The effect of Tourism on Urban Sustainable Development ——Evidence from Guangdong Province

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Abstract. The United Nations General Assembly (NUGA) emphasizes that using sustainable and resilient tourism as the tool for sustained and inclusive economic growth, social development, and financial inclusion, will help promote domestic resource mobilization and environmental protection. Based on social-economic development and tourism data from the Guangdong Provincial Statistical Yearbook, this paper uses the panel two-way fixed effect model to empirically analyze the impact of tourism on urban sustainable development in 21 prefecture-level cities in Guangdong Province from 2000 to 2019. Results show: (1) Overall, tourism has a negative effect on urban sustainable development, and this effect is mainly Derived from domestic tourism rather than international tourism; (2) The impact of tourism on urban sustainable development has a threshold effect. When the average tourism income is greater than 0.07 hundred million yuan, its adverse impact will be enhanced. (3) In the context of well-developed urban infrastructure (real rental cars and express delivery at the end of the year), tourism exacerbates the city's various burdens, not conducive to the sustainable development of the city, but at the same time in terms of public services, slowing down the pressure of residents on the demand for transportation and driving up the city's tourism revenue, the negative impact of tourism on the sustainable development of the city will be weakened.

Keywords: Tourism; Urban sustainable development; Heterogeneity; Guangdong

1 Introduction

The idea of sustainable development first originated from the Conference on the Human Environment, held in Stockholm, Sweden in June 1972. This conference aims to call on governments and people to work together to preserve and improve the human environment for the benefit of all people and future generations. The idea was formally introduced in 1987 with the publication of the book "Our Common Future".[1] The basic idea is to satisfy the current generation’s needs without compromising the ability to meet the needs of future generations. This initiative prompts countries to find more sustainable development patterns. For example, Italy's Ministry of Economic Development (MISE) released a new National Integrated Plan for Climate and Energy 2030, which researches renewable energy sources and

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practices the concept of ecological civilization; the Netherlands enacted the Environment and Planning Act in 2016, which focuses on sustainable development and aims to unify and simplify the existing land-use planning, environmental protection, urban and rural construction, cultural heritage preservation, water resource management, and mineral resource development regulations; Germany's development policy includes eradicating hunger and poverty, protecting climate and biodiversity, advocating health and education, promoting gender equality, building fair supply chains, leveraging digitization and technology transfer, and strengthening private investment for global sustainable development. The implementation models for sustainable development in the above three countries are government-led, society-led, and shared governance, respectively. In recent decades, China's rapid economic growth has been accompanied by many problems, such as resource depletion, economic and industrial decline, environmental damage, and rising unemployment. All these problems have imposed restrictions on the realization of sustainable development.

The United Nations General Assembly (NUGA) emphasizes that using sustainable and resilient tourism as the tool for sustained and inclusive economic growth, social development, and financial inclusion, will help promote domestic resource mobilization and environmental protection. As the southeastern coastal province with unique geographical advantages and rich tourism resources, tourism plays an important role in the socio-economic development of Guangdong Province. Zhang et al. (2023) empirically analyzed the network spatial association structure and spatio-temporal development trend of 21 cities in Guangdong Province from 2000 to 2020 by using social network analysis and modified gravity modeling methods. The results of the study show that the network density, hierarchy, and efficiency need to be further improved, which is conducive to narrowing the relative development gap of urban tourism and effectively enhancing the overall development level of Guangdong's tourism economy. Many studies have shown that tourism promotes economic growth, employment increase, and coordinated regional development in Guangdong Province. However, the adverse effects of tourism on Guangdong Province have been greatly overlooked. Studies based on other provinces have shown that the impacts of tourism are not always positive.[2] Wang et al. (2022) find that tourism significantly increases regional carbon emissions in Chinese central and western provinces. If all aspects of the impacts are considered, the impact of tourism on urban sustainable development is uncertain. Few scholars have focused on this overall impact so far.

A large number of existing studies focus on defining sustainable development (Zhang Yi. 2021; Zhao Yongchao. 2021), using different indicators and indicator systems to measure sustainable development (Wang Enxu. 2014), identifying its influencing factors (Guo Cunzhi; Luo Linlin. 2013), socially sustainable development (Leal Filho et al.2022), analysis of environmental performance for sustainable development (Young NN et al. 2023) and analyzing its economic performance (Yang Junchuan. 2005). There are also some articles focusing on the impact of tourism on social, economic, or environmental sustainability (Muhammad; Sami; Asif; Cai; Sunday.2023). In fact, urban sustainable development encompasses various aspects of society, the economy, the environment, etc. Focusing solely on the impact of tourism on any aspect of them makes it difficult to understand the relationship between tourism and sustainable development. Therefore, it is necessary to identify the impact of tourism on sustainable development based on the comprehensive and integrated sustainable development indicators.

