determinants are statistically significant at the 1 percent significance level in long-term relationship.

In the long run, carbon dioxide emissions, population, and trade openness are positively correlated with the explained variable (international tourism income); transportation, fossil energy consumption are negatively correlated with the explained variable. One percent increase in carbon emissions will increase international tourism revenue by 2.026 percent; a one percent population growth will increase international tourism revenue by 4.047 percent; an increase in trade openness by one percent will increase tourism revenue by 1.811 percent. Moreover, for every one percent increase in the value-added of transportation equipment, international tourism revenue will decrease by 0.642 percent; for every one percent increase in fossil energy consumption, international tourism revenue will decrease by 4.098 percent.

Table 9 shows the results of the panel ARDL model for Chinese provinces. This paper also uses two methods, MG and PMG, to investigate the short-term and long-term effects of determinants on international tourism income. We can obtain the conclusion that PMG estimation is better than MG estimation by Hausmann's test. In the PMG model, the coefficient of the error correction term is negative and significant at the one percent level, which proves that the determinant and the explained variable (international tourism receipts) are strongly correlated in the long run.

Similar to the European model, the coefficients of the determinants are not statistically significant in the short run. However, the coefficients of all variables are enormously significant at the one percent level in the long run. In the long-term relationship, carbon emissions per capita, population, and road length are positively correlated with the explained variable (international tourism income), while fossil energy consumption and trade openness are all negatively correlated with international tourism income.

Table 9. Results of MG and PMG Models for China's Provinces

	Variables	MG		PMG	
		Coefficients	p-value	Coefficients	p-value
Long-run	lnCO2	1.821	0.32	-0.495*	0.07
	lnPOP	1.478***	0.00	0.929***	0.00
	lnTran	0.294	0.83	-0.893***	0.00
	lnEC	-2.422	0.33	1.255***	0.00
	lnTO	-0.064***	0.00	-0.022**	0.04
Short-run	ECM	-0.837***	0.00	-0.471***	0.00
	ΔlnCO2	-0.921	0.32	-0.091	0.85
	ΔlnPOP	-0.926	0.11	-0.268	0.46
	ΔlnTran	0.207	0.43	0.170	0.51
	ΔlnEC	0.143	0.84	-0.457	0.42
	ΔlnTO	0.011**	0.01	-0.004	0.40
	_cons	3.01***	0.00	2.34	0.00
Hausman test		Chi2:	2.86	Prob>Chi2	0.72
Dependent variable:		LNTR		Observations	300

Note: *, **, *** represent statistical significance of coefficients of determinants at the 10 percent, 5 percent, and 1 percent levels respectively.

In the long run, a percentage increase in carbon emissions per capita will decrease international tourism receipts by 0.495 percent; a one percent increase in population will increase international tourism income by 0.929 percent. One percent increase in the length of highways will decrease the income of international tourism by 0.893 percent. At the same time, if fossil energy consumption increases by one percent, tourism revenue will decrease by 1.255 percent; if trade openness increases by one percent, international tourism revenue will decrease by 0.022 percent.

For causality, causality can be observed through ECM, long-term, and short-run coefficients. Because the coefficients of the error correction terms of the two models are enormously significant at the one percent level, we can conclude that joint causality is strong. While the short-run coefficients are not significant, it reveals that the short- run causality is not significant; The long- run coefficients are all enormously significant at the one percent level, so there is the strong long-run causality.

Comparison between Europe and China

To compare the results of Europe to China, the current study organizes the PMG model results of the two regions into Table 10. The pronounced difference lies in carbon emissions. One percent increase in per capita carbon emissions will increase international tourism income by 2.026 percent in Europe. On the contrary, in China, a one percent increase in carbon dioxide emissions will reduce international tourism income by 0.495 percent. This phenomenon is interesting because the long-run effects of the same determinant in different regions are opposite. In the original data, Chinese provinces' average per capita carbon emissions is 5.93 tons per capita. In comparison, in European countries, it is 8.08 tons per person (in descriptive statistics and models) to avoid negative logarithms (this study transforms the original data). However, considering that the population of Chinese provinces is much larger than that of European countries, there would be a pronounced difference in the total amount.

