Research on the Coupling Coordination Degree of Tourism Economy and Regional Resilience and Its Obstacle Degree Factors Based on the Obstacle Degree Model

Xun Chen

Beibu Gulf University, Qinzhou, China
Email: 18710185811@163.com
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***Abstract*—In order to explore the coupling coordination degree and obstacle degree factors of China's tourism economy and regional resilience, this paper selects a total of 25 indicators from the five aspects of economy, community, industry, ecology and infrastructure to build China's regional resilience evaluation system. Meanwhile, the level of China's tourism economy is comprehensively measured from two aspects: domestic tourism level and international tourism level. This paper selects the official data of the decade from 2012 to 2021 and divides it into three obstacle types according to the coupling coordination degree of China's tourism economy and regional resilience in the decade to analyze the main influencing factors of the coupling coordination degree of China's tourism economy and regional resilience under different obstacle degrees. Research methods: This paper refers to the construction of the resilience index system of existing studies, meanwhile, comprehensively uses entropy weight method and obstacle degree model to analyze the obstacle factors that affect the coupling coordination degree of the two, which finds that the coupling coordination degree of China's tourism economy and regional resilience is on the whole in a steady increase trend from 2012 to 2021. However, the impact of the COVID-19 pandemic has significantly reduced the degree of coordination between the two in 2020. At the same time, when the coupling coordination relationship between China's tourism economy and regional resilience is in an obvious dissonance, the industry level and domestic tourism level are the main systematic influencing factors. When the coupling coordination between China's tourism economy and regional resilience is in the basic coordination type, the industry level and the basic implementation level are the main system influencing factors. When the coupling and coordination relationship between China's tourism economy and regional resilience is in good coordination mode, the industrial level and community level are the main system influencing factors.**

***Keywords*—tourism economy**, **regional resilience**, **coupling coordination degree**, **obstacle factors**

I. Introduction

The word "resilience" means "the ability of people or things to feel better quickly after something unpleasant, such as shock, injury, etc." This concept was first adopted by the physics and then applied to the research in the field of systems ecology. Recently, many scholars began to become interested in the concept of "resilience". With the deepening of research, more and more research fields begin to adopt the concept of "resilience", such as "engineering resilience" (Berkes and Folke, 1998), "ecological resilience" (Carpenter *et al.*, 2001) "evolutionary resilience" (WALKER *et al.*, 2004) and so on. In recent years, due to the continuous emergence of natural disasters and public health problems, the stability of the social system has been affected. Therefore, how to improve the resilience of the city has become a hot topic and it attracts social attention. Regional resilience refers to the ability of urban systems and regions to achieve normal operation of public safety, social order and economic construction by reasonably preparing, buffering and coping with uncertainties and disturbances.

In terms of regional and urban resilience, foreign scholars mainly focus on the theoretical framework construction of urban resilience (Cutter *et al.*, 2008), urban resilience research from the perspective of disasters, urban planning and the improvement path of urban resilience (Dastoorpo, 2016), regional adaptability to climate change (Abdrabo and Hassaan, 2015), etc. Meanwhile, the research on regional and urban resilience has gradually shifted from disaster governance to how to improve regional resilience through effective management (Sitinjak *et al.*, 2018). As the research on regional resilience becomes more and more specific, some scholars begin to take tourism industry and tourism economy as the research objects including exploring the impact of tourism industry in protected areas on communities from the perspective of resilience (Strickland-Munro *et al.*, 2010), the resilience of tourism enterprises when disasters strike(Biggs *et al.*, 2012) and the construction of tourism destination sustainability framework based on resilience building (Calgaro *et al.*, 2014). Research on tourism and tourism economy is becoming more and more in-depth. The overall development trend of tourism is stable and improving. Despite the impact of COVID-19 in 2020 and 2021, tourism and related industries are recovering in an orderly manner so the tourism economy is also recovering.