Taking Guangdong Province as the research area, this paper first describes the spatial and temporal evolution characteristic of tourism and the sustainable development level of prefecture-level cities. Then, we identify the effect of tourism on urban sustainable development and explore the heterogeneity of this effect by adopting the panel two-way fixed effect model. Further, considering that there are differences between cities in terms of infrastructure, transportation, etc., we explore the heterogeneity of this effect across different levels of economic development and different levels of transportation.

The following structure of this paper consists of four parts. In the next section, we summarize the existing literature. After introducing the research method in section 3, we describe our empirical results, including the spatial and temporal evolution of tourism and urban sustainable development level, the effects of tourism on urban sustainable development, and their heterogeneities. Finally, we present our conclusion and discussion in Section 5.

2 Literature Review

Since the 21st century, countries, especially developing countries, have faced problems such as resource shortage, environmental pollution, traffic congestion, and urban space congestion[3] with rapid economic growth. These problems make the national development path contrary to sustainable development. To solve these problems and realize the goal of sustainable growth, many scholars began to participate in the study of sustainable development. Existing studies about sustainable development can be classified into four categories, i.e., economic sustainable development, social harmony, environmental friendliness, and comprehensive sustainable development.

2.1 Economic Sustainable Development

According to the World Health Organization (WHO), urban sustainable development should be based on the premise of minimizing the use of resources, so that the urban economy can evolve in the direction of higher efficiency, stability, and innovation.[4] Nijkamp Petal argues that cities should fully utilize their inherent strengths and potentials, pursue high quantitative and qualitative social, economic, demographic, and technological outputs, and play an active role in securing their position in the urban system. position in the urban system.[5] Dan Cui, Yuanxi Li, and Tingting Wu conducted an in-depth analysis of the influencing factors of regional tourism economic growth based on panel multiple regression models and spatial econometric models and found that GDP per capita, the number of star-rated hotels, tourism development policies, and major tourism events are main influencing factors of tourism economic growth in the Beijing-Tianjin-Hebei region. Chinese scholars focus more on the utilization and management of existing resources; they propose the rational development of urban land resources and the adjustment of land-use structures to realize urban sustainable development.[6] International scholars focus more on human life concepts and management styles and endeavor to promote the transformation of traditional consumption concepts and the implementation of environmental tax policies.[7]

Chen Q used nonlinear autoregressive distributed lag (NARDL) to find that GDP, national income, tourism policies related to tourist arrivals, and FDI are positively related to the sustainability of tourism growth. In addition to this, the results show that environmental

factors such as carbon dioxide emissions, greenhouse gas emissions, and nitrous oxide emissions are negatively related to the sustainability of tourism growth.[8]

2.2 Social harmony

Social harmony refers to the harmonious relationship among members of society and the harmonious state of society as a whole; it is an important component of sustainable development. The rapid global economic development since the middle 20 century has led to a series of social problems, such as high-income segregation, extreme poverty, and high unemployment and crime rates. All these problems seriously compromise the well-being of individuals and restrict urban development. Yiftachel suggests that the social aspect of sustainable urban development should seek a society in which human interaction, information dissemination, and culture are greatly developed, marked by vitality, stability, equity, and the absence of crime. [9] Pu Wenli (2022) conducts a panel fixed-effects model regression analysis to explore the main influencing factors of population urbanization on the sustainable development of Yunnan province, and results show that it is necessary to upgrade the industrial structure, give full play to the advantages of location and resources, promote the two-way flow of population between urban and rural areas, and promote the reform of the land system, to achieve the sustainable development. Zhang Xinle (2022) used the entropy value method to measure the level of sustainable development and utilized the two-way fixed effect, mixed OLS method to study the impact of urban population agglomeration on sustainable development, and found that the impact showed an "inverted U" type, indicating that the relationship between population agglomeration and high-quality economic development was first promoted and then inhibited, making the level of sustainable development also first increased and then decreased. Meanwhile, its influence on the four dimensions of innovation, greenness, coordination, and openness also shows an "inverted U" shape. Meanwhile, Khan SU and Cui Y (2022) use Super efficient Slack-based Measure, improved STIRPAT, and OLS regression to study the impacts of environmental degradation, population density, industrial structure, GDP per capita, urbanization, and technology on the efficiency of sustainable development, and the results showed that population density and industrial structure have the greatest impact on the efficiency of rural sustainable development.

