

Coupling Coordination Analysis of Green Tourism - Regional Economy - Regional Logistics

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Abstract. By using the panel data of 30 provinces and cities in China from 2011 to 2021, the entropy weight method, coupled coordination model and obstacle degree model are used to construct the coupled coordination index system of green tourism, regional economy and regional logistics, and explore the spatio-temporal evolution, coupled coordination evolution characteristics and impact factors of different regions. The results showed that: (1) Green tourism and regional economic system showed an overall upward trend, while regional logistics system showed a trend of first increase and then decrease. (2) The coupling coordination degree showed an upward trend, from moderate imbalance to mild imbalance, but the overall coupling coordination degree in the country was not high enough. (3) Total investment of foreign-invested enterprises, express delivery volume, total import and export volume of business units, and total postal business are the main obstacle factors. They are the main obstacle factors of economic development module, regional logistics scale module, economic development scale and logistics infrastructure module respectively.

Keywords: Green tourism, regional economy, regional logistics, coupled coordination.

1. Introduction

The development of green tourism is the general trend of the current tourism industry [1]. The research on the theory and reality of green tourism is of great significance for promoting sustainable tourism development and promoting the realization of economic, environmental and social benefits. However, with the rapid development of green tourism, green tourism faces difficulties such as capital and technology restrictions, lack of tourists' awareness of environmental protection, and imperfect tourism supply chain. In order to solve this problem, focusing on the development of green tourism-related industries, the research finds that the sustainable development of regional logistics and regional economy can drive the vigorous development of green tourism industry. Green tourism will provide a broader market and development space for logistics enterprises by increasing people flow, transportation demand and foreign exchange income. Under the general trend of the industry, The Times require the logistics industry to adopt a more environmentally friendly way to promote its sustainable development. The development of green tourism is expected to become a strong driving force for the logistics industry and bring more opportunities and development for the industry [2]. At the same time, green tourism also plays a positive role in promoting economic development [3]. By driving the development of tourism and promoting the prosperity of local economy, green tourism provides new impetus and opportunities for economic development. The vigorous development of logistics industry and economy also provides infrastructure conditions for the development of tourism. Green tourism, regional logistics and regional economy affect each other [4]. How to actively respond to national policies and drive the overall system of green tourism, regional economy and regional logistics to develop well is a question we need to consider.

Coupling theory is a term used in physics to describe and study the interaction and influence between two or more systems. Through coupling theory, we can quantitatively study the relationship between variables, and then explore the channels to promote the development of green tourism. Many scholars use coupling theory to study the coupling and coordination between green tourism and regional economy. Zheng Boming [5] et al used DEA model to explore the key coupling between tourism economy and regional economy in western provinces. Huang Rongjuan [6] et al. explored

the coupling and coordination between tourism industry and regional economy in Guangxi; Wang Fali [7] et al. explored the coupling coordination degree analysis between tourism industry and regional economy in ethnic areas, especially in Tibet. Bao Jianfei [8] et al. took the Yangtze River Delta urban agglomeration as an example to study the coordination of tourism industry and regional economy. Some scholars have also studied the coupling coordination between green tourism and regional logistics, such as Zhang Kai [9] et al., who constructed the coupling coordination evaluation index system of green tourism economy and regional logistics in Zhejiang Province. Li Linhong et al. [10] conducted an empirical analysis on the coupling and coordination between regional logistics system and green tourism economic system in Yunnan Province. A large number of scholars have also done some studies from the perspective of the coupling of regional logistics and regional economy. For example, Ma Xinchun [11] et al built the measurement index system of logistics and regional economy based on principal component analysis and VAR model. Li Yihua et al. [12] studied the coupling coordination degree of two systems in Hunan province based on models such as entropy method. The above studies all demonstrate the strong pairwise correlation among the three systems of green tourism, regional logistics and regional economy, but they are all conducted from the perspective of a specific region, without coupling analysis at the provincial level in China. For the national provincial perspective studies, they are carried out from the perspective of two of them, such as Cui Liang [13] and Li Xiaomei [14].

Since the 18th National Congress of the Communist Party of China, the Party Central Committee with Comrade Xi Jinping at its core has attached great importance to the construction of ecological civilization. Government departments have issued relevant policies to promote the development of green tourism. Green development has become a widespread consensus in various industries of the national economy, including tourism, and among all sectors of society. This article combines data from 30 provinces and cities across the country to explore for the first time the degree of coordinated development between the tourism industry, economic development level, and ecological environment. Through in-depth research and practice of the principles and practices of green tourism, sustainable development of the tourism industry can be achieved, making it an important force to promote economic growth and drive the development of the logistics industry.