Studies on the interaction between regional development and tourism economy are becoming more mature. However, scholars mostly study the economic development of tourism areas from the perspective of vulnerability while few scholars combine regional resilience with tourism economy to study the interaction between the two from the perspective of resilience. This paper selects China as the research object and analyzes the coupling relationship between tourism economy and regional resilience. Meanwhile, the passage studies the obstacle factors affecting the coupling coordination degree between tourism economy and regional resilience based on the obstacle degree model.

II. Research Hypothesis and Model Building

A. Research Hypothesis

Referring to the construction method of regional resilience

indicator system (Burton, 2015) and combined with the current development status of China's tourism industry and social various aspects, the paper selects 25 indicators from the economic level, social level, ecological level, industrial level and infrastructure construction level to measure regional resilience. What's more, this passage selects four indicators from the two dimensions of domestic tourism level and international tourism level to establishes an indicator system based on the selected indicator variables. The details are shown in Table 1.

B. Model Building

Table 1. Regional resilience system and tourism economy system

System Layer	Criterion Layer	Weight	Indicator Layer	Nature	Weight
Regional resilience	Economic resilience	0.1976	The value added of the tertiary industry accounts for the proportion of GDP (%)	Positive	0.0173
			Household consumption rate (%)	Positive	0.0292
			The percentage increase of investment in fixed assets (%)	Positive	0.0877
			National income per capita (USD)	Positive	0.0368
			Share of research and development expenditure in GDP (%)	Positive	0.0266
	Community resilience	0.2022	Higher education enrollment rate (%)	Positive	0.0436
			The growth rate of general public budget revenue (%)	Positive	0.0214
			Health technical personnel number per one thousand people (person)	Positive	0.0422
			Proportion of the population under 14 years old (%)	Positive	0.0763
			Unemployment rate (%)	Negative	0.0188
	Industrial resilience	0.2650	Number of employed persons in accommodation and catering industry (ten thousand people)	Positive	0.0508
			Budgetary expenditure accounted for the proportion of transport expenditure (%)	Positive	0.0540
			Number of star hotels (PCS)	Positive	0.0526
			Number of travel agencies (PCS)	Positive	0.0673
			Informatization development index	Positive	0.0405
	Ecological resilience	0.1400	Harmless treatment rate of household garbage (%)	Positive	0.0253
			Investment in completion of industrial pollution control (ten thousand yuan)	Positive	0.0334
			Number of National nature reserves (PCS)	Positive	0.0227
			Forest coverage rate (%)	Positive	0.0265
			Renewable fresh water resources per capita (cubic meters)	Positive	0.0321
	Infrastructure resilience	0.1952	Growth rate of Internet broadband access users (%)	Positive	0.0589
			Length of railway in operation (10,000 km)	Positive	0.0371

			Road area per capita (square meters)	Positive	0.0440
			Growth rate of postal outlets(%)	Positive	0.0298
			Every ten thousand people with the bus (car)	Positive	0.0255
Level of tourism economy	International Tourism	0.3365	Number of international tourists (million people)	Positive	0.1638
			International tourism Revenue (in USD billion)	Positive	0.1727
	Domestic tourism	0.6635	Number of domestic tourists (million people)	Positive	0.3363
			The total cost of a domestic tourism (one hundred million yuan)	Positive	0.3272

III. Research Methods

A. Entropy Weight Method

In this paper, we use the entropy method to determine the weight of each index. The entropy method can judge the dispersion degree of an index and then judge the influence of each index on the comprehensive evaluation. Because there are differences between positive and negative indicators and dimensions, the data of each index is first processed without dimensionalization.

For the positive indicator that the larger the value is, the better the system is:

$$o_{it} = \frac{x_{it} - \min(x_{it})}{\max(x_{it}) - \min(x_{it})} \quad (1)$$

For the negative indicator that the smaller the value is, the better the system is:

$$o_{it} = \frac{\max(x_{it}) - x_{it}}{\max(x_{it}) - \min(x_{it})} \quad (2)$$

where, x_{it} represents the original value of the TTH index of the ith system, o_{it} represents the standardized value of the TTH index of the ith system, $\max(x_{it})$ and $\min(x_{it})$ represents the maximum and minimum values of data.