Alamineh GA et al. (2023) found that tourism has both positive and negative impacts on the locality. The positive impacts of tourism on society are shown to a moderate extent, as evidenced by the expansion of hotels, road transportation, air transportation, electricity, internet, banking and other infrastructures. Negative impacts on society were found to be lesser in the form of inequality in social services as mentioned above, expansion of prostitution, the persistence of theft and illegal trade in cultural artifacts, and casual adoption of tourists' lifestyles and manners by the inhabitants.[10]

2.3 Environmental sustainability

Onishi has stated that "sustainable urban development is the process by which a city continuously realizes its natural potential to create a green garden city based on subsistence capacity.[11]" Studies focused on environmentally sustainable development mainly focus on the contradiction between pollution emissions from human activities and the self-purification capacity of the natural environment. Many scholars have explored how to realize the coordination between the environment and urban economic development. For example,

Tjallingii proposes that sustainable cities should be "responsible cities"; these cities can never arbitrarily expand the environmental problems of the present to a larger scale or leave them to future generations.[12]According to Gu Chaolin, sustainable development should restore the natural cyclical process.[13] Qian Lexiang and Wang Qian used the integrated technology of RS and GIS to analyze the impact of urban green cover dynamics on the sustainable development of the urban environment, i.e., the living environment of the residents. Based on this, Fang Chuanglin puts forward the "Three Circle Theory" of the interactive coupling between urbanization and the ecological environment in the "International Symposium on Sustainable Development of Cities" held at Peking University in 2010, namely, the Sustainability Circle (including resources, environment, and ecology) and the Development Circle (including economy, humanities and society).[14] Baloch QB et al. empirically investigate the relationship between tourism development and environmental suitability and propose a modeling framework for sustainable ecotourism development, including supportive government policy interventions to ensure effective protection of the environment and natural resources without compromising the economic vitality and social well-being of the local people.[15]

Ullah A, Raza K, and Mehmood U use modern methodological tools, including the CS-ARDL test, Westerlund Cointegration test, and panel data unit root test, to examine the relationship among economic development, tourism, the use of natural resources, technical advancement, and carbon dioxide emissions. Results show that except for tourism, the rest of the variables like technical innovation, natural resources, and economic growth have positive and significant effects on carbon dioxide emissions both in the short and long runs. Furthermore, in the long run, a 1% increase in tourism in the panel dataset leads to a 0.39% reduction in CO_2 emissions across countries. Therefore, the promotion of sustainable tourism and the advancement of technological innovations are very important for these countries, which can mitigate environmental degradation pressures to some extent.[16]

2.4 Comprehensive Sustainable Development

Some scholars study the influencing factors of sustainable development by constructing comprehensive indicators including socio-economic and environmental aspects. Hontoria Eloy et al. use a framework for assessing key relationships between social domains, a methodology for selecting the best indicators including entropy, and a multivariate modeling management (MCDM) methodology for calculating composite indicators for measuring the evolution of a country (CIMCE), constructing composite indicators to represent sustainable development, to study the relationship between economic and social and sustainable development.[17] Yongqing Wang uses a comprehensive indicator system and a weight determination method for analyzing the hierarchical process to evaluate the sustainable development of the Damao sub-basin.[18] Suizi Wang et al. proposed a comprehensive indicator system to evaluate LRCC in NFPE by using GIS analysis and statistical techniques, integrating remote sensing, model simulation, and statistical data, and studying and evaluating the spatial and temporal evolution characteristics of LRCC.[19]

Yuedi Huang et al. (2023) evaluate the sustainable development of tourism in Aragon City based on the theory of sustainable tourism development and related methods and propose the construction of synthetic indicators based on the environmental-social-economic ternary model and find that environmental and social factors significantly impact sustainable

development.[20] Blancas Francisco Javier and Lozano-Oyola Macarena propose a synthetic indicator that combines two approaches for the empirical study of sustainable tourism in the most demanded destinations of Andalusia (Spain) by implementing aggregations with different levels of compensation at different stages.[21]Punzo Gennaro et al. use a multi-modeling approach to build and validate a composite indicator of sustainable tourism (SusTour-Index),[22]which includes the three main interrelated dimensions of tourism sustainability, namely the economic, environmental, and social dimensions.

2.5 Research Gaps

Existing studies have mainly explored the influencing factors of sustainable development from a single dimension such as economy, society, environment, etc. Few studies use the comprehensive indicator and examine the influencing factors of sustainable development. Rare studies have tested the impacts of tourism on sustainable development, especially using composite indicators. Meanwhile, existing studies mainly focus on smaller scales such as prefecture-level cities and counties, with insufficient attention paid to provincial scales (Wang Xiao; Zhang Mei. 2021). Few studies distinguish between the impact of foreign and domestic tourism revenues.

3 Research method

3.1 Entropy method

We use the Entropy method to measure the sustainable development index. Table 1 shows the variables we used. The specific steps for the assignment using the entropy method are as follows:

(1) Since the units of measurement of the indicators are not consistent, the heterogeneous indicators need to be homogenized and standardized before calculating the weights of the composite indicators. To achieve the quantitative unity of the indicators, the method of polar deviation standardization can be used. Its calculation formula is shown below:

$$Z_{ij} = \frac{X_{ij} - minX_i}{maxX_i - minX_i} (\mathrm{i} = 1,2,3, \dots, \mathrm{n}; \mathrm{j} = 1,2,3, \dots, \mathrm{m}) \quad (1)$$

Where X_{ij} is the jth indicator value of the ith evaluation object, Z_{ij} is the indicator value after the standardization process, $X_j min$ is the minimum value of j indicator among all respondents, and $X_j max$ is the maximum value of j indicator among all respondents.

