Environmental Degradation, Economic Growth and Tourism Development in Chinese Regions

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Abstract

Tourism development is recognised as an essential tool in promoting economic growth; however, it may also contribute to environmental degradation. Increased pressure for reducing CO_2 emissions poses new challenges to policymakers who try to promote economic growth and environmental protection in tandem. Since 2010, 19 scenic areas in China have been declared as low-carbon tourism demonstration zones. It follows that investigating whether CO_2 emissions originating in the tourism industry could, in fact, compromise sustainable development in China becomes an essential area of study. Whilst this is a key concern to society, there is only a limited number of studies that analyse the environmental impact of tourism and the validity of the tourism-led-growth hypothesis. This study considers both domestic and international tourism and explicitly tests the relationship among tourism development, economic growth and CO_2 emissions in China, employing a Panel Vector Autoregressive Model and utilising regional data between 2006 and 2017. Results show that the development of either international or domestic tourism, contributes to economic growth; however, at the expense of the environment.

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1. Introduction

Global warming is one of the most important environmental considerations of our time, while in fact, increased CO_2 emissions appear to be its main driver. At the same time, discovering ways to reduce CO_2 emissions has been at the heart of political and academic debate. As far as China is concerned, the 2017 Global Carbon Budget documents that China is the world's largest carbon emitter, accounting for 28% of the total global carbon emissions (Le Quéré et al., 2018). In 2012, the number of emissions in China was nearly the same as that of the United States and Europe's total carbon emissions combined. It follows that, in terms of volume and growth trend, China's carbon emissions could have a major impact on global emissions' levels. Overall, China is one of the most important regions considering global carbon reduction and low-carbon growth. In addition, in line with the Paris Agreement - an agreement signed in 2016 within the United Nations Framework Convention on Climate Change which encourages nations to undertake efforts to combat climate change - China anticipates to begin reducing CO_2 emissions after 2030 (State Council of the People's Republic of China, 2016). However, there are different opinions on the CO_2 emissions reduction project target in China. Some researchers claim that China's CO_2 emissions should peak approximately 5 to 10 years ahead of the current Paris target of 2030 by examining CO_2 emissions from 50 cities from 2000 to 2016 (Wang et al., 2019). Others believe that China will achieve the CO_2 emissions peak if the GDP is lower than 1514261.5 billion Yuan or reduce its annual GDP growth rate less than 4.5% by 2030 (Li, Xu and Ma, 2018; Mi et al., 2017).

Nonetheless, in the last ten years from 2009, emissions reduction goals were never accomplished not only by China but also by other countries around the world. In the light of these facts, the establishment of a legal and political framework that stipulates low carbon emissions and circular development was announced during the 19th National Congress of the Communist Party of China (Xi, 2017). However, China is still undergoing both industrialisation and urbanisation, and as a direct consequence, it still exhibits a large carbon footprint. More particularly, both industrial production and thermal power account for 85% of the total CO_2 emissions in China. The concentration of manufacturing industry and coal-based energy structure are the main factors for China's high carbon emissions. In this regard, there have been considerations that a transition to a relatively low-carbon era might have a negative impact on growth across Chinese regions.

To be more explicit, China's tourism emerged as the new driving force for the world's second largest tourism economy (i.e., following the United States) and contributed 9% of Chinese GDP in 2016 (World Travel and Tourism Council, 2017). At the same time, between 1995 and 2014 direct CO_2 emissions in China from its tourism industry increased nearly 5 times. It is worth noting that early on in 2009, the State Council of China (2009) proposed plans to support the national economy, energy conservation efforts, as well as, environmental protection efforts, by promoting low-carbon tourism in China. Low-carbon tourism emphasises sustainable development and minimises environmental degradation. As a result, since 2010, 19 scenic areas in China have been declared as low-carbon tourism demonstration zones.

However, domestic and international tourism in China have different spatial distributions (Goh, Li and Zhang, 2015). According to the tourism spending data from the 'The Yearbook of China Tourism Statistics 2001-2016', international tourists' receipts are mainly from transportation and accommodation, while domestic tourists spend more on shopping and food. Using the tourism receipts from 7 provinces and cities part of China's 'low-carbon province and city' project, we find that nearly 45% of international tourism receipts were form these low carbon places but only 29% of domestic tourists choose these places in China. Moreover, domestic tourism is the main contributor to China's total tourist income, also the case in several top tourism destination countries like the United States, China, Spain and Italy (Cortes-Jimenez, 2008; Shen et al., 2018). Well planned and controlled sustainable tourism may minimise adverse economic and environmental impact. Therefore, the analysing of the impact of both international and domestic tourism will provide more comprehensive results to the policy maker.

It follows that investigating whether CO_2 emissions originating in the tourism industry could, in fact, compromise sustainable development in China has become rather important both for policy makers trying to achieve the sustainable development goal and for the development of the tourism industry per se. More specifically, increased pressure for reducing CO_2 emissions poses new challenges to policymakers with regard to choosing the best practice to promote urbanisation, economic growth and environmental protection.

The objective of this study is to identify the relationship among tourism development, economic growth and CO_2 emissions. This is aim to analyse the impact of tourism on economic growth and pollutions, find the balance between economic growth and reducing CO_2 emissions, and to provide useful policy recommendations that will help the coordination between sustainable economy and tourism development, as well as, between the specific social and environmental sustainability goals stipulated by: '*The Development Plan of China's Innovation Demonstration Zone for the Implementation of the 2030 Agenda for Sustainable Development*', prepared by the state Council of the People's Republic of China (2016). The 2030 Agenda for Sustainable Development has set development goals affecting 17 policy-fields including poverty alleviation, health, education and environmental protection to be pursued within the following 15 years.

