A Study on Coupling Mechanism and Coordinated Development of Provincial Tourism Supply-Demand System

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Abstract : Clarifying the relationship between destination tourism supply and demand is an important prerequisite for solving the imbalance of supply and demand structure in the tourism market and deepening the supply-side structural reform (SSR). Therefore, this paper takes Guangdong Province of China as an example, based on the theory and model of coupling coordination and grey correlation, establishes an evaluation index system for tourism supply and demand systems, and empirically analyzes the coupling and coordination relationship of tourism supply and demand system in Guangdong Province from 2007 to 2017, as well as the degree of relevance of the tourism supply system elements and the coordination relationship between supply and demand of tourist destinations. The results show that the coupling and coordination relationship of tourism supply and demand system in Guangdong Province from 2007-2017 experienced seven stages of mild disorder-adjacent dislocation-reluctant coordination-primary coordination-intermediate coordination-good coordination-quality coordination, showing a steady upward trend. Particularly, the transportation environment and the economic environment are most related to the coordinated development of the tourism supply and demand system, indicating that they are the key factors to be considered in decision-making. The results show that the combination of the coupling coordination model and the grey correlation model can effectively assess the tourism supply and demand relationship at the provincial scale.

Keywords: Supply-demand relationship; coupling relationship; grey correlation; supply-side structural reform

Introduction

Tourism supply is the supply of tourism products to tourist destinations, while tourism demand is the demand of tourists for tourism products (Dai, 1997). Tourism supply and demand are two aspects of opposition and unity in the tourism market, which constitute the basic structure of the tourism system (Gunn & Var, 2002). The imbalance in the basic structure of the tourism system; that is, the excess tourism supply or demand, will affect the quality of tourism, price and demand time in the market, further restricting tourism employment, investment, and even the business activities of tourism enterprises (Zhang, 1990). It can be seen that the relationship between tourism supply and demand significantly affects the coordinated development of the tourism industry and is an important research issue in the field of tourism. Different from other supply and demand relationships, complex tourism supply and demand relationships have unique spatial characteristics and geographical distribution patterns (Niu, 1996). This determines

that the relationship between tourism supply and demand needs to be implemented into a specific tourism destination platform for research.

Almost all the tourist destinations in the world are facing the contradiction between supply and demand in the tourism market during the development of tourism (Zhang, 1990). Among them, the tourism destination that uses the city as the development unit, the contradiction between tourism supply and demand has not been well resolved (Ashworth & Page, 2011). Especially in recent years, China is at a stage where economic growth is slowing down and structural contradictions in industrial supply and demand are increasingly prominent. The supply-demand relationship of China's tourism industry faces a structural imbalance that cannot be ignored, presenting a large number of 'low-level, homogenous, and extensive' tourism products, and 'high-level, personalized, and refined' new format, as well as the lack of structural surplus and shortage of leisure and holiday products (Liu, 2016), blocking the sustainable development of tourism industry in various regions of China. Therefore, the government has allocated distortions to the elements of the economic market and put forward the policy of macroeconomic regulation and control 'supply-side structural reform'. The implementation of 'Tourism Supply Side Structural Reform' aims to achieve the optimal allocation of tourism elements, realize the dynamic balance of the supply and demand system in the tourism market, promote the healthy and sustainable development of tourism, and improve the quality and quantity of tourism economic growth. The clarification of the supply and demand relationship of tourist destinations is a prerequisite for solving the contradiction between supply and demand in the tourism market and deepening the structural reform of the tourism supply side. Therefore, how to measure the supply and demand relationship of tourism destinations has become the focus of this study.

In recent years, Chinese scholars have increasingly used the "coupling theory" to study the tourism system. "Coupling" originated in the field of physics and refers to the concept of interaction and mutual influence between two or more systems or elements (Wang & Wang, 1999). Based on the interaction between tourism supply and demand, this study proposes the concept of coupling and coordination of tourism supply-demand systems. In this concept, the coupling coordination model is used to quantitatively study the coordination relationship between tourism supply and demand. Through the coordination degree of observation model indicators, the coordination degree of tourism supply and demand relationship can be judged. On the basis of the coupling coordination model, the grey correlation model is used to further explore the degree of correlation between the internal coordination elements of the tourism supply system and the coupling and coordination relationship between the supply and demand system (Huang & Fang, 2003), and deepen the internal understanding of the system coupling mechanism.

Based on this, in the context of supply-side structural reform, this study selects China's important tourist reception center and tourism earning base, Guangdong Province, as a case study, based on the coupling theory, constructing a coordinated

evaluation system for the supply and demand system of tourist destinations, and using the coupling coordination model and the grey correlation model to empirically explore the balance of tourism supply and demand in Guangdong Province from 2007 to 2017. This has certain reference significance for correctly grasping the coupling and coordination development mechanism of tourism supply and demand, solving the contradiction between supply and demand of tourist destinations, and promoting the sustainable development of tourism industry in Guangdong Province.

Theoretical basis and mechanism of action

Coupling coordination

The word 'Coupling' is derived from physics and usually describes the interaction and mutual influence relationship between two or more systems or elements, which is called the 'coupling relationship' that often uses the index 'coupling degree (C)' to measure the looseness or tightness of the relationship between systems or elements (Wang & Wang, 1999). The coupling degree C has a value range of [0, 1]; the larger the C value, the higher the coupling degree, and the closer the relationship between subsystems, the more orderly the systems are. On the contrary, the relationship between subsystems is loose and the systems tend to be disordered. However, the degree of coupling cannot accurately measure the coordination relationship between subsystems under any circumstances, and it cannot reflect the level of system development. The index 'coupling coordination degree (D)' can make up for the lack of coupling, which can be used to measure the degree of harmonious symbiosis between systems or elements in the development process, and also to reflect the level of development of systems or elements (Yu & Liu, 2017).