(2) Calculate the weight of the ith evaluation object under the jth indicator:

$$p_{ij} = \frac{Y_{ij}}{\sum_{j=1}^{n} Y_{ij}} (\mathrm{i} = 1,2,3, \dots, \mathrm{m}; \mathrm{j} = \mathrm{i} = 1,2,3, \dots, \mathrm{n}) \quad (2)$$

(3) Calculate the entropy value of the jth indicator:

$$E_j = -k \sum_{i=1}^{n} P_{ij} \ln(P_{ij}) \quad (3)$$

Where k > 0 and ln is the natural logarithm satisfying E_j>0. The constant k is related to the number of samples m. In general , then 0≤E_j≤1.

(4)The weights of the risk evaluation indicators are：

$$W_j = \frac{D_j}{k - \sum_{i=1}^{m} E_j} \tag{4}$$

Table 1 Indicator system chart

Type	Abbreviation	Metric unit	Indicator meaning
Societies	population	10000 persons	Total population with residence registration at year-end
	landarea	Sq.km	Administrative area land area
	urbanemp	10000 persons	Number of employed persons at the year-end
	secschl	Unit	Number of regular secondary schools
	healinsti	Unit	Number of health care institutions
	techperspon	Person	Research and development personnel
Economics	realdgp	100 million yuan	Real gross domestic product(GDP)
	tradeinc	100 million yuan	Trade income
	fixasset	100 million yuan	Investment in Fixed assets
Environmental	waterwaste	100 million tons	Total volume of waste water discharged
	exhaust	100 million cubic meters	Total volume of industrial waste gas emission
Matrix	greenarea	Hectare	Green area (of a building or park)
	czshlacll	%	Urban domestic waste disposal rate
	dust	10 kilo-tons	Industrial smoke and dust emissions
Science and technology	dscyjycyry	10,000 people	Tertiary education practitioners

3.2 Pannel two-way fixed model

According to previous research on identifying influencing factors, this paper uses a panel two-way fixed effects model to estimate the effect of tourism on urban sustainability. The formula used is as follows:

$$Y_{it} = \theta_i + \alpha Tourism + \beta X_{it} + \gamma_t + \epsilon_{it} \tag{5}$$

Where Y_{it}represents the sustainable development index of the city i in period t. The higher the index, the higher the level of sustainable development of the city. *Tourism* is the core explanatory variable representing tourism development in this paper, i.e., tourism revenue α is the corresponding coefficient. $X_{it}$is the control variable vector representing a range of factors that could potentially affect sustainable development. β is the associated coefficient vector. $\theta_i, \gamma_t \; and \; \epsilon_{it}$represent fixed effects, time effects, and residuals, respectively.

Table 2 demonstrates that the control variables in this paper include total population with residence registration at year-end, administrative area land area, number of employed persons at the year-end, number of regular secondary schools, number of health care institutions, research and development personnel, real gross domestic product(GDP), trade income, investment in fixed assets, total volume of wastewater discharged, total volume of industrial

waste gas emission, green area (of a building or park), urban domestic waste disposal rate, industrial smoke and dust emissions, tertiary education practitioners.

Table 2 Descriptive characteristics of variables

Variable	Abbreviation	Unit	Mean	Min	Max
Gross tourism receipts	Tourincome	Hundred million yuan	266.6731	6.2300	4454.5800
Domestic revenue from tourism	Toudosincome	Hundred million yuan	228.3057	5.4600	4003.3600
Foreign exchange earnings from tourism	Touforincome	Hundred million yuan	38.3567	0.1200	451.2200
Employment rate	Employrate	%	0.1954	0.0047	1.4731
Per capita GDP	Avergdp	Yuan	45182.5800	3149.9184	517012.8400
The proportion of tertiary industry in GDP	Tertigdp	%	40.7314	27.2300	71.7500
Number of bed	Yycws	Sheet	14281.1100	2178.0000	93067.0000
Average wages of employees	Zgpjgz	Yuan	41374.1110	7884.8600	139436.0000
Tertiary industry education practitioners	Dscyjycyry	10,000 people	53955.0800	12400.0000	313544.0000
Total number of bus and tram passengers	Cartrans	10,000 people	28153.8400	25.0000	269581.0000
Total volume of post and telecommunications services	Totlepost	Million	238.1059	6.0300	4917.3800
Mobile phone user	Moblie	10000 Households	491.4497	19.0000	3200.0200
Express delivery	Express	10000 Pieces	19704.4300	4.7000	761578.1000
Taxis are available at the end of the year	Rentcar	Unit	2565.6900	70.0000	22457.0000
Green area	Greenarea	Hectare	15208.7900	222.0000	147720.0000
Urban sewage treatment rate	Czwscll	%	80.5481	0	100.3400