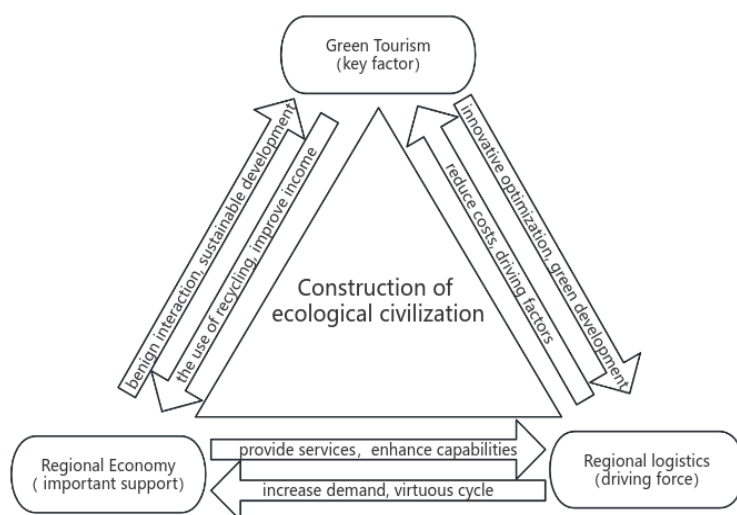


Figure 1. Mechanism Analysis Diagram

2. Research Design and Data Sources Analysis

2.1. Entropy weight method

In this paper, entropy method is used to calculate the weights of green tourism, regional economy and regional logistics index system. The entropy method determines the weight according to the size and variation of the information provided by the observed value of the index, so as to avoid the error

caused by subjective judgment. First, the extreme value of the data is standardized, then the entropy method is used to calculate the weight, and finally the linear weighting method is used to calculate the score value to ensure the scientific rationality of the data analysis results. With reference to relevant literature [15], the specific calculation formula is as follows:

Standardized processing of raw data:

Positive Indicators:

$$x'_{ij} = \frac{x_{ij} - \min(x_{1j}, x_{2j}, \dots, x_{nj})}{\max(x_{1j}, x_{2j}, \dots, x_{nj}) - \min(x_{1j}, x_{2j}, \dots, x_{nj})} \quad (1)$$

Negative Indicators:

$$x'_{ij} = \frac{\max(x_{1j}, x_{2j}, \dots, x_{nj})}{\max(x_{1j}, x_{2j}, \dots, x_{nj}) - \min(x_{1j}, x_{2j}, \dots, x_{nj})} \quad (2)$$

In the formula: x_{ij} is the j index of the i region.

Calculate the characteristic proportion of the i region of the j index:

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

Calculate the entropy value of the j index:

$$e_{ij} = -k \sum_{i=1}^n p_{ij} \ln(p_{ij}), (0 \ll e_j \ll 1) \quad (4)$$

Calculate the difference coefficient of the j index:

$$g_j = 1 - e_j \quad (5)$$

Calculate the weight of item j :

$$W_j = \frac{g_j}{\sum_{j=1}^m g_j}, (j = 1, 2, \dots, m) \quad (6)$$

The comprehensive evaluation model is the weighted summation method of weights and indicators. This paper uses the comprehensive evaluation model to calculate the comprehensive development index of green tourism, regional economy and regional logistics in all provinces and regions in China, so as to evaluate the comprehensive development level among green tourism, regional economy and regional logistics. The specific formula is as follows:

$$U = \sum_{j=1}^m W_j \times X'_{ij} \quad (7)$$

In the formula: W_j index weight; X'_{ij} is the i ($i=1, 2, \dots$) of a province or region, ..., n) and year j ($j=1, 2, \dots, m$) the value obtained after standardization.