Grey correlation

Grey System Theory was founded in 1982 by Professor Deng Julong of China. It is based on the fact that there are a large number of uncertain small sample information with clear and partially unknown information in the real world, mainly to develop parts of information that are known to be valuable, hence the theory of correct description and effective monitoring of the evolution of system behavior is realized (Deng, 1990). The grey relational degree model is a multi-factor statistical analysis method based on the grey system theory. The basic idea of calculating the degree of correlation is to judge the degree of correlation of the grey process development state by comparing the degree of similarity between the reference sequence and the time series curve geometry of the comparison series (Xiao, 1997). When the correlation degree R_j is between 0 and 1, it indicates that the comparison sequence X_j is associated with the reference sequence X_0, and the closer the value of R_j is to 1, the higher the correlation between the two.

Mechanism of action

The tourism system as a whole includes two subsystems of supply and demand with synergy, and the two subsystems also contain many elements. As the main body of tourism, the tourists can intuitively reflect the tourism demand of the tourist destinations in the tourism process, which constitutes the elements of the tourism demand system. For example, the number of inbound tourists, the number of domestic tourists received by the city, and the foreign exchange income of tourism. As an object that satisfies the tourist's tourism demand and carries tourists to implement tourism behavior, the tourist destination's attractiveness and hospitality actually reflect the tourism supply and constitute the elements of the tourism supply system. Examples include regional GDP, population density, rental vehicles, number of scenic spots, etc. Under the control of the external tourism market, the development of the tourism system is affected by the nonlinear effects of the two subsystems and their internal factors (Xue, Ma, Huang, Fang, & Zhang, 2014), which promote the independent adjustment of the system structure (Haken, 2006), from disorder to order, and advances from the low-level to the advanced form of sustainable development. Tourist destinations are developed in the process of maintaining the dynamic balance between tourism supply and demand (Niu, 1996); as such, the coupling and coordination of supply and demand is the basis for the sustainable development of tourism (Tanguay et al., 2010). From the perspective of the system's mechanism of action, the relationship between tourism supply and demand systems can be described by a 'coupling relationship'. The coupling coordination model can be used to accurately grasp the development of tourist destinations.

The coupling coordination model is based on the system perspective, revealing the degree of coupling coordination between systems, and the development level of systems and internal factors. The grey relational degree model is based on the internal basic elements of the system, exploring the degree of coupling between elements and systems or between features and elements. This paper refers to the grey relational model as revealing the degree of association between the elements of the tourism supply system and the coupling degree of the supply and demand system based on the results of the coupling and coordination degree of the tourism supply and demand system, which helps to deepen the internal understanding of the system coupling mechanism. The greater the correlation value, the stronger the correlation between the internal coordination of the tourism supply system and the system, and the change of this factor will have a greater impact on the coupling coordination degree of the tourism supply-demand system. If the factor is a positive impact indicator, then in the case of stabilizing the development of other factors, a modest increase in the value of the factor will effectively promote the coupling and coordination relationship between supply and demand systems; if the indicator is a negative impact indicator, then in the case of stabilizing the development of other factors, a moderate reduction in the value of this factor will effectively promote the coupling and coordination of supply and demand systems.

Based on the above considerations and on the results of the established evaluation index system, this study refines the tourism demand system indicators into three factors: travel scale, travel time and tourism consumption level, and divides the tourism supply system into five elements: economic environment, ecosystem, traffic environment, cultural environment, and tourism resources and service facilities, and a possible mechanism framework for the coupling of tourism supply and demand systems in Guangdong Province was constructed.
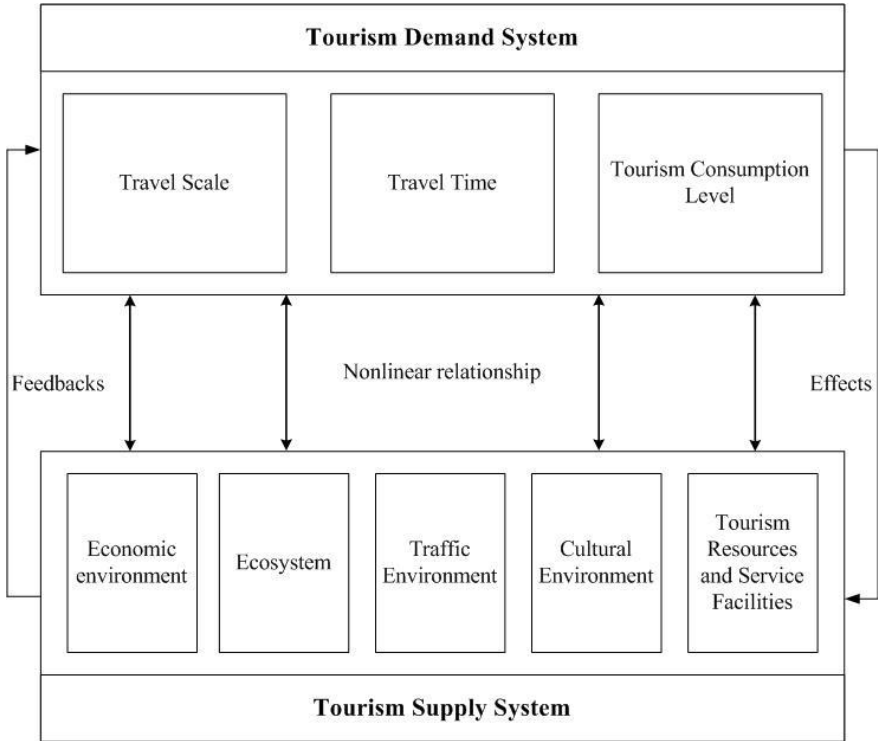

Figure 1. Mechanism of the Coupling Mechanism of Tourism Supply and Demand System in Guangdong Province

Index system and research method design

Evaluation index system

The construction of the evaluation index system is the basic work to study the coupling mechanism of tourism supply and demand system. On the basis of the principles of science, completeness, operability, principal component and independence (Liu, Li, & Song, 2005), this paper initially determines the indicators of the tourism supply and demand system based on previous research (Yu & Liu, 2017; Xue et al., 2014; Zhang, Ma, Wu, & Zhu, 2013; Liu & Ma, 2017a, 2017b; Zhang, Ma, & Bai, 2016; Li, Hu, & Ma, 2013; Dong, Ma, Li, &

Gao, 2013; Zhong & Liu, 2012; Zhang & Halik, 2014; Gao, 2013; Wang & Ma, 2011). The indicators are then set and filtered by frequency statistics, theoretical analysis and Delphi method (Cao & Wang, 1998). On the basis of finding the source of the data, the indicators that cannot be calculated due to the lack of large amounts of data, inconsistent expressions of statistics, and changes in statistical caliber are eliminated. Finally, the entropy method of objective weighting method is used to calculate the index weights; therefore, a multi-index comprehensive evaluation index system of tourism supply and demand system consisting of two levels, eight first-level indicators and 29 second-level indicators was constructed (Table 1).