This research contributes to the literature in following ways. First, to the best of our knowledge, this is the first study to employ regional data that help investigate the relationship among tourism development, economic growth, and CO_2 emissions. Similar existing empirical studies focus on the impact of tourism and economic growth on CO_2 emissions, others consider CO_2 emission on tourism and economic growth separately, thereby missing key policy considerations for tourism sustainable development. For example, De Vita et al., (2015) for Turkey, Zhang and Gao (2016) for China, and Paramati, Shahbaz and Alm (2017) for 28 EU countries. Second, we employ the detailed database developed by Shan et al., (2016) that accounts for CO_2 emissions in China. Using their approach should lead to more accurate results compared to the common emissions calculation method provided by the Intergovernmental Panel on Climate Change (IPCC), which is typically employed by existing literature. The new provincial CO_2 emission inventories re-calculate China provincial CO_2 emissions based on 'apparent energy consumption' and updated emission factors. The inventory includes all the fossil fuel related CO_2 emissions within the regional boundary and reduces the uncertainty of previous source with nearly 20% gap between aggregated energy consumption from provinces and national levels.

Furthermore, this study considers both domestic and international tourism. Domestic tourism has been a largely under-researched topic in the developing world (Ghimire, 1997; Skanavis and Sakellari, 2001). Most existing studies provide evidence on international tourism but rather neglect domestic tourism which is perhaps the main part of the tourism market in many destination countries, such as China whereby, domestic tourism has clearly outpaced international tourism (Wang and Qu, 2004). Finally, this study offers recommendations to national policy-makers regarding the implementation of China's tourism development plan, considering both the economic and the social (macro-environment) aspects. The aim is to highlight the importance of considering the balance between given priority to economic growth or environment for future sustainable development planning strategies.

Turning to the empirical method, we employ the Panel Vector Autoregressive model (PVAR) developed by Abrigo and Love (2016) in order to investigate the linkages across tourism development, economic growth and CO_2 emissions in China considering data from 2006 to 2017. We choose the PVAR model as it treats all variables and allows for generating Impulse Response Functions (IRFs) that help trace the effect of each variable on all other variables across time.

Results indicate that both international and domestic tourism increases CO_2 emissions and economic growth. We argue that the tourism development will be an effective tool to promote economic growth but increasing CO_2 emission in China. Should developing countries like China follow the environmental protection as a priority or economic growth should be given priority deserves further attention as a means towards reaching the Country's sustainable development goal. The policy makers will need to find the balance between environmental and growth by reducing high energy consuming and high polluting industries and by increasing the proportion of the services industry into the national economy. Tourism development, especially domestic tourism development may be prioritised but with an introduction of low carbon tourism. Moreover, destination capacity and carbon tax are worth to introduce into the low carbon tourism planning strategies in China (Zhang and Zhang, 2018).

The rest of this paper is organised as follows: Section 2 discusses key related literature; section 3 describes both the data used and the econometric models employed; section 4 presents the empirical results; and Section 5 provides a discussion of the results and policy recommendations.

2. Literature Review

The investigation of the relationship between tourism, economic growth and carbon emissions using an integrated approach could provide important policy implications and help solve sustainability issues. Sustainable tourism development is associated with economic, environmental and social impacts. Research in this area can be traced back 40 years or so, however, there is still a significant amount of confusion relating to what are the specific objectives of sustainable tourism (Fletcher et al., 2017). Emphasizing the economic benefits of tourism has gained much prominence in recent years and many authors have provided evidence on a variety of countries. However, tourism may also have negative environmental impact. Skanavis et al. (2004) state that the relationship between tourism and the environment can be symbiotic or competitive. The relationship between the environment and tourism will be mutual benefit in symbiotic relation; on the contrary in the competitive relation economic and human' thoughtless growth of activities leads to the degradation of environment (Skanavis and Sakellari, 2011). On general principles, existing literature does not appear to have reached a consensus, while results are rather ambiguous.

The impact of tourism on economic growth have been well researched in numerous empirical studies. The causal relationship between tourism and economic growth can be grouped into four different strands as follows: Tourism-led growth (Balaguer and Cantavella, 2002; Brida, Cortes-Jimenez and Pulina, 2016; Nunkoo et al., 2020); Economic-driven tourism growth

(Aratuo and Etienne, 2019); Bidirectional causality between tourism and economic growth (Dritsakis, 2004; Durbarry, 2004; Khoshnevis Yazdi, Homa Salehi and Soheilzad, 2017), and No causal relationship (Katircioglu, 2009).

Although different results have been reported, most of the studies are in favour of tourism-led growth hypothesis since the first paper on the tourism-led growth hypothesis was published in 2002 (Brida, Cortes-Jimenez and Pulina, 2016; Nunkoo et al., 2020). They believe that tourism development contributes to foreign exchange earnings, creating employment opportunities, attracting external investment, stimulating regional consumption and tax increase. Moreover, tourism development is a favourable option to promote the boom of less developed regions (Liu et al., 2017). Moreover, Suresh and Tiwari (2018) find that the co-movement between tourism and economic growth varies over time and across different time horizons. At the same time, Shi et al., (2020) investigate 147 countries/regions from 1995 to 2015 conclude that the lager impact of tourism on CO_2 emissions in the lower income regions than the middle and higher ones. Therefore, especially in the less developing regions the development of tourism may increase economic growth but causing the environmental degradation at the same time.