According to Zha et al. (2015), most regions in China mainly promote tourism economic growth at the expense of the ecological environment. When tourism development is at the cost of increased carbon emissions, the environment may be further polluted, which will affect the development of tourism. From the current results, a reasonable explanation is that the increase in carbon emissions has already caused pollution to the environment, thus negatively impacting the tourism industry. This also explains the two-way causality between tourism receipts and CO2 emissions in the previous literature. In Europe, it seems that it is still before the critical point where the impact of carbon emissions on tourism income changes from positive to negative.

As for the determinants of population, the influence of population on international tourism is positive in China and Europe. This is in line with empirical analysis since more population brings more labour force. However, a population increase of one percent can increase European countries' international tourism revenue by 4.047 percent, but it can only increase China's international tourism revenue by 0.929 percent. The reason can be that China's population is large enough, and the marginal effect is diminishing.

Table 10. Comparison of Long Run Effects

	Variables	European Countries	China's Provinces
		Coefficients	Coefficients
Long run	LNCO2	2.026***	-0.495*
	LNPOP	4.047***	0.929***
	LNTRAN	-0.642***	-0.893***
	LNEC	-4.098***	1.255***
	LNTO	1.811***	-0.022**
ECM		-0.295***	-0.471***
Observations		450	300

Note: *, **, *** represent statistical significance of coefficients of determinants at the 10 percent, 5 percent, and 1 percent levels respectively.

The impact of transportation infrastructure is both negative in Europe and China. This may be because the infrastructure in the two regions is relatively mature. The effect of energy consumption on international tourism income is negative in Europe and positive in China. Meanwhile, the impact of trade openness on international tourism is positive in Europe and negative in China.

Conclusion

This study collects China's provincial panel data and European country panel data. Then, it investigates the impacts of five determinants (per capita carbon emissions, population, transportation infrastructure, fossil energy consumption per capita, and trade openness) on international tourism by the same methods. Firstly, the paper performs the pooled regression, random effect, and fixed effect model. The F test and LSDV method results reveal that the individual effects exist, so the fixed effect model is better than pooled regression. Moreover, the Hausman test rejects the null hypo-study, and then we can conclude that the fixed effect method is better than the random effect model. However, the Jarque-Bera (JB) test reveals that the distribution of all variables is non-normal. Therefore, the traditional OLS linear regression method may lead to biased estimation results. In other words, it is more plausible to apply the panel ARDL method.

In the panel ARDL model, this paper examines the Cross-sectional Dependence. Through the second-generation unit root test method, the current study obtained that all variables of the two panels are stationary at I(0) or I(1). Furthermore, the results of Pedroni and Kao co-integration indicate that there is a significant co-integration relationship between variables. After obtaining the optimal lag, this paper ran the MG and PMG models of panel ARDL and found that PMG is better through Hausmann's test. Therefore, we obtained the final estimate.

This study has applied pooled, random effect, and fixed effect models to investigate five determinants: carbon emission, population, transportation, energy consumption, and trade openness on international tourism. The JB test and Hausman test results reveal that the PMG model of panel ARDL is the best option. The study focuses on European countries and China's provinces, and the PMG method has obtained long-run effects in two areas. This study compares the results of European countries and Chinese provinces to understand each determinant's effects better.