Table 1. Evaluation index system and weight of tourism supply and demand system.

System	Primary indicators	Secondary indicators	Unit	Effects	Weight
A1 Demand System	B1 Travel Scale	C1 Inbound tourist trips	Ten thousand people	+	0.1244
		C2 City receives domestic tourists	Ten thousand people	+	0.1278
	B2 Travel Time	C3 Inbound tourists per capita stay Days	Day	+	0.1138
	B3 Tourism Consumption	C4 Tourism foreign exchange income	Billion	+	0.1241
		C5 Domestic tourism income	Billion	+	0.1394
		C6 Inbound tourists per capita cost	Yuan	+	0.1257
		C7 Tourism foreign exchange income as a share of GDP	%	+	0.1074
		C8 Domestic tourism income as a share of GDP	%	+	0.1375
A2 Supply System	B4 Economic Environment	C9 Regional GDP	Billion	+	0.0435
		C10 Per capita GDP	Yuan	+	0.0424
		C11 The tertiary industry accounts for the proportion of GDP	%	+	0.0430
		C12 Urban residents' per capita disposable income	Yuan	+	0.0427
		C13 Engel coefficient of urban residents	%	-	0.0568
		C14 Total investment in fixed assets	Billion	+	0.0467
	B5 Ecological Environment	C15 City per capita public green area	M2	+	0.0436
		C16 Forest coverage	%	+	0.0583
		C17 Population density	Person/km2	-	0.0554
	B6	C18 Civil aviation passenger traffic	Ten thousand people	+	0.0455

	Traffic Environment	C19 Railway passenger traffic	Ten thousand people	+	0.0495
		C20 Highway passenger traffic	Ten thousand people	+	0.0520
		C21 Per capita urban road area	M2	+	0.0364
		C22 Taxi vehicle	Vehicle	+	0.0456
		C23 Civil aviation passenger turnover	100 million people	+	0.0491
	B7 Cultural Environment	C24 Number of cultural centers, museums and libraries	One	+	0.0622
	B8 Tourism Resources And Service Facilities	C25 Number of A-level scenic spots	One	+	0.0490
		C26 Number of travel agencies	One	+	0.0511
		C27 Number of star hotels	One	+	0.0348
		C28 Number of catering establishments above designated size	One	+	0.0413
		C29 Number of travel agency employees	People	+	0.0511

Coupling coordination level standard

This paper refers to Liao Zhongbin's coupling coordination degree classification standard (Liao, 1999), which judges the absolute level of coupling and development of the supply and demand system of the tourist destination, in order to clarify the general context of the coordinated development of tourism supply and demand in Guangdong Province (Table 2). The coordination degree D has a value interval of [0, 1] and the uncoordinated critical point is 0.5000. The larger the value of D, the more inclined the supply and demand system is to be coordinated and orderly; the smaller the value of D, the more biased and disordered the supply and demand system is.

Table 2. Coupling coordination grade evaluation level division criteria.

D value range	Grade	D value range	Grade
0.0000～0.0999	Extreme imbalance	0.5000～0.5999	Reluctant coordination
0.1000～0.1999	Serious disorder	0.6000～0.6999	Primary coordination
0.2000～0.2999	Moderate imbalance	0.7000～0.7999	Intermediate coordination
0.3000～0.3999	Mild disorder	0.8000～0.8999	Good coordination
0.4000～0.4999	Adjacent dislocation	0.9000～1.0000	Quality coordination

Data sources

The data of tourism supply and demand system in this paper comes from the Guangdong Statistical Yearbook (2008-2018), the Yearbook of China Tourism Statistics, China City Statistical Yearbook, China Tourism Statistical Bulletin, and other official statistics (Guangdong Bureau of Statistics, 2008-2018; China

National Tourism Administration, 2008-2018; National Bureau of Statistics, 2008-2018). Individual missing data is supplemented by the interpolation or mean method on the basis of existing data.

Coupling coordination model

This paper builds a coupling coordination model and is divided into four steps:

The first step is the dimensionless processing of data (U_{ij}). The dimensionless processing has an extreme value method, a standardized method, a mean value method, a standardized difference method, etc. (Ye, 2003). This paper selects the common extremum method and uses the maximum and minimum values of the variable to calculate. The X_{ij} in Eqn. (1) represents the j index of the i-th year.

$$u_{ij}= \begin{cases} \dfrac{X_{ij}-\min(X_{1j},X_{2j},\cdots,X_{mj})}{\max(X_{1j},X_{2j},\cdots,X_{mj})-\min(X_{1j},X_{2j},\cdots,X_{mj})} & \left(\text{When } X_j \text{ is a positive indicator}\right) \\[2ex] \dfrac{\max(X_{1j},X_{2j},\cdots,X_{mj})-X_{ij}}{\max(X_{1j},X_{2j},\cdots,X_{mj})-\min(X_{1j},X_{2j},\cdots,X_{mj})} & \left(\text{When } X_j \text{ is a negative indicator}\right) \end{cases} \tag{1}$$