Compared to the positive side of tourism, its negative impact on the environment is rather more evident (Shakouri et al., 2017; Holden, 2003). Tourism involves major transport components, cultural mixes and fierce resource competition. The better the quality of the destination, the higher supply, relative to demand, of both natural and human resources. When destinations reach and, in some cases, exceed their carrying capacity no matter how carefully the tourism activity has been planned there is greater potential for environmental degradation of the tourism destination (Shakouri et al., 2017). Therefore, the environment will probably be affected by the presence of both economic and tourism activity (Fletcher et al., 2017; Tribe, 2016). United

Nations World Tourism Organisation (UNWTO, 2008) report that the global tourism-related CO_2 emissions contribute around 5% of total global emissions, showing that the contribution of tourism to CO_2 emissions is a world-wide issue that remains largely underexplored by existing literature.

Most studies find that tourism activity increases CO_2 emissions, especially emissions from transportation and accommodation during travel activities (De Vita, et al., 2015; Eyuboglu and Uzar, 2020; Gössling and Peeters, 2015; Katircioglu, 2014; Raza et al., 2016; Solarin, 2014; Tiwari et al., 2013). To be more explicit, Tiwari et al., (2013) empirically examine the relationship between tourism and CO_2 emissions for 25 OECD countries during 1995-2005 using a panel VAR model. Their findings show that tourism increases CO_2 emissions through the transportation and accommodation of tourists. Furthermore, there are authors who report that the development of interconnected infrastructures for transport, accommodation and attractions for tourism development, considerably increases CO_2 emissions (Eyuboglu and Uzar, 2020; Høyer, 2000). Transportation in particular is heavily associated with consumption of fossil fuels within destinations, which in turn, is linked to greenhouse gas emissions (Eyuboglu and Uzar,2020). Tsai et al. (2014), Katircioglu (2014), Tan et al. (2014), Katircioglu, Feridun and Kilinc (2014) and Durbarry and Seetanah (2015) report that tourism increases both energy consumption and CO_2 emissions in the destination countries. On a parallel note, tourism greenhouse gas emissions in France could increase by 90% by 2050 (Dubois and Ceron, 2006).

Furthermore, Lee and Brahmasrene (2013) explore the effects of tourism on CO_2 emissions within European Union countries. Their results show that tourism development mitigates pollution in European Union countries. This finding is consistent with Basarir and Cakir (2015) and LeitÃ and Shahbaz, (2016) who argue that tourist arrivals decrease CO_2 emissions by 0.11

per cent in Turkey and four European Union countries France, Spain, Italy and Greece from 1995 to 2010. In addition, Paramati, Shahbaz and Alam (2017) investigate the dynamic impact of tourism on economic growth and CO_2 emissions for 28 countries of the Eastern and Western EU from 1991 to 2013. They provide evidence that tourism reduces CO_2 emissions in the Western EU while increases emissions in the Eastern EU.

Turning to studies of tourism and CO_2 emissions in China, Zhang and Gao (2016) investigate the relationship among international tourism, economic growth, energy consumption and pollution from 1995-2011 in 30 provinces of China. They report that tourism development contributes to mitigating environmental degradation by helping reduce the CO_2 emissions in the Eastern China. This is possibly due to a series of technology innovations and green hotel programs that have been developed in Eastern China (e.g., the Zhuhai area). Therefore, in some countries regional tourism development may lead to environmental degradation but not in others. In general, the destinations will be able to secure the greatest benefits with minimum costs from tourism activity associated with the more developed and industrialised economy (Cooper, 2008). The development of technology with higher efficiency of energy consumption will help secure the greatest benefits from tourism activity entailing minimum negative impact both on the environment and on the consumption of resources (Fletcher et al., 2017; Zha et al., 2020).

Overall, the relationship between tourism growth and CO_2 emissions is not very clear and most studies tend to overlook domestic tourism (Bigano et al., 2007b). However, international tourists do not always support the tourism sector, particularly during years of economic, political and social turmoil, and this is why domestic tourism is important in that it can bring stability to the industry (Okello, Kenana and Kieti, 2012). It was not until very recently that tourism researchers begun to discover the phenomenon of domestic tourism (Ghimire, 2013). Bigano et al., (2007a) introduced the global tourism destination database (which includes both domestic and international tourists) and utilised statistical models to show that domestic tourism accounts for 86% of total tourism in the world. Thus, it is far more important than international tourism. Moreover, UNWTO (2014) estimates that domestic tourism will represent 74% of total arrivals on the global scale in 2030.

Skanavis and Skallari, (2011) believe that due to the increasing use of air travel and energy consumption for domestic tourism, the impact of domestic and international tourism on the environment practically converges. However, as domestic tourists travel to more different places than international tourists do (Bigano et al., 2007a), the impact of climate change on domestic and international tourism demand differs across tourism destinations (Bigano et al., 2007b; Rosselló-Nadal, 2014). In addition, the change of tourists' choice behaviour on transportation-planning in tourism destinations can significantly affect the energy consumption and greenhouse gas emissions (Kelly et al., 2007). These studies investigate the different impact of domestic and international tourism on climate change considering only the impact of climate change relating to the destination marketing strategies in a short-term profit.