2.2. Coupling Coordination Model

The coupled coordination model is usually used to study the development relationship between the two systems. When it is necessary to evaluate the development level of the coupled coordination between the three systems, the calculation method of the coupled coordination model can be improved. The following is the revised formula:

$$C = \left[\frac{X_i \times Y_i \times Z_i}{\left(\frac{X_i + Y_i + Z_i}{3} \right)^3} \right]^{\frac{1}{3}} \quad (8)$$

$$T = \alpha \times X_i + \beta \times Y_i + \gamma \times Z_i \quad (9)$$

$$D = \sqrt{C \times T} \quad (10)$$

In the formula: D is the coupling coordination degree; C is the coupling degree; T is the comprehensive evaluation index of the system development level, reflecting the coupling and

coordinated development level of the system; α , β , γ of undetermined coefficients, $\alpha+\beta+\gamma=1$, the influence of system differences, the reference value of other research [16], take $\alpha=\beta=\gamma=0.33$; X_i , Y_i and Z_i are the comprehensive evaluation indexes of green tourism, regional economy and regional logistics in i respectively.

According to the fuzzy mathematical thought and the concept of coordination development level, the coupling coordination degree can be divided into misalignment, borderline misalignment and coordination [17]. The specific division principles are as follows:

Table 1. Coupling Coordination Development Type and Classification

Coupling Coordination Degree D	Level	Coordination Type
$0 \leq D \leq 0.2$	Severe Imbalance	Dissonance
$0.2 \leq D \leq 0.3$	Moderate Imbalance	
$0.3 \leq D \leq 0.4$	Mild Imbalance	
$0.4 \leq D \leq 0.5$	On the Verge of Dissonance	Coordination
$0.5 \leq D \leq 0.6$	Basic Coordination	
$0.6 \leq D \leq 0.8$	Initial Coordination	
$0.8 \leq D \leq 1.0$	High-Quality Coordination	

2.3. Obstacle Degree Model

This model determines the key factors that hinder the development of the system by calculating the obstacle degree of each influencing factor in the comprehensive evaluation. The obstacle degree of each element is evaluated by calculating the contribution and deviation of each influencing factor to the overall goal, so as to clearly understand the degree of hindrance of different elements to the coordinated and harmonious development of the system [19]. The specific calculation formula is as follows:

$$U_j = \frac{I_j \times F_j}{\sum_{j=1}^m (I_j \times F_j)} \times 100\% \quad (11)$$

In the formula: I_j is the deviation degree of the j index; F_j is the factor contribution degree of the j index. U_j is the obstacle degree of the j index.

2.4. Data Source

Based on the availability and scientificity of data, this paper selects panel data from 30 provinces and regions in China from 2011 to 2021 (lacking Tibet) as samples for research. The data mainly come from *China Statistical Yearbook*, *China Urban Statistical Yearbook*, *China Tourism Statistical Yearbook*, *China Culture and Tourism Statistical Yearbook*, *China Tourism Statistical Yearbook* and *the Statistical Communique of National Economic Development from 2011 to 2021*. A few missing values were supplemented by Bayesian interpolation.

2.5. Evaluation Index System

After data standardization, Bayesian interpolation method is used to predict and complete individual missing data. On the basis of meeting the construction principles of the index system, and referring to relevant research results [18], the coupled and coordinated evaluation index system is constructed considering the development situation and future planning of green tourism, regional economy and regional logistics in Chinese provinces and cities, as shown in Table 2.

Table 2. Coupled and Coordinated Evaluation Index System

System	Indicator Types	Indicator
Green Tourism System	Tourism Basic Module	Number of A-level scenic spots (in individuals)
		Domestic Tourist Arrivals (in one thousands)
		Number of Star-Rated Hotels (in individuals)
	Green Tourism Module	Forest Coverage Rate (%)
		Green Coverage Rate of Built-Up Area (%)
		Per Capita Green Park Area (Square meters per person)
	Economic Benefit Module	Domestic Tourism Revenue (in one hundred million yuan)
		Total Retail Merchandise Sales (in one hundred million yuan)
		Added Value of the Tertiary Industry (in one hundred million yuan)
		Per Capita Disposable Income of All Residents (yuan)
Regional Economic System	Scale of Economic Development	Total Amount of Imports and Exports at the Location of the Business Unit (in one thousand dollars)
		Total Investment of Foreign-Invested Enterprises (in one hundred million dollars)
		Retail Sales Index
	Economic Development Level	Total Retail Sales of Consumer Goods (in one hundred million yuan)
		Per Capita Consumption Expenditure of All Residents (yuan)
		Gross Regional Product Per Capita (yuan of one person)
	Economic Development Potentialities	Industrial Added Value (in one hundred million yuan)
		Added value of the Tertiary Industry (in one hundred million yuan)
Regional Logistics System	Logistics Infrastructure Module	Highway Mileage (kilometers)
		Business Volume of Post Services (in one hundred million yuan)
		Quantity in the Parcel (in ten hundreds)
		Total Length of Post Route (kilometers)
	Regional Logistics Scale Module	Postal Outlets (sites)
		Volume of Freight Traffic (in ten thousands)
		Passenger Capacity (in ten thousands)
		Express Volume (in ten thousand yuan)
	Logistics Development Prospect Module	Number of Staff and Workers (in ten thousands)
		Added Value of Logistics Industry (in one hundred million yuan)
	Investment in Fixed Assets in Logistics Industry (in one hundred million yuan)	
	Freight Turnover (in one hundred million kilometers per ton)	