The results of comparison between Europe and China can find that the population is positively correlated with international tourism receipts and transportation infrastructure, negatively affecting international tourism receipts in China and Europe. Carbon emission per capita has a positive impact on tourism in Europe but a negative effect in China. Fossil fuel energy consumption has a negative correlation with international tourism receipts in Europe but positively correlated in China. Trade openness has a positive effect in Europe while has a negative impact on tourism in China, all coefficients, in the long run, are significant, and most are significant at the level of one percent. The paper finds that carbon emission per capita has a positive impact on tourism in Europe but a negative effect in China. The reason could be that China promoted tourism economic growth at the expense of the ecological environment (Zha et al., 2015), but in the long run the increasing emission will restrain the tourism since the total carbon emission per capita in west provinces of China is already higher than European countries. Fossil energy consumption is negatively correlated with international tourism receipts in Europe but positively correlated in China. Trade openness has a positive effect in Europe while has a negative impact on tourism in China, all coefficients, in the long run, are significant, and most are significant at the level of one percent. The PMG model for individual countries or provinces provides the impacts of determinants in particular countries (or provinces).

The contribution of this study lies in the analysis of the impact of CO2 emissions per capita, population, transportation infrastructure, energy consumption, and trade openness on the international tourism industry based on quantitative analysis, taking Europe and China as samples. Previous literature has rarely studied the effects of these determinants on international tourism, especially carbon emissions and population. Most of the literature focuses on exploring the impact of tourism on carbon emissions, but there is little literature on the impact of carbon emissions on tourism. After obtaining the results through effective research methods, this study compares the results of the two regions to gain a deeper understanding of the impact of these determinants.

The limitation of this study is that for European countries, the receipts generated by tourism between these countries are also regarded as part of the international tourism revenue. However, for Chinese provinces, travel between these provinces is not considered international travel. For instance, the revenue generated by German tourists in Spain is counted as international tourism income; but the income generated by Yunnan tourists in Sichuan is not included in international tourism income.

Therefore, the explained variables of the two databases, namely the income of the international tourism industry, contain different content. This weakens the comparison to a certain extent. In addition, the panel data is an unbalanced panel, the method that requires a strongly balanced panel in the analysis process cannot be used in this study. For example, the Granger causality test cannot be employed, so the study can only determine the causality by long-run coefficients and ECM coefficients of the PMG method.

This study is of reference significance for policymakers. According to the five determinants, European and Chinese policymakers can adjust to promote tourism. For example, since the carbon emission coefficient is negative in China, China's western provinces should reduce carbon emissions to increase international tourism income; Europe should minimize fossil energy consumption because the energy consumption coefficient is negative and has a considerable value. The model results of this study can provide reference for policy decisions.

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Appendix

Table A1. Data sources and definition

Variables	Definition	Transform	Sources
TR	International tourism receipts (million USD)	Logarithm form (LNTR)	World Bank (Europe); National Bureau of Statistics (China)
CO2	CO2 emission per capita (ton per capita)	Logarithm form (LNCO2)	World Bank (Europe); Carbon Emission Account & Datasets (China)
Population	Total population (Europe: aged 15-16; million)	Logarithm form (LNPOP)	World Bank (Europe); National Bureau of Statistics (China)
Transport	Percentage of value added in transport (Europe; %) Length of highway (China; km)	Logarithm form (LNTRAN)	World Bank (Europe); National Bureau of Statistics (China)
EC	Fossil fuel energy consumption (kg per capita)	Logarithm form (LNEC)	World Bank (Europe); National Bureau of Statistics (China)
TO	Trade openness, proportion of international trade	Logarithm form (LNTO)	World Bank (Europe); National Bureau of Statistics (China)

Table A 2. LSDV results for European countries and China's provinces

VARIABLES	LNTR	VARIABLES	LNTR
LNCO2	-0.0516	LNCO2	0.668*
LNPOP	1.003***	LNPOP	3.889***
LNTRAN	-0.520*	LNTRAN	0.0755
LNEC	0.296	LNEC	-2.575**
LNTO	-0.00823	LNTO	0.897***
GUANGXI	3.129***	Belgium	-1.962***
GUIZHOU	1.613***	Czech	-2.232***
HAINAN	1.076***	Demark	0.856**
INNER MONGOLIA	1.932***	Finland	-1.147
NINGXIA	-3.278***	France	-6.960***
QINGHAI	-1.332***	Germany	-7.902***
SHAANXI	2.859***	Greece	-0.273
SICHUAN	2.658***	Hungru	-2.007***
XINJIANG	1.417***	Ireland	1.184
YUNNAN	3.837***	Italy	-5.644***
CONSTANT	2.502**	Netherland	-2.992***
		Norway	0.253
		Poland	-5.866***
		Portugal	-0.746**
		Spain	-4.637***
		Sweden	-2.765***
		Switzerland	-0.637**
		Constant	-45.55**