3.3 Panel threshold model

The threshold effect refers to the phenomenon that the direction or quantity of a parameter changes when it reaches a certain critical value, which is called the threshold value[23]. Considering that the impact of tourism on sustainable development is probably not a simple linear relationship, we introduced the threshold variable based on equation (5) to obtain the formula (6) of the threshold effect model.

$$Y_{it} = \theta_i + \alpha Tourism + \beta X_{it} + \gamma_t + \epsilon_{it}$$

$$Y_{it} = \theta_i + \alpha_2 Tourism(Tourisem \leq \tau) + \alpha_3 Tourism(Tourisem > \tau) + r_t + \varepsilon_{it} \quad (6)$$

Among them, τ is the threshold value, indicating that when tourism income reaches τ, the direction or intensity of tourism's contribution to sustainable growth (Y_{it}) will change. α_2 and

α_3 are the effect coefficients of tourism development on sustainable growth when tourism development does not reach the threshold value and when tourism development reaches the threshold value, respectively. Other variables are consistent with equation (5).

4 Empirical Findings

4.1 Analysis of the spatial and temporal evolution of tourism and sustainable development

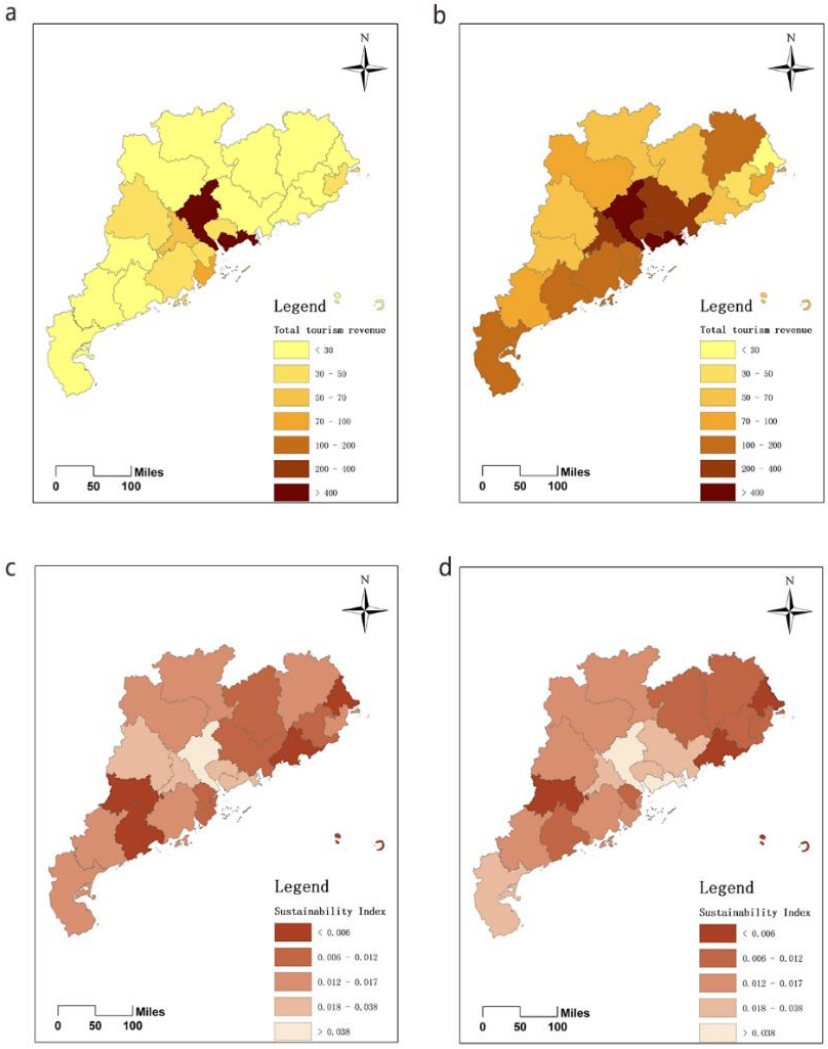

Figure 1. Spatio-temporal evolutionary analysis of the tourism industry and sustainability
Notes: 1) a, b, total tourism receipts in Guangdong Province in 2001 and 2020
2) c, d, Sustainable Development Index for Guangdong Province, 2001 and 2020.