3. Results and Analysis

3.1. Comprehensive evaluation analysis of subsystem development

The entropy method is used to calculate the comprehensive evaluation value of the three systems of green tourism, regional economy and regional logistics in China and provinces during 2011-2021, as shown in Figure 2. As can be seen from Figure 2, overall, green tourism index, regional economic index and green tourism - regional economy - regional logistics - system comprehensive index all show an overall upward trend, and only regional logistics shows a trend of first increase and then

decrease. Since the reform and opening up, the state has paid attention to economic development, promoted the all-domain development of the tourism industry, and paid attention to the coordinated development of tourism, economic industry and logistics industry, so the comprehensive value index of green tourism, regional economy and system has risen steadily. However, due to the impact of the new coronavirus epidemic, the development trend of the logistics industry is different from that of previous years, which leads to a decline in the coupling coordination index.

From the analysis of each subsystem, the green tourism evaluation index has been higher than other indexes, mainly because the state has issued a number of policies to help the development of green tourism, so that the concept of environmental protection has been deeply popular. At the same time, the Ministry of Agriculture has issued the "Ten models" of beautiful countryside, and government departments have continuously strengthened environmental regulation and environmental technology innovation, and gradually improved environmental protection policies. We will promote the sound development of green tourism. From 2011 to 2017, the regional economic index was lower than the regional logistics index. This indicates that there was a relative lag in regional economic development at that time, which may be because before 2017, China was in a period of rapid economic growth, and the national economic policy mainly focused on GDP growth. However, the provinces and cities pursued economic speed too much and ignored economic quality, so that we did not propose regional economic development policies until relatively late. However, due to the late proposal of this policy, the implementation of policies and measures aimed at improving economic quality in various regions started relatively late compared with other subsystems, which also increased the incoordination of the coupled system to a certain extent. After 2016, the regional logistics index showed a decreasing trend and was lower than the regional economic index in 2017. In 2016, with the in-depth development of e-commerce, Ali, Jingdong and other large e-commerce platforms have a comprehensive ecological mode layout, and logistics supply chain has become the core of e-commerce development. Faced with the change of logistics development pattern, the development direction of logistics industry has been affected, making the regional logistics index decrease. After stabilizing the pattern in 2019, it has been affected by the epidemic. Lead to the regional logistics index in a depressed state.

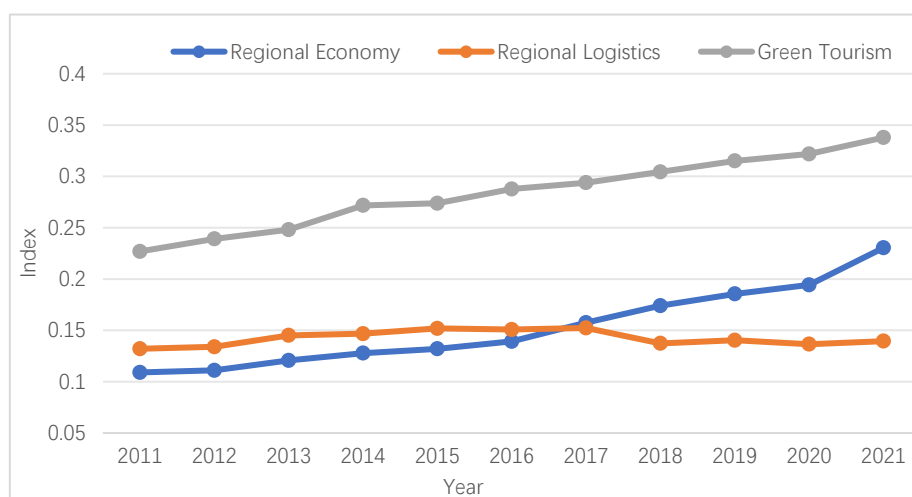


Figure 2. 2011-2021 development index of 30 provinces and cities in China

3.2. Spatiotemporal Evolution Analysis of Coupling Coordination Degree

According to the results of measuring the coupling coordination degree of green tourism, regional economy and regional logistics in China from 2011 to 2021 by using the coupling coordination degree model, this paper divides 30 provinces into four regions, namely, southeast, northeast, central and west, and analyzes the spatio-temporal evolution of the coupling coordination degree. To reveal the coupling relationship between green tourism, regional economy and regional logistics.