The environmental economics literature on the GDP and CO_2 emissions issues includes two distinct areas of research. The first one, relates to the development of theoretical models (e.g., mathematical growth models) that investigate pollution considering the difference between optimum and equilibrium points (Panayotou, 2016). The second, includes empirical studies that are mainly based on the Environment Kuznets Curve (EKC) hypothesis since the mid-1990s, which postulates an inverted U-shaped relationship between different pollutants and per capita income. While negative environmental impact increases at the early stages of economic growth, after a certain threshold of income per capita, emissions subsequently decline (Dinda, 2004). In other words, an inverted U-shaped relationship exists between economic growth and environmental pollutants (Stern, 2004). Then, Holtz-Eakin and Selden (1995) single out the pollutant of per capita CO_2 emission and per capita GDP as carbon Kuznets curve (CKC). However, the results of the CKC hypothesis are conflicting due to the different sample time period and methods (Papavasileiou and Tzouvanas,2020). The uncertainty results of ECK estimation for CO_2 emissions have also been founded by Shahbaz and Sinha, (2019).

Furthermore, on the ecological economics literature during 1970s, Ehrlich, Holdren and Commner (1971) announced IPAT as a first hypothesis to analyse the driving forces of environmental changes. IPAT comprises four interacting components: environment or pollution (I), population (P), the level of economic activities (A), and technology level or efficiency defined by the amount of pollution per unit of economic or consumption (T). Then, Dietz and Rosa (1997) proposed a reformulation of IPAT, which is Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT), it is used to operationalise the concept of the human ecosystem and emphasises the impact of social systems on the natural environment and vice versa (Dietz and Rosa, 1997; York et al., 2003). Here, carbon emissions and energy demand are modelled as being dependent on socio-economic variables (Puliafito et al., 2008). Zhang and Zhao (2019) investigate the factors of CO_2 emission in China based on STIRPAT model from 1996 to 2015 by using a 30 provinces panel data. The result confirmed that economic growth is the major impact factors of CO_2 emissions in China. Furthermore,

With these in mind, in this study we aim to investigate whether the development of the tourism sector contributes to economic growth rate (i.e., a process which decreases CO_2 emissions) in China. Alternatively, we investigate whether tourism growth is driven by economic growth (i.e., a process that increases CO_2 emissions) in China. Finally, we investigate whether there are any differences between international and domestic tourism.

3. Data and Methods

3.1 Data

This study utilises annual data for 30 mainland Chinese provinces (excluded Tibet due to the data availability) from 2006-2017 to empirically analyse the relationship between tourism development, economic growth and CO_2 emissions. Considering the previous tourism and environmental studies (Paramati, Alam & Chen, 2017; Paramati, Alam & Lau, 2018), we selected the following variables for our empirical analysis:

CO_2 emissions (CO), which is the summarising the emissions from different energy types together in each province of China. Affluence is measured by GDP per capita; Technology in this study is measured by energy consumption (EE) and refers to the total energy consumption; Tourism is further disaggregated into domestic arrivals (TAR) and international tourist arrivals (ITAR). Due to the availability of domestic tourist arrivals data, we collected the growth rate of domestic tourist arrivals, the former refers to the growth rate of number of domestic visitors while the latter to international visitors; Service sector (SER) and industrial sector (IND) includes the value-added of the tertiary and industrial sectors, respectively.

The data for GDP, SER, IND and ITAR have been collected from the National Bureau of Statistics of China. TAR data are gathered from the Provincial Statistical Communique of The

National Economic and Social Development (2007-2018). CO_2 emissions (CO) data are obtained from China Emissions Accounts and Datasets. The data is an updated version of the default emission factors provided by IPCC and NDRC (for year 1994 and 2005) based on measurements of 602 coal samples from the 100 largest coal-mining areas in China to create a more accurate values of emission for each province, as the default emission factors recommended by the IPCC and NDRC are higher than the real emissions factors in China (Shan et al., 2016). Energy consumption (EE) is collated form the China Energy Statistical year book (2007-2018).

Table 1 reports the descriptive statistics and the results of the cross-sectional dependence for all included variables. In order to apply an appropriate unit root test, it is important to check for slope homogeneity (Pesaran and Yamagata, 2008) and cross-section dependence (Pesaran, 2004). According to the results from the two slope homogeneity tests (i.e., Δ and Δ_{adj}) both reject the null hypothesis of the slope homogeneity hypothesis for the panels, which supports the existence of heterogeneity. In addition, the null hypothesis of cross-sectional independencies is rejected at 1% level. The panel LM unit root test of Lee and Strazicich (2003) with breaks allows for heterogeneous variance structure across cross-section units, while also correcting for cross-correlations in the panel (Jewell et al., 2003; Lee and Tieslau, 2019). It allows one and two endogenous structural breaks in the intercept and trend and results are presented in Table 2. In particular, results suggest that all variables are integrated of order I (0). Therefore, we do not carry out the panel cointegration test and we rather proceed with a Panel vector autoregressive model in order to estimate the relationship between tourism development, economic growth and CO_2 emissions. In order for all variables to have the same functional form we transform all variables into growth rates to run the PVAR test.