As shown in **Figure 1**,in terms of time evolution, tourism in Guangdong Province has grown rapidly, with tourism revenue increasing significantly from 2001 to 2020. This trend is more obvious in the southeast coastal cities, such as Huizhou, Foshan and Dongguan. The combination of factors based on locational advantages and destination image building, coupled with more complete infrastructure development, policy support, and economic development, have jointly promoted the development of tourism in these places, leading to rapid growth in tourism revenue.[24] Specifically, in 2001, tourism revenue in Guangdong Province was generally low, and the vast majority of other regions were less than 300,000 yuan. Only individual prefecture-level cities in the central region reached more than 4 million yuan such as Guangzhou and Shenzhen. The tourism revenue gap between different regions is very large. Compared with 2001, in 2020, tourism revenue in Guangdong Province increased as a whole, and the vast majority of cities have with total tourism revenue of more than 500,000 yuan. The gap in total tourism revenue between regions decreases. For spatial distribution, in 2001, the cities with the highest tourism income were Guangzhou and Shenzhen. The next highest income is Foshan and Zhuhai, etc. In 2020, however, Guangdong Province gradually showed a decreasing trend in tourism revenue from coastal cities to inland cities.

In terms of temporal evolution, the overall sustainable development level (SDL) of Guangdong Province has changed little from 2001 to 2020. However, some cities have experienced significant changes in SDL. Among them, Huizhou has an index of 0.0127 in 2001 and 0.0224 in 2020. Shenzhen is 0.0388 at the beginning and 0.0761 later. from the point of view of spatial distribution, the highest sustainable development index in 2001 is Guangzhou, which represents a higher level of sustainable development; the lowest is Shanwei, with a Low level of sustainable development; in 2020, the highest sustainable development level is Guangzhou with an index of 0.0388, and the lowest is Chaozhou, with an index of 0.0388, and the lowest is Chaozhou with an index of 0.0033, development level in a low state; in 2020, the highest sustainable development level was Guangzhou with an index of 0.1181, and the lowest was Chaozhou with an index of 0.0033. In contrast, places with a high level of tourism development and high income tend to have a low sustainability index, and the two show a preliminary negative correlation.

4.2 Identification of the impact of tourism on sustainable development

Model in **Table 3** shows the results of our regression using the panel two-way fixed effects model. The coefficient of tourism income has a negative significance, indicating that the increase in tourism income is negatively related to sustainable development. Although tourism development can promote local economic growth, it may also cause environmental pollution[25] and increase social instability by increasing the risk of theft, fraud, and infringement. Baloch et al. (2023) reported social vulnerability by analyzing the data through hierarchical regression finding that tourism development has led to overuse of land, invasion of external cultures, and air and water pollution due to traffic congestion, solid waste, sewage, and carbon emissions.[14] Also, if a region overly relies on tourism, it will cause the region's manufacturing inputs and technological innovation inputs to be inhibited[26], which is not conducive to local economic growth in the long run.

Table 3 Results of panel fixed effects

VARIABLES	Total Model	Domestic Model	Foreign Model
lnavertouincome	-0.1400469***	-0.0864153*	0.0248052
	(0.0300173)	(0.0432946)	(0.0227819)
lnemployrate	0.0257542	-0.0319611	-0.033973
	(0.028698)	(0.0253565)	(0.0210941)
lnavergdp	0.1380114**	0.1253024**	0.1001231*
	(0.0501704)	(0.057767)	(0.0508401)
lntertigdp	-0.1049939	-0.1217563	-0.2086125*
	(0.1011652)	(0.112147)	(0.1092114)
lnaveryycws	0.2035159**	0.269045**	0.1921016**
	(0.073894)	(0.0857361)	(0.0768734)
lnzgpjgz	0.2997589**	0.1131076	-0.016227
	(0.1218262)	(0.142368)	(0.1186963)
lnaverdscyjycyry	-0.197272**	-0.1704247*	-0.202947**
	(0.077219)	(0.0962176)	(0.08596)
lnavercartrans	-0.0026181	-0.0072004	-0.0076225
	(0.0123805)	(0.0114118)	(0.0111397)
lnavertotlepost	0.0385836	0.0023141	-0.0047039
	(0.0464876)	(0.045187)	(0.0415947)
lnavermobile	-0.0435484	-0.0531808	-0.0574442
	(0.0490135)	(0.0512303)	(0.0484868)
lnaverexpress	0.0508412**	0.0558048**	0.0574421**
	(0.0199785)	(0.0203855)	(0.0194532)
lnaverrentcar	-0.0135769	-0.0213975	-0.01189
	(0.0248705)	(0.0272607)	(0.0261145)
lnavergreenarea	0.0011232	-0.0028866	-0.0056502
	(0.0120148)	(0.0154646)	(0.0149603)
lnczwscll	-0.0122788	-0.0153296	-0.0148871
	(0.0137314)	(0.0131424)	(0.0140624)
Year dummy	Yes	Yes	Yes
R-squared	0.5563	0.4399	0.3640