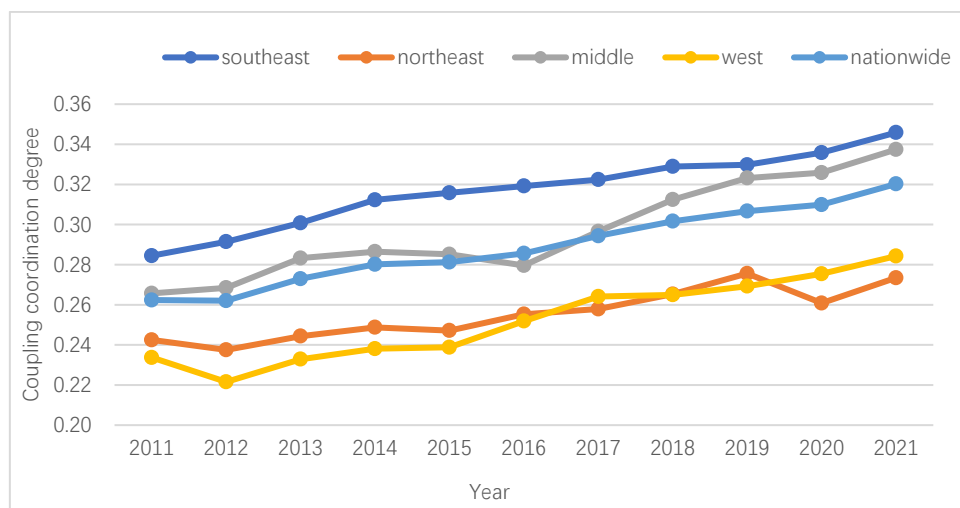


Figure 3. 2011-2021 Coupling coordination degree in 30 provinces and cities

From the perspective of time, the coupling coordination degree of green tourism-regional economy-regional logistics system in 30 provinces and cities shows an overall rising trend. Among them, the coupling coordination degree of provinces and cities was in a moderate imbalance during 2011-2017. The main reason is that the country has not yet introduced perfect measures to promote the development of green tourism in 2011, and the people's awareness of green development is relatively lacking, and the ecological pressure protection pressure is relatively large. Moreover, the regional economy and regional logistics foundation are relatively weak, and they are in the development stage, which cannot be coordinated with green tourism accordingly. Since 2018, the coupling coordination degree of the national provincial and municipal systems has entered a stage of mild imbalance. This is mainly due to two factors: First, the country pays more attention to green tourism, strengthens the protection of the ecological environment, and reduces the impact on the ecological pressure. This makes provinces and cities pay more attention to the protection of ecological environment while developing tourism, thus improving the quality and sustainability of green tourism. Secondly, the regional economy and regional logistics base have been improved to a certain extent. With the development of economy and the construction of infrastructure, the traffic and logistics conditions between provinces and cities have gradually improved, which provides better conditions for the development of green tourism. At the same time, economic growth also provides more support for the development of tourism, so that the coordination degree between green tourism and regional economic and logistics systems has been improved.

In summary, from 2011 to 2017, the coupling coordination degree of the national provincial and municipal system was in a moderate imbalance stage, mainly due to the insufficient attention paid to green tourism, the greater ecological pressure, and the weak regional economic and logistics foundation. Since 2018, due to the increasing importance of the country to green tourism and the improvement of regional economic and logistics foundation, the coupling coordination degree of the national provincial and municipal system has entered the stage of mild imbalance.