Information entropy value of the t-th index:

$$e_t = -\frac{1}{\ln n}\sum_{i=1}^{n} p_{it} \ln p_{it} \quad (3)$$

$$p_{it} = \frac{o_{it}}{\sum_{i=1}^{n} o_{it}} \quad (4)$$

Weight of the t-th index:

$$w_{it} = \frac{1 - e_t}{\sum_{i=1}^{n} 1 - e_t} \quad (5)$$

Finally, the comprehensive evaluation scores of regional resilience and tourism economic level are calculated:

$$O_i = \sum_{i=1}^{n} w_{it} o_{it} \quad (6)$$

B. Coupling Coordination Degree Model

Calculation method of coupling coordination degree *C* value: Coupling degree is a method to measure the mutual influence degree of two or more systems under the action of their own and external factors. In this paper, the coupling degree model is used to measure the mutual relationship between the regional resilience and the level of tourism economy.

Calculation method of coupling coordination degree value:

$$C = n \times \left[\frac{O_1 O_2 \ldots O_n}{(O_1 + O_2 + \cdots + O_n)^n}\right]^{\frac{1}{n}} \quad (7)$$

C represents the coupling degree between the regional resilience and the level of tourism economy. Although *C* can reflect the resonance relationship between systems, it is sometimes difficult to reflect the synergistic effect between systems, which means the coupling degree may be exaggerated but the coordination type is poor. Therefore, the coupling coordination degree model is introduced on this basis:

$$D = \sqrt{CT} \quad (8)$$

$$T = \alpha_1 O_1 + \alpha_2 O_2 + \cdots + \alpha_n O_n \quad (9)$$

D represents the coupling coordination degree between regional resilience and tourism economic level; *T* represents the comprehensive coordination index between the two; $\alpha_1\alpha_2$ is the coefficient to be determined, which respectively represents the relative importance of the two subsystems of regional resilience and tourism economic level. Meanwhile, $\alpha+\beta=1$. In this paper, because regional resilience and the level of tourism economy are two equally important subsystems of tourism city development, the two systems are given equal weight. In general, a high value of *D* indicates a high-level mutual promotion relationship between the systems, while a low value of *D* indicates a low-level mutual restriction relationship between the two systems

C. Obstacle Degree Model

This paper introduces the obstacle degree model to evaluate and diagnose the obstacle factors affecting the coupling coordination degree between the regional resilience and the level of tourism economy.

$$U_t = \frac{u_{it} w_t}{\sum_{t=1}^{n} (u_{it} w_t)} \quad (10)$$

$$u_{it} = 1 - r_{it} \tag{11}$$

$$F_t = \sum_{t=1}^{n} U_t \tag{12}$$

where, U_t is the obstacle degree of the TTH indicator to the coupling and coordination between regional resilience and tourism economic level; u_{it} is the deviation degree of indicator, which represents the deviation between the TTH single indicator of the ith subsystem and the development goal. r_{it} is the standardized value of each index; w_t is the weight of t index calculated by entropy method; U_t is the contribution degree of obstacle factor; F_t is the obstacle degree of subsystem to coupling coordination.

D. Data Collection

In order to further study China's regional resilience and tourism economic development level, this paper selects China as the research object and the research data come from the official data such as China Statistical Yearbook, International Statistical Yearbook and UNWTO database.

IV. Analysis of Results

A. Regional Resilience

From Fig. 1, it can be seen that China's regional resilience is in a steady growth trend from 2012 to 2021, increasing from 0.33 in 2012 to 0.56 in 2021. It can be seen that the development of regional resilience is generally good and all levels of society are developing steadily. Despite the outbreak of COVID-19 in 2019, it has had little impact on China's regional resilience.