For the control variables, results in **Table 4** shows the coefficient of GNP per capita is positively significant, indicating that Gross Domestic Product (GDP) per capita can promote sustainable growth. Economic growth can improve the quality of life and social welfare[27], thus promoting sustainable development. The coefficient of the number of hospital beds is significant positively, suggesting there is a positive correlation between the level of healthcare facilities and sustainable urban development. The improved healthcare facilities allow local residents to have more opportunities to enjoy fair healthcare, thus promoting sustainability by increasing social harmony. The coefficient of average employee wage is positive and significant, indicating a positive correlation between wage level and sustainable development. On the one hand, a high wage level is conducive to enhancing the motivation of employees, which can effectively promote the growth of enterprises and the local economy. On the other hand, high wages mean that people have more economic resources to meet their basic needs, which can enhance the happiness of residents and promote social harmony. For example, Karaferis D et al. (2022) utilized Frederick Herzberg's theory of motivational hygiene as a theoretical framework using twelve phrases corresponding to intrinsic and extrinsic motivational factors, i.e., growth, nature of the job, organizational policies, supervision, interpersonal relationships, working conditions, salary, and job security, and found that the

motivation of healthcare employees was influenced by factors related to supervision, financial benefits, job training, and growth.[28]The coefficient of education practitioners is negative and significant. Guangdong Province is in the leading position in China in education; a further increase in the number of practitioners, especially practitioners in the compulsory education stage, will not lead to a significant improvement in education. On the contrary, it will generate vicious competition due to the overpopulation of the industry, thus affecting the education quality and thus damage sustainable development. The coefficient of express delivery is positively significant, indicating that infrastructure development contributes to sustainable development. The postal industry is an important information transmission channel. With the rise of e-commerce, the express logistics industry has also developed rapidly, providing a variety of services and information support for the community; its development can better meet the needs of the people.[29] Thus, it is positively related to sustainable development.

Further, we categorize tourism revenues into domestic and international tourism revenues, to identify the negative impact of tourism on sustainable growth originating from domestic or international tourism. The regression results in the second column show that the negative impact of tourism on sustainable development is mainly derived from domestic tourism. In history, Guangdong has been a large tourism province with rich natural resources; its inbound tourist proportion is always the highest in China. Although foreign tourists make an important contribution to the local tourism industry, the number of domestic tourists occupies a larger proportion. According to statistics from the Ministry of Culture And Tourism of the People's Republic of China, in 2022, the total number of domestic tourist trips will be 2.530 billion, and the domestic tourism revenue (total tourism spending) will be 2.04 trillion yuan[30], which is 84.3 times more than the number of outbound tourists. This has a more profound impact on the tourism industry in various regions of China.

We further identify whether there is a threshold effect on the impact of tourism on sustainable development. The result of threshold regression shows that the threshold value is -2.728 (corresponding to the average tourism income value of about 0.07 hundred million yuan), and it is significant at the level of 10%, which means that there is indeed a threshold effect. When the average tourism income is less than 0.07 hundred million yuan, the sustainable development level decreases by about 0.125% for every 1% increase in tourism. When the average tourism income rises to more than 0.07 million yuan, its adverse impact on sustainable development is strengthened, and the sustainable development level decreases by about 0.162% for every 1% increase in tourism. This may be due to the fact that when tourism develops to a certain extent, it exceeds the economic, social, and environmental carrying capacity, and thus the adverse impact on sustainable development becomes greater.

Table 4 Regression results of threshold effect model

VARIABLES	Model 1
threshold value (lnavertouincome)	-2.728
Lnavertouincome($\tau \leq$ -2.728)	-0.1250983*** (0.0207381)
Lnavertouincome($\tau >$ -2.728)	-0.1623889*** (0.0224728)
Control variables	Yes
Year Dummy	Yes
R-squared	0.3232

4.3 Heterogeneous impacts of tourism on sustainable development

Considering that the impact of tourism on sustainable development may differ between cities with different levels of transportation and infrastructure. We conducted a heterogeneity analysis. Model 1 in Table 5 shows the regression results with both tourism revenue and the interaction term of tourism revenue and year-end real rental cars. Results show that the coefficients of tourism and its interaction term with year-end real rental cars are negatively and positively significant respectively. Tourism has a positive effect on sustainable development in cities with developed transportation, while its effect on sustainable development is negative in cities with poor transportation. Sorupia proposed that access to tourist locations depends on the beauty of the location, infrastructure, and the effectiveness of the public transport system[31]. Similarly, Crouch and Ritchie overviewed several elements that make a tourist site attractive, such as road infrastructure, transportation services, and hospitality services[32]. Improvements in roads and transportation have made destinations more accessible to tourists and tourist attractions more attractive, which not only increases the flow of tourists and improves the tourism business, but also raises the image of the region.