Table A 3. PMG model for individual China's Provinces

VARIABLES	ECT	LNCO2	LNPOP	LNTRAN	LNEC	LNTO	CONSTANT
LONG-RUN		-0.495*	0.929***	-0.893***	1.255***	-0.0221**	
GANSU	-0.164	-2.073	-1.319	0.396	4.316	-0.0488	0.507
GUANGXI	-0.728***	-0.218	0.682	-0.342	-1.449*	-0.00315	5.006***
GUIZHOU	-1.137***	-3.811**	0.825	1.154***	0.733	0.00573	5.295***
HAINAN	-0.0276	-0.149	0.967	-1.570*	-0.142	-0.00497	0.2
INNERMONGOLIA	-0.466***	1.808***	2.164***	0.131	-2.785***	0.0108**	2.029***
NINGXIA	-0.183	0.431	-1.668	-0.714	-1.204	0.0118	0.316*
QINGHAI	-0.416**	0.0196	0.881	1.549**	-1.544	-0.00789	0.627**
SHAANXI	-0.752***	0.907	0.0308	0.376	-1.835	0.00652	4.537***
SICHUAN	-0.667***	0.539	-1.228	-0.0088	-0.907	-0.00077	4.232***
TIBET							
XINJIANG	-0.526***	1.436	0.402	0.588	0.358	-0.00899	2.130***
YUNNAN	-0.114*	0.11	1.211***	0.311	-0.566**	-0.0065	0.824

Table A 4. PMG model for individual European countries

VARIABLES	ECT	LNCO2	LNPOP	LNTRAN	LNEC	.LNTO	Constant
Long run		2.026***	4.047***	-0.642***	-4.098***	1.811***	
Austria	-0.195***	1.403*	-7.919	0.525	-2.888	-0.412	-8.653**
Belgium	-0.219	-0.0609	3.092	1.286**	-1.136	0.239	-10.37
Czech	-0.369***	-0.196	4.418	-0.549	0.0707	0.025	-17.37**
Demark	-0.398***	-0.852**	-48.77***	-0.319*	2.259*	-0.790***	-17.19**
Finland	-0.483***	-0.359	-4.38	-0.0137	1.125	-0.0115	-22.30**
France	-0.548***	-1.178	-11	-0.39	1.358	-0.838**	-28.04**
Germany	-0.145	-0.565	-3.765	-0.0954	2.949	0.345	-7.558
Greece	-0.744***	-1.917**	-17.51	-0.0694	5.543	-0.249	-33.10**
Hungru	-0.660***	1.475**	-3.572	0.902***	-3.690*	-0.548***	-30.43***
Ireland	-0.0269	0.7	4.327	0.00468	-2.921	-0.862	-1.19
Italy	-0.119	0.386	16.10***	-0.64	1.29	-0.0575	-5.86
Netherland	-0.189	0.434	-10.69	-0.147	-2.499	-0.501	-8.999
Norway	-0.106*	-0.0529	18.80**	-0.281	-0.183	0.201	-4.862
Poland	-0.156	1.214	5.296	0.00525	-7.689	0.729	-7.879
Portugal	-0.339***	-0.18	-15.35***	0.0335	0.298	0.246	-15.09**
Spain	-0.326***	-0.479	0.715	1.585*	1.42	0.687**	-15.88**
Sweden	-0.169	0.348	-7.659	0.0194	0.15	0.464	-7.951
Switzerland	-0.122	-0.0111	13.94**	-0.031	-0.521	0.117	-5.62

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