In the second step, the power function (U_i) is calculated. The linear weighting method is used to calculate the comprehensive evaluation function of the tourism supply and demand system. The u_{ij} ($0 \leq u_{ij} \leq 1$) of Eqn. (2) is the result of the dimensionless processing, and w_j ($0 \leq w_j \leq 1$) is the index weight. The U_i value reflects the comprehensive evaluation function of the system in the first year.

$$U_i = \sum_{j=1}^{n} w_j \cdot u_{ij} \tag{2}$$

In the third step, the coupling degree function (C) is calculated. This paper only studies the coupling relationship between supply and demand systems and is shown in Eqn. (3) as follows:

$$C = 2\sqrt{\frac{U_1 \cdot U_2}{(U_1 + U_2)^2}} \tag{3}$$

In the fourth step, the coupling coordination function (D) is calculated. Compared with the degree of coupling, the degree of coupling coordination not only measures the strength of the interaction between systems, but also reflects the level of system development. C in Eqn. (4) is the degree of coupling, and T is the comprehensive evaluation index of the coupled system.

$$D = \sqrt{C \times T} \tag{4}$$

In Eqn. (5), U_1 and U_2 are the comprehensive evaluation indexes of the two systems, and a and b are the undetermined coefficients, indicating the proportion of the two subsystems between the entire coupled systems. Since the tourism supply system and the demand system have a positive effect on the development

of the tourism industry, this paper considers it to be of equal importance, hence the values of a and b are both set to 0.5 (Tang, 2015).

$$T = aU_1 + bU_2 \tag{5}$$

Grey correlation model

The construction of the grey correlation model in this paper is mainly divided into five steps:

The first step is to determine the reference sequence and the comparison sequence. The reference series needs to reflect the behavior of the system, and the comparison series is the study of objects that affect system behavior. In this paper, the calculated series of tourism supply and demand system coupling coordination degree from 2007 to 2017 is set as the reference sequence X_0. The comprehensive evaluation index of the 21 secondary indicators that measure the supply system is set as the comparison series X_i, and the correlation analysis of the coordinated development of the tourism destination supply system and the tourism supply and demand system is carried out.

In the second step, the data is subjected to dimensionless processing using the means of averaging.

The third step is to calculate the correlation coefficient $\xi_i(k)$. Let the reference sequence $X_0 = \{X_0(1), X_0(2), \cdots, X_0(m-1), X_0(m)\}$, then the jth sequence is $X_j = \{X_j(1), X_j(2), \cdots, X_j(m)\}$, j = 1, 2, 3, ..., n; k = 1, 2, 3,..., m. In Eqn. (6), $\xi_j(k)$ indicates the degree of association between X_0 and X_j at point k, and $\max\limits_{j} \max\limits_{k} \Delta_j(k)$ and $\min\limits_{j} \min\limits_{k} \Delta_j(k)$ values indicate that both j and k are in the range of values, with the maximum and minimum values of the absolute difference between X_0 and X_j. For the Distinguish Coefficient, the value range of ρ is [0, 1], which is usually taken as 0.5 in the equation calculation (Feng & Tao, 2015).

$$\xi_j(k) = \frac{\min\limits_{j} \min\limits_{k} \left| X_0(k) - X_j(k) \right| + \rho \max\limits_{j} \max\limits_{k} \left| X_0(k) - X_j(k) \right|}{\left| X_0(k) - X_j(k) \right| + \rho \max\limits_{j} \max\limits_{k} \left| X_0(k) - X_j(k) \right|}$$

$$\xi_j(k) = \frac{\min\limits_{j} \min\limits_{k} \Delta_j(k) + \rho \max\limits_{j} \max\limits_{k} \Delta_j(k)}{\Delta_j(k) + \rho \max\limits_{j} \max\limits_{k} \Delta_j(k)} \tag{6}$$

In the fourth step, the degree of correlation R_j is calculated. The correlation degree of X_j and X_0 is obtained by weighting the correlation coefficient of the

reference series coordination degree and the comparison sequence to the secondary index of the system.

$$R_j = \frac{1}{m}\sum_{k=1}^{m}\xi_j(k)$$

(7)

When $0<R_j<0.35$, the correlation degree between X_j and X_0 is weak; when $0.35<R_j<0.65$, the correlation degree between X_j and X_0 is moderate; when $0.65<R_j<0.85$, the correlation degree between X_j and X_0 is stronger; when $0.85<R_j<1$, X_j is highly correlated with X_0.

In the fifth step, the degree of correlation R_j is sorted. The relevance of the secondary indicators under the same level of indicators is ranked from large to small, and the average of the calculated correlations of the secondary indicators is the degree of relevance of the primary indicators. Then, the first-level indicators are ranked in order of largest to smallest, and finally the results of the relevance of the indicator system are obtained.

Results and Discussion

Analysis on the Coordinated Development of Tourism Supply-Demand System in Guangdong Province

From the perspective of coupling coordination indicators, the coupling and coordination relationship of tourism supply and demand system in Guangdong Province showed a clear upward trend from 2007 to 2017. In 2010, it was the uncoordinated demarcation point that experienced seven stages of mild disorder - adjacent dislocation - reluctant coordination - primary coordination - Intermediate coordination - good coordination - quality coordination, objectively reflecting the situation in which the supply and demand structure of tourism in Guangdong Province is disorderly to orderly and from disorder to coordinated development.

Table 3. Coordination degree of tourism supply and demand system in Guangdong Province from 2007 to 2017.