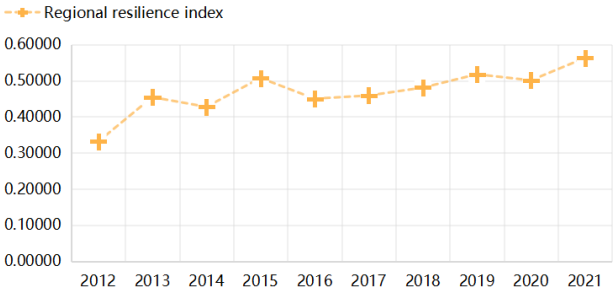

Fig. 1. Regional resilience index.

B. Tourism Economy

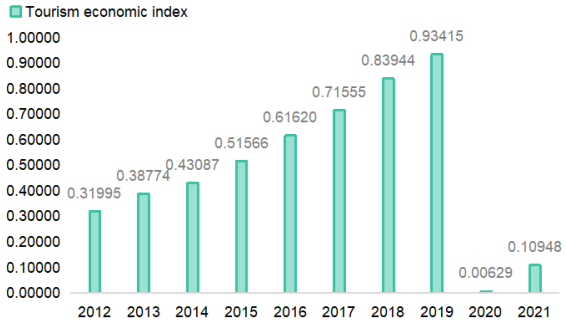

Fig. 2. Tourism economic index.

It can be seen from Fig. 2 that the overall level of China's tourism economy is on the rise with a good growth trend from 2012 to 2019. However, the level of tourism economy from 2020 to 2021 is significantly worse than that of previous years mainly due to the impact of the outbreak of the novel coronavirus at the end of 2019. The number of domestic and foreign tourists has dropped sharply and tourism revenue has also fallen off a cliff. The development of tourism economy has been hit hard.

C. Coupling Coordination Degree

Table 2. Coupling coordination degree of China's tourism economic level and regional resilience

Year	Coupling value	Harmonizing Index	Coupling Degree	Coordination level
2012	0.333	0.176	0.242	3
2013	0.992	0.472	0.684	7
2014	0.999	0.438	0.661	7
2015	0.987	0.651	0.802	9
2016	0.993	0.583	0.761	8
2017	0.967	0.654	0.804	9
2018	0.987	0.766	0.869	9
2019	0.994	0.894	0.943	10
2020	0.231	0.369	0.292	3
2021	0.619	0.554	0.586	6

It can be seen from Table 2 that the coupling coordination degree of China's tourism economic development level and regional resilience from 2012 to 2021 increases from 0.242 in 2012 to 0.943 in 2019, showing a steady growth trend. The reason for the decline in coupling coordination degree in 2020 and 2021 is that the outbreak of the novel coronavirus at the end of 2019 has affected both domestic and international tourism in China. It can be seen from the coordination level that 2012 is moderate incoordination, 2013 and 2014 are primary coordination, while 2015, 2017 and 2018 are good coordination, meanwhile, 2016 is intermediate coordination, 2019 is high-quality coordination and 2021 is barely coordination. According to the coupling coordination degree, this paper classifies the decade into three coordination types for follow-up research. 2012 and 2020 are defined as obvious incoordination type, 2013, 2014, 2016 and 2021 as basic coordination type, and 2015, 2017, 2018 and 2019 as good coordination type. In the next step of this paper, in the study of the obstacle degree factors affecting the coupling coordination degree of tourism economic level and regional resilience. The three coordination types will be compared and analyzed.