[Table1 here]

[Table2 here]

3.2 Methods

3.2.1 Panel vector autoregressive model (PVAR)

We investigate the dynamic relationship among tourism development, economic growth and CO_2 emissions in China over the period 2006 to 2017 with the panel vector autoregressive using the Abrigo and Love (2016)'s GMM-type estimators, which is an extended and updated version of Love and Zicchino (2006). The PVAR model allows analysis of the dynamic interlinkage between variables with the traditional VAR approach take all the variables in the system as endogenous, which allows for unobserved individua heterogeneity (Abrigo and Love, 2016; Acheampong, 2018; Bakirtas and Cetin, 2017; Love and Zicchino, 2006). It also has a few advantages provides accurate and consistent forecasting of results, prevents problems from possible endogeneity issues, consider the interactions between among variables and provides dynamic responses of each other's to an exogenous shock and can be illustrated as following:

$$Y_{it} = \alpha_1 Y_{it-1} + \beta_1 X_{it} + u_{it} + \varepsilon_{it} \quad (1)$$

where $Y_{it}$is a vector of the endogenous stationary series; X_{it} is a vector of exogenous covariates (CO, TA, ITA, GDP, EE, SER, IND) , CO is the CO_2 emissions; TAR and ITAR refer to the growth rate of domestic and international tourist arrivals; GDP is the growth rate of GDP per capital; EE is the growth rate of total energy consumption; SER and IND is the growth rate of value-added service and industrial sector, respectively; α, β are parameters to be estimated; u_{it} and ε_{it} are vectors of dependent variable-specific fixed-effects and idiosyncratic errors, respectively.

The panel Granger causality tests undertaken using the Wald test will help clarify the direction of the casual relationship tourism development, economic growth and CO_2 emissions within the panel context. In our analysis, we also focused on the impulse response functions (IRFs), which describe the reaction of one variable to the innovations in another variable in the system, holding all other shocks at zero.

4 Results

In this Section, we illustrate the results using a PVAR model, whereupon the optimal lag order (1) has been selected by the maximum likelihood-based model-selection criteria, namely, the Akaike information criteria (AIC), the Bayesian information criteria (BIC) (Schwarz, 1978; Rissanen, 1978; Akaike, 1977) and the Hannan-Quinn information criteria (HQIC) (Hannan and Quinn, 1979). The Granger causality and impulse response results will help analyse the dynamic relationship between tourism, economic growth and CO_2 emissions. In order to attain a better understanding of the results, we discuss domestic tourism and international tourism, separately.

4.1 Panel Granger Causality Tests

[Table 3 here]

The panel Granger causality test is used to test the causality between the variables in China from 2006 to 2017. Results are given by Table 3. We note that there exists unidirectional causality from CO_2 emissions to both domestic and international tourism. Similarly, economic growth in China Granger-causes both domestic and international tourism, while at the same time, domestic tourism Granger-causes economic growth significantly, but the effect of international tourism on economic growth is not significant. Compared to international tourism, domestic tourism seems to Granger-cause economic growth in China. This indicates that the impact of international tourism on economic growth can be recognised as a potential economic development strategy but will be insignificant due to a lack of economic support (Fawaz, Rahnama and Stout, 2014). Therefore, the so called economic-driven tourism growth hypothesis (EDTG) holds true in China. The EDTG hypothesis has been supported in the studies by Oh (2005) for Korea, Tang and Jang (2009) for USA and Lin, Yang and Li (2019) for some less developed and developing provinces in China. As Payne and Mervar (2010) explain, the EDTG hypothesis means that the tourism growth of the destination is mobilised by well-designed economic growth policies, governance structures and investments in both physical and human capital. Moreover, the bi-directional causality relationship between economic growth and CO_2 which in line with the studies summarised by Mardani et al., (2019) from 1995 to 2017 in different countries, regions and both developed and developing countries. Therefore, tourism development in China will need a positive economic environment, government policy support, infrastructure that encourages tourism activities to proliferate and flourish. Then the significant contribution of tourism to economic growth will occur only when the economic, environmental and sociocultural benefits outweigh the corresponding cost in the tourism industry in China (Cárdenas-García et al., 2015). It is worth noting that there is a bi-directional causality between service industry and CO_2 emissions. Therefore, we can confirm that China's fast tourism growth can mainly be attributed to the growth of income per capita, to the structural adjustment of China's national policies, and to the importance of domestic tourism for the economic growth of developing countries (Skanavis and Sakellari, 2011; Wu and Wu, 2018).

4.2 Impulse responses

Before we present the impulse response functions (IRF) and our results, we first discuss the stability conditions of the Panel VAR model that we implement. Stability implies that the model is invertible and represents the infinite-order vector moving-average (Abrigo and Love, 2016). It follows that all eigenvalues of our model lie within the unit circle. Therefore, it can be said that our panel VAR model conforms to the stability condition and the results are reliable and appropriate for analysing the issue at hand and for making policy recommendations.

[Figure 1 here]

The section presents IRFs based on full sample estimation for the period 2006-2017 and the 95% confidence interval that was generated based on 500 Monte Carlo simulations. The solid line denotes the point estimate of the impulse response, whereas the dotted lines represent its confidence intervals. The response of CO_2 emissions to a shock in both tourism and economic growth is shown in Fig. 1. There is a significant positive response of CO_2 emissions to the international tourism shock. The graph shows that the maximum positive impact occurs in year 1 with a value equal to 1.31. It then become insignificant after year 3.