From the perspective of space, the spatial distribution of green tourism-regional economy-regional logistics coupling coordination degree showed the characteristics of southeast > central > Northeast > west during the study period. According to relevant research results [20], the eastern region has a strong advantage in promoting the development of green tourism. These regions have a rational and high-grade industrial structure, suitable eco-tourism space and efficient pollutant disposal facilities, which make all aspects of the coupling and coordination, forming a benign feedback mechanism, so that the eastern region of the coupling and coordination degree is the highest. In contrast, the coupling coordination degree in the western region is low, which is mainly affected by the geographical location and natural environment. In addition, the development of tourism in the region is relatively slow, the development mode is relatively extensive, the utilization rate of resources is low, and the relevant policy system is not perfect, and the integration of various industries is not effective enough.

These factors lead to the low development level of green tourism, regional economy and regional logistics coupling coordination degree. The western region still faces some challenges and problems in promoting the development of green tourism. It is necessary to further strengthen policy support and system construction, accelerate the development of green tourism, improve the coupling and coordination degree, and achieve the goal of sustainable development.

3.3. Analysis of Influence Factors

As shown in Figure 3, the index of the green tourism subsystem in the coupled coordination model is significantly higher than that of other systems, and the coupled coordination ability of the green tourism subsystem is higher. Therefore, in the analysis of the influencing factors of coupling coordination, it is necessary to focus on regional economy and regional logistics.

The obstacle degree model is used to evaluate the influence of factors that affect the coupling coordination degree of regional economy-regional logistics, and to improve those factors with greater obstacle intensity, so as to promote the high-quality development of the system. According to the actual situation of regional development, 20 influencing factors such as total retail sales of social consumer goods, added value of the tertiary industry, added value of logistics industry, freight volume and highway mileage are screened out, and the obstacle degree of the criterion layer and indicator layer of coupled coordinated development of 30 provinces and cities in China is estimated from 2011 to 2021.

Based on the evaluation results of the handicap model, The average influence of the factors that affect the coupling coordination degree of regional economy and regional logistics is, in descending order, economic development scale (25.86%), logistics infrastructure (22.84%), regional logistics scale (18.58%), logistics development prospect (8.91%), economic development level (8.75%), and economic development potential (4.93%). In the decade 2011-2021, the main influencing factor has been the scale of economic development. Since 2016, logistics infrastructure barriers have been on the rise. This shows that the scale of China's economic development is constrained by a variety of factors and still faces the problem of uneven scale and speed of development, due to the impact of the complex and volatile international environment and the unexpected impact of the epidemic. As the world gradually enters the era of interconnection and the national economy enters the "new normal", "smart logistics" has become a new model of the logistics industry, and the new logistics industry model will make the infrastructure of the logistics industry keep up with the development of The Times in the early stage of development, resulting in the decline of the benefits of the logistics industry.

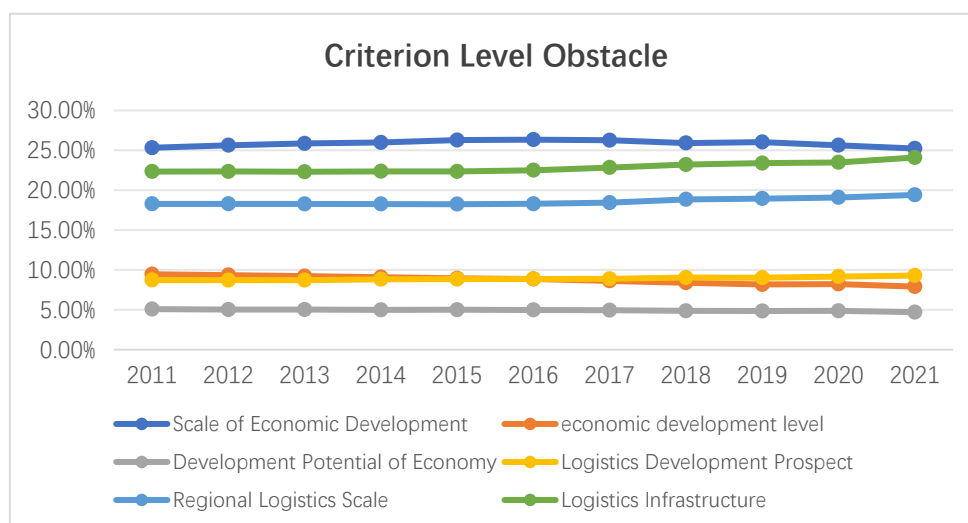


Figure 3. 2011-2021 Coupling coordination degree in 30 provinces and cities

Specifically, the influence factors of different time nodes have different effects on the coupling coordination degree. At the index level, the top four in terms of average influence are: total investment