Year	U1 (Demand)	U2 (Supply)	C	D	Grade	Reason
2007	0.1829	0.1213	0.9793	0.3859	Mild disorder	Supply lag
2008	0.1122	0.1655	0.9814	0.3691	Mild disorder	Demand lag
2009	0.1226	0.2348	0.9494	0.4119	Adjacent dislocation	Demand lag
2010	0.3113	0.3060	1.0000	0.5555	Reluctant coordination	Supply lag
2011	0.4289	0.3843	0.9985	0.6371	Primary coordination	Supply lag
2012	0.5041	0.4697	0.9994	0.6976	Primary coordination	Supply lag

2013	0.4043	0.6051	0.9800	0.7033	Intermediate coordination	Demand lag
2014	0.4755	0.6839	0.9837	0.7552	Intermediate coordination	Demand lag
2015	0.5696	0.7633	0.9894	0.8120	Good coordination	Demand lag
2016	0.7963	0.8389	0.9997	0.9041	Quality coordination	Demand lag
2017	0.8896	0.8635	0.9999	0.9362	Quality coordination	Supply lag

From the comparison results of the comprehensive evaluation index of supply and demand systems, it is possible to analyze the lagging reasons for the coordinated development of the two systems. When u1<u2, the system is lagging for tourism demand; when u1>u2, the system supplies hysteresis for tourism; when u1=u2, the system is synchronously developed (Yu & Liu, 2017). Comparing the calendar year values of 2007-2017, it is found that the tourism supply and demand system in Guangdong Province in the early stage mainly showed the lag of tourism supply. In 2008 and 2009, the development was abrupt, and the tourism demand lag could not match the tourism supply. Since 2013, the tourism supply and demand system in Guangdong Province has mainly shown that tourism demand is lagging behind, except that tourism supply cannot effectively meet the tourism demand in 2017.
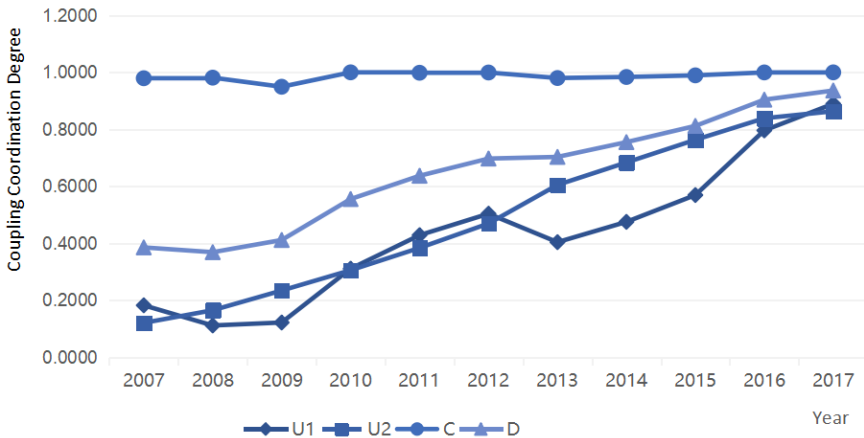

Figure 2. Coordination degree of tourism supply and demand system in Guangdong Province from 2007 to 2017

Combined with the coupling coordination degree index and the lag result analysis, it can be found that when the tourism industry in Guangdong Province was not affected by a major crisis in 2007, the tourism supply could not effectively meet the tourism demand, resulting in an imbalance in the supply and demand relationship in the tourism market. In 2008 and 2009, the tourism industry in Guangdong Province suffered successive major crisis impacts, resulting in a lack

of tourism demand, showing an imbalanced state of demand behind supply. Among them, in 2008, Guangdong Province faced the impact of major snowstorms in the south, the Beijing Olympic Games and the global financial turmoil, which caused the tourism demand in Guangdong to shrink sharply. In 2009, on the basis of the previous year's heavy losses, the tourism market in Guangdong Province suffered from the ongoing financial crisis and the outbreak of influenza A (H1N1), which is highly contagious and has a high mortality rate, as well as demand for tourism lagging behind. However, from 2007 to 2009, due to the gradual improvement of the economic strength, ecological environment, tourism resources and service facilities in Guangdong Province, the level of coupling and coordination development of tourism supply and demand system in Guangdong Province is driven by the increase in supply capacity, and it has gradually moved closer to coordination.

After two years of recovery, the tourism crisis in Guangdong Province was alleviated in 2010, resulting in a rapid increase in the level of tourism demand development and reducing the gap between demand and supply. The coupling and coordination value of supply and demand system exceeded the critical point, and the system synergy was enhanced leading to the coupling relationship being transitioned from near to dysfunctional to reluctant coordination. From 2010 to 2012, the supply and demand systems have steadily increased. However, in the past three years, the tourism supply in Guangdong Province has not yet reached the level that can meet the demand for tourism, indicating that the supply and demand systems are still in the running-in stage.

From 2012 to 2013, the entry market of Hong Kong, Macao and Taiwan was greatly reduced, and the low demand for tourism has caused the overall level of development of the demand system to fall. On the other hand, tourism supply has not stopped developing due to the temporary drop in tourism demand; rather, it has shown a favorable trend of continued increase. Therefore, the comprehensive development level and coupling coordination degree of the supply and demand system have only slightly declined, resulting in no change in the level of coupling coordination. Beginning in 2013, the trend of tourism demand has warmed up, and the coupling coordination degree has continued to increase steadily. In 2015, the tourism supply and demand system of Guangdong Province reached a good coordination relationship. In 2016 and 2017, the demand for tourism soared, closely tracking the supply of tourism, significantly promoting the coordinated development of tourism supply and demand system, and the system's coupling coordination value exceeded 0.9, achieving high-quality coordination of supply and demand systems.

At the same time, from the end of 2007 to the end of 2017, the tourism supply and demand system in Guangdong Province has always presented a structural imbalance between supply and demand, and in 2017, the tourism supply capacity of Guangdong Province has significantly improved. This paper speculates that the government has implemented and promoted the supply-side structural reform policy. Therefore, comprehensively deepening supply-side structural reforms,

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optimizing supply structure, increasing effective supply, and improving the comprehensive development level of tourism destinations are effective means to stimulate tourism demand. In addition, the change in the coupling coordination degree of tourism supply and demand system caused by the change of demand shows that the coupling and coordination relationship of tourism supply and demand system is greatly driven by the tourism demand system.