Model 2 in Table 5 shows the effects of tourism on sustainable development in cities with different infrastructure levels. The coefficients of tourism are negatively significant, but the coefficients of its interaction term with express delivery are positively significant. This indicates that tourism has a positive effect on sustainable development in cities with a well-developed express delivery industry, while tourism shows a negative significant effect on sustainable development in cities with a poor express delivery industry. Take tourism products as an example, the price of the same tourism products in different scenic spots is very different, but when the cost of tourism increases, the scenic spot revenue is reduced. But if the courier industry is developed, the equivalent of goods courier costs down, the revenue will increase. The continuous improvement of service infrastructure is conducive to the promotion of sustainable urban development, so when the courier is developed, the bad impact of tourism on the city will be weakened.

Table 5 Heterogeneity of sustainable development impacts

VARIABLES	Total Model 1	Total Model 2
lnavertouincome	-0.1321335 *** (0.0295384）	-0.0967248** (0.0352063)
Lnavertouincome*lnaverrentcar	0.0209046** (0.0089604)	
Lnavertouincome*lnaverexpress		0.0111234** (0.0050107)
Control variables	Yes	Yes
Year Dummy	Yes	Yes
R-squared	0.6346	0.6461

5 Discussion

The impact of tourism on sustainable development has attracted extensive scholars' attention. Based on data from the Guangdong Statistical Yearbook, this paper analyzes the impact of tourism development on sustainable development and the heterogeneity of this impact among

different types of cities. We have the following findings:1) First, in terms of time evolution, tourism in Guangdong Province has developed rapidly, with tourism revenue increasing significantly from 2001 to 2020, a trend that is more pronounced in the southeastern coastal cities of Huizhou, Foshan, and Dongguan; the overall sustainable development level (SDL) of Guangdong Province has not changed much, but the SDLs of some of the cities have undergone significant changes. In terms of spatial distribution, in 2001, the cities with the highest tourism income were Guangzhou and Shenzhen, followed by Foshan and Zhuhai, etc. The highest SDL was in Guangzhou, which had a high level of sustainable development, and the lowest was in Shanwei, which had a low level of sustainable development. However, by 2020, tourism income in Guangdong Province gradually shows a decreasing trend from coastal cities to inland cities; the highest level of sustainable development is Guangzhou and the lowest is Chaozhou. On the contrary, places with high levels of tourism development and high incomes tend to have lower sustainable development indexes, and the two show a preliminary negative correlation.2) Overall, tourism is detrimental to the sustainable growth of cities and this effect is more significant when the average tourism income is greater than 0.07 hundred million yuan, the adverse impact will be enhanced, and this impact mainly comes from domestic tourism rather than foreign tourism. 3) In the case of well-developed urban infrastructure (real rental cars and express delivery at the end of the year), it can serve to regulate the negative effects that tourism brings to the city, and, in terms of public services, it slows down the pressure of the residents' demand for In terms of public services, the negative impacts of tourism on the city's sustainable development will be reduced by easing the pressure on residents' demand for transportation and boosting the city's tourism revenue.

6 Conclusion

Despite the richness of Guangdong's resources and the prosperity of its tourism industry, there are still some obvious shortcomings in the development of tourism compared to provinces such as Guangxi or Yunnan. The development model of Guangdong's tourism industry tends to utilize resources at a low to medium level.[33] There are several problems with the development of regional tourism in Guangdong, including a lack of understanding of the market demand for the sector, a lack of clarity in the promotion programs and image-building of certain attractions, and a lack of clear trends for future growth. At the same time, the overall planning and architectural design of each region is not sufficiently prominent and distinctive enough to be widely recognized and to enhance the actual value and influence of the scenic spots. Due to the growth of people's spiritual culture and demand, the tourism industry needs to continuously improve the diversity of its products. The lack of an in-depth analysis of the psychology of tourists and the future trends of the tourism industry has in some ways affected the attractiveness of these regions, which are not fully in line with the diversified requirements and changes of the world's travelers. In order to realize the stable and sustainable development of tourism in Guangdong Province, the following points are proposed: Firstly, it should fully utilize its advantages in terms of the seashore to establish the image label of a globally renowned tourist destination. At the same time, it should rationally utilize the core tourism assets along the 'Belt and Road', re-discover, sort out, and coordinate all kinds of coastline characteristic resources, and commit to creating a more attractive brand image. Secondly, tourism should be utilized as an excellent means of communication to showcase local culture

and characteristics to the world; new marketing strategies should be adopted to enhance the internationalization of Guangdong's traditional attractions. Improve and promote tourism programs such as sightseeing tours, vacations, and luxury cruises, and develop a wider range of marine tourism to meet the requirements and tastes of domestic and foreign tourists. Thirdly, to utilize advanced tourism management and service concepts and practical experience to promote the upgrading of services and quality of scenic spots in Guangdong Province. To upgrade the tourism industry in Guangdong Province and achieve better results, it is necessary to better understand the psychology and concerns of different travelers, to develop goods and services that are more in line with their consumption habits; in addition, this can promote the overall enhancement of the quality of tourism throughout the province as well as the professional improvement improvement.

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