D. The Obstacle Factors at the Criterion Layer

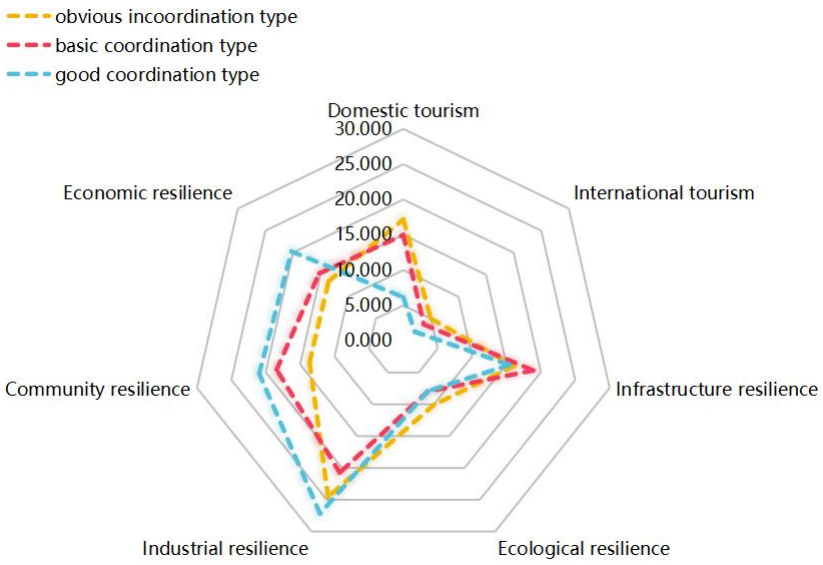

Fig. 3. The proportion of obstacle factors at the criterion layer.

The obstacle factors that affect the coupling coordination degree of China's tourism economic development level and regional resilience can be obtained through the obstacle degree model. Fig. 3 shows the proportion of obstacle factors at the criterion layer that affect the coupling coordination degree of tourism economy level and regional resilience under the three different coordination types. The obstacles are obvious in the resilience of the industry and the level of domestic tourism.

When China is in the basic coordination type, the main influencing factors of the criterion layer are industrial resilience and infrastructure resilience, indicating that when the coupling and coordination degree of ancient urban areas is better, industrial resilience and infrastructure resilience are important hindering factors. When the region is in a good coordination type, the main influencing factors of the criterion layer are industrial resilience and social resilience. It is worth mentioning here that industrial resilience is an important obstacle factor under the three different coordination types.

E. The Obstacle Factors at the Indicator Layer

Table 3. The obstacle factors at the indicator layer

Main Indicator Layer	Obvious Incoordination Type	Basic Coordination Type	Good Coordination Type
The total cost of a domestic tourism	0.085	0.073	0.031
Number of domestic tourists	0.087	0.077	0.031
Number of travel agencies	0.073	0.067	0.059
Number of employed persons in accommodation and catering industry	0.062	0.038	0.066
Proportion of the population under 14 years old	0.043	0.085	0.101
Investment in completion of industrial pollution control	0.054	0.083	0.140
Growth rate of Internet broadband access users	0.059	0.076	0.050

After analyzing the obstacle factors at the criterion layer that affect the coupling coordination degree of China's tourism economy level and regional resilience, this paper further obtains the obstacle factors at the indicator layer. Table 3 lists the main obstacle factors corresponding to the top four of each category. It can be seen that when a region is in obvious incoordination type, that is, when the coordination degree between regional resilience and tourism economy level in China is low, the four indicators that hinder the coordinated development of regions are the total domestic tourism expenditure, the number of domestic tourists, the number of travel agencies and the number of employees in the accommodation and catering industry, indicating that when the coordination degree between regional resilience and tourism economy development is low, focusing on the improvement of these four indicators can effectively enhance the degree of regional coordination.

When the region is in the basic coordination type, the top four main obstacles are the number of domestic tourists, the growth rate of the number of Internet broadband users, the

proportion of the population under 14 years old, and the percentage increase of fixed asset investment. For the well-coordinated years, the number of travel agencies, the number of employees in the accommodation and catering industry, the proportion of the population under 14 years old, and the percentage increase in fixed asset investment are the main influencing factors. Among them, the number of travel agencies and the number of employees in the accommodation and catering industry are the common influencing factors of the obviously uncoordinated type and the well-coordinated type, indicating that in the post-epidemic era, in order to enhance the coordination between regional resilience and tourism economic level. It is more necessary to pay attention to the number of travel agencies and the number of employees in the accommodation and catering industry.

V. Conclusion and Suggestions

China's tourism economy is developing in a good momentum. Although the COVID-19 outbreak at the end of 2019 has had an impact on China's tourism economy, the Chinese government has taken timely measures to promote the recovery of production capacity in various industries, which show the world "Chinese wisdom", and the tourism economy is also slowly recovering.