Time Series Analysis of Comprehensive Development Level of Tourism Demand System in Guangdong Province

The comprehensive evaluation index of the secondary indicators of the tourism demand system of Guangdong Province shows that during 2007-2017, the demand development level reflecting the domestic tourist group indicators showed a steady increase trend, such as C2 and C5. It indicates that the number of domestic tourists and the amount of consumption to travel to Guangdong Province has increased year by year, and the group has high stability and is not susceptible to sudden factors, which has greatly changed the level of tourism demand. Indicators reflect the group of inbound tourists, such as C1, C3, C4, C6, etc., and the level of demand development shows a trend of high and low fluctuations and a slow upward trend. It shows that the travel demand of inbound tourists is highly vulnerable to sudden factors.

As a port of entry for China, Guangdong Province borders Hong Kong and borders Macau. Inbound tourism has developed earlier and the momentum is ahead of the country. According to the data and ranking of international tourism foreign exchange income indicators, Guangdong Province has always ranked first in the national ranking of tourism foreign exchange earnings. However, between 2007 and 2017, the data on inbound tourism related indicators in Guangdong Province fluctuated several times. Among them, the comprehensive evaluation index of the two indicators of C1 inbound tourist number and C3 inbound tourist per capita staying days decreased in 2009, and the comprehensive evaluation index of C4 tourism foreign exchange income and C6 inbound tourists per capita cost were both decreased significantly in 2008. The reason was that in early 2008, Guangdong Province was affected by major snowstorms in the south, which led to traffic congestion in many regions, affecting the development of inbound tourism in Guangdong Province. In March, a violent incident of Tibetan independence broke out in western China, and capitalist countries such as Europe and the United States have suppressed China's inbound tourism flows from political thoughts and ideological aspects; in August, the state strengthened its control over inbound tourist flow to ensure the safety during the Beijing Olympics, resulting in restrictions on the size of the country's inbound tourists, as well as inbound tourism groups more likely to flow to Beijing. Also, the number of inbound tourism flows in other provinces has rapidly decreased. At the end of the year, the outbreak of the global financial crisis caused the economy of many source countries to suffer and affected the development of China's inbound tourism. In 2009, the financial turmoil intensified and its subsequent impact was far-reaching. As a major province for inbound tourism development, the development of

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inbound tourism in Guangdong Province continued to be sluggish. Therefore, the comprehensive evaluation index of inbound tourism related indicators fell in 2008 and 2009.

In addition, between 2012 and 2014, the comprehensive evaluation index of C1 inbound tourists once again fell, and the comprehensive evaluation index of C4 tourism foreign exchange income showed a trend of increasing year by year. The reason was that Hong Kong, Macao and Taiwan tourists were the mainstay of the inbound tourism market in Guangdong Province. It accounted for about 80% of the inbound tourism in Guangdong Province. Around 2012, the economic situation of Hong Kong, Macao and Taiwan was not clear, and the continuous appreciation of the renminbi and the rise in prices has caused a sharp contraction in the Hong Kong, Macao and Taiwan markets. The 2013 China Tourism Statistics Yearbook publicity data confirms the grim situation of the above-mentioned inbound tourism market: 'In 2012, the number of visitors to the ports in Guangdong Province decreased by 2.6% compared with the previous year. Among them, foreigners grew by 0.6%, Hong Kong compatriots fell by 0.5%, Macao compatriots fell by 10.7%, and Taiwan compatriots fell by 2.6%' (National Bureau of Statistics, 2013).

Table 4. 2007-2017 Guangdong Tourism Demand System Comprehensive Evaluation Index

Year	C1 Inbound tourist trips	C2 City receives domestic tourists	C3 Inbound tourists per capita stay Days	C4 Tourism foreign exchange income	C5 Domestic tourism income	C6 Inbound tourists per capita cost	C7 Tourism foreign exchange income as a share of GDP	C8 Domestic tourism income as a share of GDP
2007	0.0364	0.0000	0.0241	0.0045	0.0000	0.0053	0.1074	0.0052
2008	0.0369	0.0061	0.0241	0.0000	0.0037	0.0000	0.0413	0.0000
2009	0.0269	0.0145	0.0000	0.0084	0.0093	0.0109	0.0413	0.0112
2010	0.0546	0.0265	0.0552	0.0372	0.0184	0.0400	0.0595	0.0198
2011	0.1202	0.0396	0.0689	0.0478	0.0336	0.0420	0.0363	0.0403
2012	0.0884	0.0524	0.0862	0.0628	0.0474	0.0632	0.0413	0.0625
2013	0.0136	0.0651	0.0172	0.0666	0.0615	0.0808	0.0215	0.0780
2014	0.0000	0.0770	0.0448	0.0740	0.0787	0.0923	0.0116	0.0972
2015	0.0576	0.0921	0.0414	0.0839	0.0971	0.0922	0.0066	0.0987
2016	0.1182	0.1074	0.0862	0.1072	0.1163	0.1257	0.0083	0.1270
2017	0.1244	0.1278	0.1138	0.1241	0.1394	0.1227	0.0000	0.1375

From this, it can be analyzed that the sudden decrease in the number of tourists from Hong Kong, Macao and Taiwan is the main reason for the decrease in the comprehensive development level of inbound tourists, while the increase in the number of foreign tourists with strong spending power will help Guangdong's

tourism foreign exchange income increase. Fundamentally, the structural changes in the inbound tourism flow will cause changes in tourism demand, which in turn will affect the economic benefits of the inbound tourism market.

Time Series Analysis of the Comprehensive Development Level of Tourism Supply System in Guangdong Province

The comprehensive evaluation index of the secondary indicators of the tourism supply system of Guangdong Province shows that the economic strength, environmental greening level and transportation capacity of Guangdong Province have been comprehensively improved from 2007-2017, and the scale of cultural resources, tourism resources and service facilities has continued to expand. The comprehensive evaluation index of railway, highway passenger traffic and taxi vehicles, which measure the traffic supply of Guangdong Province, all fell in 2009, mainly due to the decline of regional traffic supply capacity caused by the subsequent impact of the snowstorm in southern China in 2008. The C17 population density index is used as a negative effect indicator, and its comprehensive development level is decreasing year by year, which is due to the increasing population density in Guangdong Province. The main reason for the decrease in the total number of C27-star hotels since 2011 is the sharp reduction in the size of hotels with three stars and below; however, the number of five-star hotels has increased year by year, and the overall trend of four-star hotels has remained flat. This phenomenon reflects the Chinese government's efforts to strengthen the supervision of the hotel industry level and increase the quality of products or services.