of foreign-invested enterprises (13.62%), express delivery volume (12.71%), total import and export volume of business units (11.83%), total postal business volume (10.12%) from 2011 to 2020, and the main influence factor is the total investment of foreign enterprises; In 2021, the main influencing factor is the volume of deliveries. This shows that from 2011 to 2020, the uncertainty of the global economic situation has increased, trade frictions and geopolitical risks have intensified, and the uncertainty of foreign investment in China has increased. Foreign investors need to consider market prospects, policy environment, laws and regulations and other factors when making investment decisions. The increase of uncertainty makes them more cautious about investment decisions, and the living environment of foreign investors is restricted, thus restricting the development of regional economy to a certain extent. In 2021, the epidemic has been effectively controlled, and the conditions for foreign investment have gradually recovered, but due to the severe impact of the new coronavirus epidemic on the global economy and trade, it has also had a greater impact on the express delivery industry. China's logistics and transportation network has been damaged to a certain extent, which has affected the normal operation of domestic express business, and the express delivery volume has been greatly affected, resulting in it becoming the biggest impact factor at present. During the study period, the influence of the retail price index on the coupling coordination degree is close to 0, indicating that this factor has no direct influence on the development of the system coupling coordination degree.

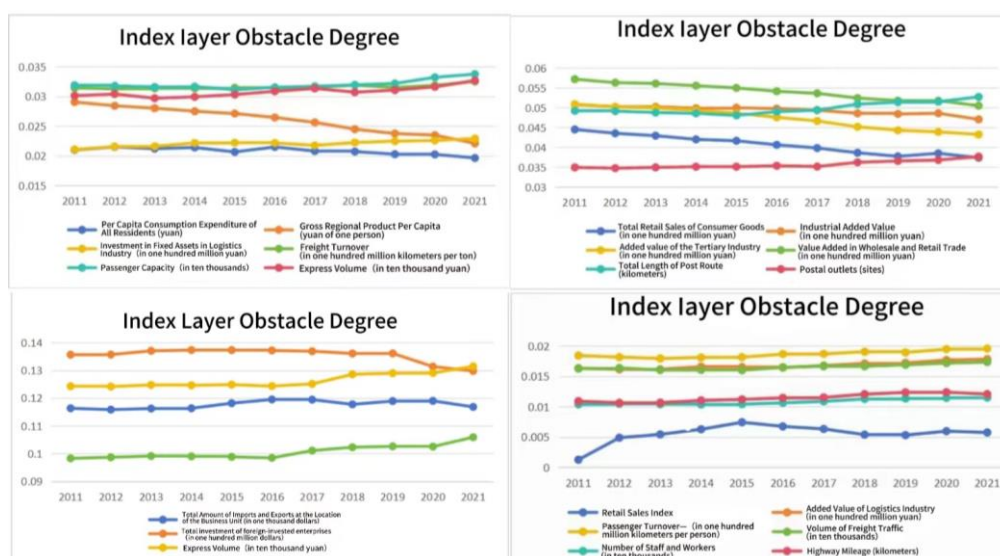


Figure 5. Criterion Level Obstacle Degree

3.4. Conclusion and Prospect

China's tourism and logistics industry has made some progress in the past decade, but it still faces some challenges. However, by promoting the concept of green tourism, promoting the innovation and development of logistics industry, strengthening the coupling and coordination between regions, promoting green and intelligent construction, improving tourism infrastructure, strengthening policy support and legal system construction, and strengthening talent training and skill upgrading, we can further promote the optimization and coordinated development of green tourism, regional economy and regional logistics in China.

In the future, we can expect China's economy and logistics industry to achieve more efficient and convenient logistics transportation under the condition of continuous development of green tourism, and provide greater support for economic development. At the same time, the construction of policy support and regulations will also provide a more stable environment for industrial development. In addition, strengthening talent training and skill upgrading will provide the industry with more high-quality practitioners and promote the innovation and development of the industry.

To sum up, by strengthening the quality improvement of green tourism, promoting the innovative development of regional economy and regional logistics, strengthening the coupling and coordination

between regions, promoting digitalization and intelligent construction, improving tourism and logistics infrastructure, strengthening policy support and regulations, and strengthening personnel training and skills upgrading. We can further promote the optimization and coordinated development of China's green tourism, regional economy and regional logistics. This will make greater contribution to China's sustained economic growth and social prosperity.

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