In contrast to earlier findings have been reported by Zhang and Gao (2016) who document that international tourism has a significantly negative impact on increasing emissions in the Eastern region, which is the most developed areas in China, as well as, Katircioglu (2014) who reports similar results for Singapore. Moreover, the fact that international tourism results in lower CO_2 emissions concurs the estimations by Lee and Brahmasrene (2013) in European Union countries. More particularly, these authors argue that (i) the new direction in tourism policy to promote a low-carbon economy, (ii) the implementation of new lower emissions technology and (iii) more energy efficient low-carbon transportation, could help keep CO_2 emissions low, despite the continued increase in the number of tourists. Therefore, policies that support, new lower emissions technology implementation and low-carbon transportation, all work in favour of sustainable tourism development. However, no evidence of developing of less developed country/region was detected to have a contribution to CO_2 reductions. It should be noted that conclusions drawn from existing studies still provide no real consensus. For instance, Katircioglu et al., (2014) find no evidence of tourism development will decrease emissions, investigating Mauritius and Cyprus, respectively. It follows that, the effect of international tourism can be different depending on the country/region. The effectiveness of tourism development on CO_2 emissions reduction may existing in a well-developed economy rather than developing or less developed country/region. Therefore, policy maker will need to carefully monitor the low carbon tourism demonstration zones especially those within the less developed regions, the infrastructure development with more efficient energy may be the priority to other tourism facilities development.

A domestic tourism shock has a positive impact on CO_2 emissions and never really decays. Domestic tourism has been growing in China since 1999 not only due to increases in disposable income but also due to economic development and holiday-system reforms (Shen et al., 2018). In the absence of a paid vacation system in China, national holidays, such as, Labour day, the National festival, and Spring festival greatly stimulated the domestic tourism. Nonetheless, domestic tourism's impact is obvious as most destinations exceed their carrying capacity particularly during the 'golden weeks' of national holidays (e.g. nearly 7.9 billion people travelled at the same time during the 2019 'National day'). This kind of large-scale population movement in a short time period leads to increased energy consumption and CO2 emissions. Therefore, environmental thresholds and destination carrying capacity is an important aspect when analysing tourism activity impact on the sustainability of the destination (Fletcher et al., 2017). The policy maker may consider the carrying capacity of the tourism destinations and control the maximum flow of tourists during the golden weeks.

The impacts of international tourism and domestic tourism on CO_2 emissions in China are equal. There is a wealth of existing studies showing that transportation, shopping and accommodation are the main factors that contribute to CO_2 emissions (De Vita, et al., 2015; Gössling and Peeters, 2015; Katircioglu, 2014; Paramati et al., 2017; Raza et al., 2016; Solarin, 2014; Tiwari et al., 2013). This is evident if we analyse tourists' consumer behaviour with regard to transportation, accommodation, shopping, eating and other activities between domestic and international tourism. According to the tourism spending data from the 'The Yearbook of China Tourism Statistics 2001-2016', international tourists' receipts are mainly from transportation and accommodation, while domestic tourists spend more on shopping and food. The impact of both domestic and international tourist arrivals' direct impact of tourism on CO_2 emissions are the same.

However, the results show that the response of CO_2 emissions to on standard deviation shock in the growth of service industry was significantly negative and does not die out in 10 years. Regarding the overall effect, the negative effect indicating that the growth of service industry can be employed as an effective tool to reduce emissions derived from carbon dioxide in China. Considering almost every industry in economy may be affected by spillovers from tourism indirect impact (Schubert and Brida, 2009). As such, we suggest that measuring and modelling the indirect effect from tourism may be more important than just the direct tourism effect when it comes to the impact on CO_2 emissions.

The response of GDP per capita growth to a shock in the growth of international and domestic tourism shows a statistically significantly and positive relationship. This indicates that the growth of both domestic and international tourism in China will promote economic growth. Comparing the impact of both domestic and international tourism on CO_2 in and GDP, we could say that the maximum positive impact on GDP occurs at the first and CO_2 emissions on 1 year after. Therefore, the development of tourism will promote economic growth earlier than increasing emissions. A well planned low-carbon tourism development will promote economic growth and minimise the impact on environment.

The IFRs regarding CO_2 emissions, economic growth and energy consumption. Results show that there is a significant positive response of the growth of CO_2 emissions to GDP per capital and energy consumption. This is indicative of the fact that GDP growth will increase the growth of CO_2 emissions over ten years' time. Hence, there is no evidence of the presence of an Environmental Kuznets curve (EKC) between economic growth and carbon emissions in China (i.e., at least for a period of 10 years ahead). This finding is in contrast with studies on other countries, for example, De Vita et al., (2015) who conduct a similar study for Turkey from 1960 to 2009 and Katircioglu (2014) who conducts a similar study for Singapore from 1971 to 2010. Yet our results draw similar conclusions to Zhang and Gao (2016) who use regional panel analysis to show that the tourism-induced EKC hypothesis does not exist in central China and is also weakly supported in both eastern and western China. With such a conclusion we also note the caveat that due to the significant regional differences in a large country, such as China, we may suffer from some aggregation bias (Xu, 2018).

Another test for robustness is to change the ordering of the PVAR model variables. Granger causality results remain the same and impulse response functions are very similar (except for domestic tourism which is less significant)[1].

[1] Results can be available upon request.