Table 5. Comprehensive Evaluation Index of Tourism Supply System of Guangdong Province, 2007-2017

Year	C9 Regional GDP	C10 Per capita GDP	C11 The tertiary industry accounts for the proportion of GDP	C12 Urban residents' per capita disposable income	C13 Engel coefficient of urban residents	C14 Total investment in fixed assets	C15 City per capita public green area	C16 Forest coverage
2007	0.0000	0.0000	0.0000	0.0000	0.0252	0.0000	0.0000	0.0000
2008	0.0042	0.0050	0.0045	0.0037	0.0000	0.0026	0.0051	0.0000
2009	0.0062	0.0071	0.0102	0.0071	0.0091	0.0063	0.0106	0.0084
2010	0.0111	0.0103	0.0072	0.0114	0.0131	0.0109	0.0166	0.0147
2011	0.0164	0.0157	0.0084	0.0169	0.0091	0.0121	0.0232	0.0210
2012	0.0193	0.0186	0.0133	0.0230	0.0091	0.0163	0.0304	0.0294
2013	0.0233	0.0228	0.0232	0.0217	0.0428	0.0222	0.0311	0.0398
2014	0.0273	0.0269	0.0238	0.0265	0.0458	0.0274	0.0329	0.0501

2015	0.0310	0.0305	0.0306	0.0313	0.0459	0.0343	0.0390	0.0541
2016	0.0368	0.0361	0.0388	0.0366	0.0493	0.0393	0.0416	0.0562
2017	0.0435	0.0424	0.0430	0.0427	0.0568	0.0467	0.0436	0.0583
Year	C17 Population density	C18 Civil aviation passenger traffic	C19 Railway passenger traffic	C20 Highway passenger traffic	C21 Per capita urban road area	C22 Taxi vehicle	C23 Civil aviation passenger turnover	C24 Number of cultural centers, museums and libraries
2007	0.0554	0.0000	0.0000	0.0025	0.0000	0.0000	0.0000	0.0000
2008	0.0524	0.0022	0.0049	0.0073	0.0072	0.0164	0.0012	0.0000
2009	0.0495	0.0092	0.0039	0.0000	0.0143	0.0069	0.0057	0.0123
2010	0.0233	0.0161	0.0085	0.0046	0.0214	0.0165	0.0121	0.0200
2011	0.0216	0.0189	0.0171	0.0113	0.0286	0.0271	0.0164	0.0184
2012	0.0181	0.0232	0.0190	0.0196	0.0279	0.0342	0.0210	0.0284
2013	0.0169	0.0267	0.0246	0.0259	0.0272	0.0399	0.0256	0.0538
2014	0.0140	0.0327	0.0342	0.0327	0.0266	0.0417	0.0314	0.0553
2015	0.0099	0.0349	0.0424	0.0402	0.0298	0.0455	0.0372	0.0568
2016	0.0052	0.0389	0.0495	0.0483	0.0331	0.0456	0.0428	0.0576
2017	0.0000	0.0455	0.0481	0.0521	0.0364	0.0420	0.0491	0.0622
Year	C25 Number of A-level scenic spots	C26 Number of travel agencies	C27 Number of star hotels	C28 Number of catering establishments above designated size	C29 Number of travel agency employees			
2007	0.0000	0.0000	0.0318	0.0065	0.0000			
2008	0.0039	0.0025	0.0313	0.0097	0.0014			
2009	0.0096	0.0044	0.0326	0.0129	0.0085			
2010	0.0146	0.0100	0.0348	0.0160	0.0128			
2011	0.0171	0.0117	0.0306	0.0244	0.0183			
2012	0.0223	0.0201	0.0255	0.0259	0.0254			
2013	0.0263	0.0258	0.0248	0.0285	0.0322			
2014	0.0363	0.0311	0.0192	0.0311	0.0368			
2015	0.0402	0.0362	0.0150	0.0326	0.0461			
2016	0.0431	0.0421	0.0072	0.0413	0.0495			
2017	0.0488	0.0511	0.0000	0.0000	0.0511			

In addition, comparing the results of the evaluation index of the tourism demand system, it can be seen that compared with the tourism demand system with slow development, weak resistance, poor stability but self-regulating ability

and strong resilience, Guangdong's tourism supply system develops rapidly, has strong resistance, high stability, and can be used to provide a good guarantee for the development of tourism demand systems.

Analysis of Grey Correlation Degree of Tourism Supply Factors in Guangdong Province

The correlation degree between the tourism supply system elements and the tourism supply and demand system coupling degree is between 0.5587 and 0.8630, which is a moderate to extremely strong degree, indicating that the relationship between tourism supply elements and tourism supply and demand system is relatively close. In order to reveal the factors that mainly affect the coupling and coordinated development of tourism supply and demand systems, this study makes a simple average calculation of the correlation degree of the secondary indicators and the primary indicators, and obtains the main dimension that restricts the coordinated development of the supply and demand system of tourism destinations. Among the first-level indicators, the ranking results of the indicators with strong correlation between tourism supply factors and tourism supply and demand system are: traffic environment > economic environment > tourism resources and service facilities > cultural environment > ecological environment.

The strong correlation degree of the traffic environment shows that this indicator occupies the decisive position of coordinated tourism development in Guangdong Province. Among them, civil aviation, railways and highways are the main modes of transportation for tourists to travel. The correlation between civil aviation and railway is far more than that of highways. On the one hand, it can explain that China's traffic conditions are more convenient, and long-distance travel has become a holiday choice for more and more tourists. On the other hand, the low correlation degree of road passenger traffic is also in line with the current trend of short-distance travellers who prefer the self-driving tour mode.