A. Conclusion

This paper selects potential influencing factors from the five levels of economy, society, industry, ecology and infrastructure to build China's regional resilience system and it can be seen that China's regional resilience has maintained a steady growth trend from 2012 to 2021. In terms of measuring the development level of tourism economy, this paper takes domestic and foreign tourism scale and tourism consumption as the research direction. It is found that the level of tourism economy maintained a good growth trend until the outbreak of the COVID-19. In 2020 and 2021, the tourism economy was seriously affected by the novel corona-virus epidemic. However, the Chinese government also actively promoted the recovery of tourism economy after the epidemic and implemented policies to stimulate residents' consumption.

Secondly, from 2012 to 2021, the coupling coordination degree of China's tourism economy and regional resilience is on the whole in a steady increase trend, but the impact of the novel corona-virus epidemic makes the coordination degree of China's tourism economy and regional resilience significantly decline in 2020. The coupling coordination degree of China's tourism economy and regional resilience recover in 2021.

Finally, according to the research results, there is a synergistic relationship between China's tourism economy and regional resilience. In the past decade, the coupling coordination degree of tourism economy and regional resilience is good in most years, however, there are some years where the coupling coordination degree of tourism economy and regional resilience is slightly poor. When the coupling coordination relationship between China's tourism economy and regional resilience is in an obvious dissonance, the industry level and domestic tourism level are the main system influencing factors. When the coupling coordination between China's tourism economy and regional resilience is in the basic coordination type, the industry level and the infrastructure level are the main system influencing factors. When the coupling and coordination relationship between China's tourism economy and regional resilience is in good coordination type, the industrial level and social level are the main system influencing factors. At the same time, regardless of the coordination type between China's tourism economy and regional resilience, the tourism industry level is the most important systematic influencing factor.

B. Recommendation

It is still of great significance in the current era to explore the coupling coordination degree of China's regional resilience and tourism economy to achieve coordinated development.

Chinese government should consider the following points:

1) The Chinese government and relevant departments, which should continue to maintain the regional industrial, economic and social levels, improve the contribution of ecological resilience and infrastructure resilience to the regional resilience level. It is a good idea to integrate the "resilience" development concept in the process of regional construction, monitor and timely respond to factors that may affect regional resilience and tourism economy and pay attention to regional development weaknesses. According to the specific development situation of our country to plan the corresponding effective construction investment, they should also respond to the development needs of tourism in a timely manner. Especially in the post-epidemic era, the government should pay more attention to the problems and difficulties faced by the tourism industry and consider providing appropriate financial and technical support at critical times to promote the recovery of the tourism industry.
2) The Chinese government may consider formulating and implementing a more comprehensive tourism employment policy and make good use of tax and fee reduction policies to help small and medium-sized tourism enterprises tide over difficulties. In the off-season of tourism, the government and relevant departments should adjust the allocation of resources in a timely manner so as not to waste idle resources in the region. In the tourist season, they should always pay attention to the tourism market to avoid unreasonable increases in prices and accommodation prices in the tourist season. The government should also timely regulate and manage the inadequate market so that both local residents and domestic and foreign tourists who come to travel can be treated equally. Then everyone can receive better experience. It will also make China form a good reputation in tourism, which could further promote the development of China's tourism economy and the improvement of regional resilience.
3) China has a vast territory and beautiful scenery. It also has own culture and unique geographical characteristics so that the government should also grasp its characteristics and create a tourism region with Chinese characteristics. On this basis, propaganda should be

carried out through the network self-media and other forms to grasp the tourism peak after the release of the epidemic. In this way, it can play cultural value and tourism economic value of China's regions. At the same time, it is also necessary to jump out of the restrictions of the "ticket economy" to point to the surface, which means the government should not only pay attention to the construction of the catering industry, accommodation industry and service industry around the tourist attractions, but also keep up with the overall infrastructure construction of the key tourist cities in order to achieve the coordinated development of the tourist attractions.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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