[Table 4 here]

The long-run impact results of forecast error variance decompositions (FEVDs) for CO_2 emissions gives the proportions of the movement in the dependent variables that are due to their own shocks, with shocks to the other variables in Table 4. In the first step 100% of the FEV is attributed to the error in the CO_2 equation (at least in this variable ordering), while all other variables have no impact on the CO_2 emissions. In the first year shows that forecast errors in CO_2 emissions are mainly due to itself. Then five year ahead, 82% of the variance is still from CO_2 emissions, 9.9% is from economic growth; 0.75% and 0.14% are from domestic and international tourist arrivals, respectively; 1% and 3.5% from the growth of service and industrial sectors and 2% from energy consumption. The results of variance decomposition over a period of 10-year time horizon reveal that at the end of 10 years over 80% of the variation in the forecast error for output is explained by CO_2 its own. About 8% of the variation in the forecast errors in the first is due to economic growth and increase to 10% at the end of 10 years, while other variables are increase but in a very small amount.

5. Conclusion

The aim of this study is to examine the relationship between tourism, economic growth and CO_2 emissions in China. For this purpose, a Panel VAR method was applied to 30 Chinese provinces between 2006 and 2017. We find that both international and domestic tourism increase GDP (per capital) growth but at the same time lead to a higher CO_2 emission.

Furthermore, energy consumption increases the level of CO_2 emissions in China. We suggest that promoting economic reconstruction is particularly crucial. That is, reducing high energy consuming and high polluting industries and increasing the proportion of the services industry into the national economy.

As there is no difference between the impact of domestic and international tourism on CO_2 emission but domestic tourism is the main contributor to tourism development in China, destination marketing strategies in low carbon areas might choose to focus more on domestic tourism demand. It is advisable to consider at the same time the respective carrying capacity of the destination, particularly when faced with increased levels of tourism demand during the 'golden weeks' as excess demand over supply is crucial factor leading to environmental degradation in China.

The EDTG hypothesis holds true in China and this is indicative of the fact that most provinces will need to consider ways to make a sustainable tourism development. This could be achieved, by appropriately allocating the benefits from economic expansion. For example, a carefully designed policy aiming to promote low carbon transportation and accommodations by expanding and strengthening existing infrastructure.

These findings help identify the linkages across domestic and international tourism, economic growth, and CO_2 emissions in China and suggest that the current low-carbon tourism strategies do not help mitigate environmental degradation. The volume of tourism arrivals in China keeps growing every year, therefore it is rather crucial to incorporate destination capacity and carbon tax into planning strategies.

Very few studies focus on domestic tourism, while as has already been mentioned, domestic tourism makes up the main part of the tourism market in most of the top tourism destination countries (e.g., China, US and Spain). In this regard, greater attention could be paid to analysing domestic tourists' carbon footprint in order to find an effective way of reducing CO_2 emissions from tourist behaviours. Moreover, we recommend that future studies investigate the impact of new technologies on tourism (e.g., smart tourism); that is, as soon as sufficient data become available. Investigating the impact of technology on sustainable tourism development, is not yet feasible for China, mainly due to lack of sufficient data.

Declarations

- *Ethics Approval and consent to participate*

The authors hereby confirm that there is no conflict of interest, that the research only involved secondary data and did not involve any Human or Animal participants.

- *Consent for publication*

N/A

- *Availability of data and materials*

Data can be available upon reasonable request, from the authors.

- *Competing interests:*

The authors hereby confirm that there are no conflicts of interest of any sort.

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- *Authors' contributions:*

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Table 1 reports the descriptive statistics for all included variables from 2006-2017

Region	Variable	Observations	mean	sd	min	max	CD-test of Pesaran	Slope homogeneity test	
								Δ	Δ_{adj}
All	CO	360	5.48	0.79	2.7	7	56.99***	2.751***	4.765***
	TAR	360	17.61	9.40	-13.5	74	12.20***		
	ITAR	360	5.04	1.47	-0.1	8	47.04***		
	GDP	360	10.44	0.59	8.7	12	71.22***		
	EE	360	9.29	0.69	6.8	11	67.56 ***		
	SER	360	8.54	1.00	5.5	11	71.81***		
	IND	360	8.45	1.04	5.5	10	66.83***		

Note: The null hypothesis of the cross-sectional dependence test is no cross-sectional dependence, and the null hypothesis of the slope homogeneity test is slope homogeneity. *** $p<0.01$

Table 2. Lee Strazicich LM unit root test

Variable	One break model		Two break model	
	LM-stat	**Breaking time**	**LM-stat**	**Breaking time**
CO	-5.116431***	2008	-5.417878**	2014; 2006
TAR	-3.206200742***	2016	-9.098003***	2009; 2007
ITAR	-4.879883***	2010	-5.490790**	2016; 2006
GDP	-5.635485***	2011	-9.007157***	2009; 2013
EE	-4.718015***	2006	-4.643035***	2007; 2017
SER	-5.566629***	2016	-5.574797***	2017; 2014
IND	-5.457601***	2016	-5.873386***	2017; 2016

*** $p<0.01$; ** $p<0.05$

Table 3 panel VAR-Granger causality Wald test

Equation / **Excluded**	**CO**	**GDP**	**TAR**	**ITAR**	**SER**	**IND**	**EE**
CO		21.138***	14.112***	9.381***	50.381***	18.758***	0.457
GDP	8.43***		15.143***	88.956***	29.556***	33.139***	41.734***
TAR	0.014	4.816**			0.013	5.516**	4.819**
ITAR	0	0.647	16.49***	0.754	0.005	4.221**	4.394**
SER	5.399 ***	1.72	1.887	12.993* **		0.710	11.203***
IND	0.011	62.854***	25.929***	77.774***	34.463***		77.202 ***
EE	7.346 ***	131.49 ***	4.38***	52.938***	147.496***	104.122***	