The strong correlation between the economic environment and the coordinated development of tourism supply and demand system confirms the important impact of the economic environment on the sustainable development of tourism in Guangdong Province. Economically developed cities often assume responsibility for holding high-level business meetings and high-profile exhibitions. Therefore, economically developed cities can focus on the development of business tourism, with a view to further promoting the economic development of tourism destinations while coordinating the development of the tourism industry.

The strong correlation between C28 and C25 and tourism supply and demand system in tourism resources and service facilities proves that today's tourists pay more attention to the food experience and sightseeing travel of the six elements of tourism.

Table 6. Coupling and Coordination Development of Supply Factors and Tourism Supply and Demand System in Guangdong Province

Primary indicator	Correlation degree B-Rj	Secondary indicators	Correlation degree C-Rj	Association	Sort
B6 Traffic Environment	0.7458	C21 Per capita urban road area	0.8630	Extremely strong	1
		C22 Taxi vehicle	0.8017	Strong	2
		C18 Civil aviation passenger traffic	0.7610	Strong	4
		C23 Civil aviation passenger turnover	0.7048	Strong	10
		C19 Railway passenger traffic	0.6841	Strong	14
		C20 Highway passenger traffic	0.6604	Strong	18
B4 Economic Environment	0.7108	C12 Urban residents' per capita disposable income	0.7581	Strong	5
		C10 Per capita GDP	0.7387	Strong	7
		C9 Regional GDP	0.7380	Strong	8
		C14 Total investment in fixed assets	0.6947	Strong	12
		C11 The tertiary industry accounts for the proportion of GDP	0.6911	Strong	13
		C13 Engel coefficient of urban residents	0.6439	Moderate	19
B8 Tourism Resources And Service Facilities	0.6989	C28 Number of catering establishments above designated size	0.7569	Strong	6
		C25 Number of catering establishments above designated size	0.7305	Strong	9
		C29 Number of travel agency employees	0.7024	Strong	11
		C26 Number of travel agencies	0.6777	Strong	16
		C27 Number of star hotels	0.6269	Moderate	20
B7 Cultural Environment	0.6760	C24 Number of cultural centers, museums and libraries	0.6760	Strong	17
B5 Ecological Environment	0.6747	C15 City per capita public green area	0.7814	Strong	3
		C16 Forest coverage	0.6840	Strong	15
		C17 Population density	0.5587	Moderate	21

Compared with other first-level indicators, the coupling degree of the cultural environment and the ecological environment and the tourism supply and demand system has the lowest correlation, but it also achieves a level of strong influence. In particular, the urban per capita park green area index in the ecological environment has a strong driving effect on the coordinated development of the tourism supply and demand system, indicating that the effect of expanding the

tourist flow can be realized by carrying out urban greening construction, increasing the supporting facilities for greening, and improving the ornamental, natural and comfortable tourism destinations. Secondly, the economic environment and the traffic environment are highly correlated, in which the economic, transport and ecological environment can be combined to create a tourism destination with economic-ecological-transportation-oriented advantages in Guangdong Province, and to improve the coupling and coordination degree between the ecological environment and the tourism supply and demand system.

Conclusions and Recommendations

In the context of structural reforms on the supply side, and taking Guangdong Province as an example, this paper is based on the evaluation index system of tourism supply and demand system, in which the coupling coordination degree model is used to study the dynamic change of the coupling degree between the tourism demand system and the tourism supply system. The grey correlation model is used to study the supply factors that mainly drive the coordinated development of tourism supply and demand systems.

The research shows that: (1) From 2007 to 2017, the coordination degree of tourism supply and demand in Guangdong Province shows an obvious S-type rising trend, and the tourism supply and demand coupling level experienced a total of seven stages of mild disorders – adjacent dislocation - Reluctant coordination - primary coordination - intermediate coordination - good coordination - quality coordination; also, the tourism supply lag is the main feature in the early stage, and the tourism demand lag is the main trend in the later stage; (2) the tourism demand subsystem is more susceptible to sudden crisis events, and the comprehensive evaluation index shows a volatility rising trend; the tourism supply subsystem has strong stability, the comprehensive evaluation index has risen steadily, and the development trend is good; (3) the correlation between the secondary indicators of the tourism supply system and the tourism supply and demand system is divided into three levels, of which the degree of relevance is extremely strong, and the indicators of moderate relevance are few, as well as the indicators with strong correlations accounting for the vast majority; (4) among the first-level indicators, the traffic environment and economic environment have the greatest contribution to the coordinated development of tourism supply and demand systems.

These findings suggest that the combination of the coupled coordination model and the grey correlation model can help local governments better clarify the complex coupling relationship between supply and demand systems in tourism destinations, deepen supply-side structural reforms, and develop sustainable development strategies. Therefore, relevant government agencies and policy makers must pay more attention to monitoring the coupling and coordination relationship of tourism supply and demand systems, and understand the leading supply factors that affect the coordinated development of the tourism industry. In terms of supply, it is necessary to improve the supply capacity of Guangdong

Province in a planned and purposeful manner in accordance with the order of transportation-economy-tourism resources and service facilities-culture-ecology. On the basis of utilizing its own resources and the advantages of the development of the status quo, it actively develops the emerging tourism industry, optimizes the spatial layout of tourism industry development, and builds a global tourism supply system. In terms of demand, we must pay attention to the needs of domestic tourists, explore the international inbound tourism market, and awaken the vitality of the Hong Kong, Macao and Taiwan inbound tourism market. More notably, considering that tourism demand is highly vulnerable to sudden crisis events, governments and enterprises should establish a set of resilience mechanisms for uncertain factors that may affect tourism demand in the future, thereby achieving a coordinated development of the tourism supply and demand system.

The coordinated development of the tourism supply and demand system is a dynamic long-term process. At the same time, the implementation of the supply-side structural reforms will bring more and more scholars to continue monitoring, calculation and verification in the future for the coordinated development of tourism supply and demand systems in Guangdong Province and even in other parts of China. In addition, the completeness and scientific nature of the indicator system can effectively improve the accuracy of the research results. Therefore, optimizing the evaluation index system is the future research direction.

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