Ho: Excluded variable does not Granger-cause Equation variable

Ha: Excluded variable Granger-causes Equation variable

*** $p<0.01$, ** $p<0.05$

Table 4 Forecast-error variance decomposition for CO_2 emissions

Response Variable and Forecast horizon	**Impulse variable**						
CO	CO	GDP	TAR	ITAR	SER	IND	EE
1	1	0	0	0	0	0	0
2	.9079856	.0797461	.0006133	.0001691	.006788	.000113	.0045849
3	.8477241	.0926353	.0071928	.0005349	.0095199	.021389	.0210039
4	.8295543	.0971836	.007456	.0007209	.009933	.0328017	.0223505
5	.8242534	.0988743	.0075425	.0010433	.0100976	.0346866	.0235024
6	.8223142	.0996836	.007577	.0011091	.0101464	.0354366	.0237331
7	.8214655	.0999953	.0076054	.0011318	.010173	.035726	.023903
8	.8211164	.1001242	.0076145	.0011395	.0101825	.03587	.0239529
9	.8209749	.1001746	.0076184	.0011435	.0101866	.0359238	.0239783
10	.8209186	.1001955	.0076198	.001145	.0101882	.0359462	.0239869

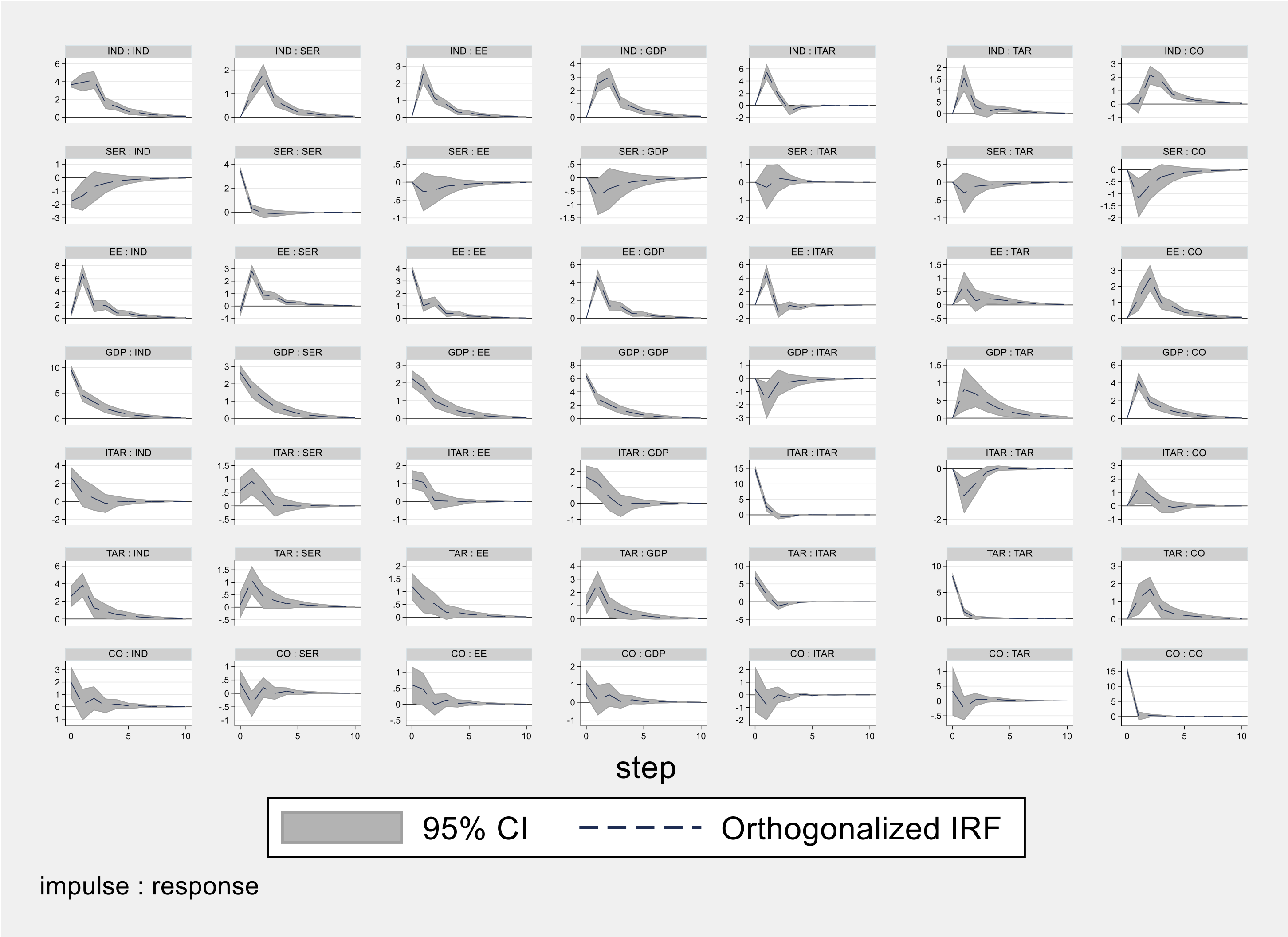

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Figure 1. Impulse response Graph (CO TAR ITAR GDP EE SER IND)