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STUDY ON COUPLING AND COORDINATED DEVELOPMENT OF TRANSPORTATION, TOURISM AND ECOLOGICAL ENVIRONMENT IN SHANDONG PROVINCE

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ABSTRACT

With the rapid development of transportation and tourism, ecological environment has been paid more and more attention. And the relationship between transportation, tourism and ecological environment has become the focus of attention. It is of great significance to study the coordinated development of the three to promote the coordinated development of Shandong Province. Based on the statistical data of 16 districts and cities in Shandong Province from 2004 to 2018, this paper constructs the index system of transportation, tourism and ecological environment, and analyzes the coupling, coordination and interactive development relationship among them through coupling coordination model and vector autoregressive model. It is found that the transportation, tourism and ecological environment of districts and cities in Shandong Province are developing well, and the coupling and coordination degree of the three systems is higher and higher. Qingdao has the highest coupling co dispatch, while Dongying has the lowest coupling coordination degree. In terms of interactive relationship, there is an interactive relationship among the three systems. And the promotion of transportation and tourism to the ecological environment is more obvious. The results provide theoretical support for the sustainable development of transportation, tourism and ecological environment in Shandong Province.

INTRODUCTION

As one of the three pillars of tourism, transportation is the prerequisite for people to carry out tourism activities, the premise and material basis for the development of tourism, and the important lifeline of tourism development [1]. The development of transportation and tourism has had many impacts on the ecological environment, which makes the sustainable development of tourism and transportation face the constraints of the ecological environment [2]. And its correlation research has been paid more and more attention by relevant scholars. Guo Xiangyang combined entropy weight method and comprehensive efficacy method to measure the comprehensive development scores of tourism economy and transportation in cities and prefectures of Yunnan Province, and applied the coupling coordination model to measure the coupling coordination situation of tourism economy and transportation [3]. Wang Zhaofeng explored the coordinated development of transportation, tourism industry and ecological environment in the middle reaches of the Yangtze River [4]. Tianli uses vector autoregressive model to analyze the dynamic relationship between tourism economy and ecological environment in Southwest China from 1998 to 2018 [5]. Wei Zhenxiang combined coupling degree and PVAR model to empirically analyzed the coupling and interactive development between ecological sustainability and high-quality economic development [6]. Using the coupling coordination degree model, Yu Feifei found that the comprehensive development level of tourism economic system and transportation system in Chizhou has improved steadily since 2002 [7].

Most of the existing studies use the coupling coordination model, which provides an important reference for a deep understanding of transportation-tourism-ecological environment. However, most scholars analyzed two of transportation, tourism and ecological environment, and rarely combine the three, and rarely verify their relationship. Combined with the data of Shandong Province, this paper analyzes the relationship among transportation, tourism and ecological environment in Shandong Province by using the coupling coordination model, and verifies it by using the vector autoregressive model.

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OVERVIEW OF RESEARCH AREA AND DATA SOURCES

Overview of research area
Shandong Province is located in East China, bordering Hebei, Henan, Anhui and Jiangsu provinces. In recent years, Shandong Province has promoted traffic interconnection, promoted the development of global tourism, strengthened pollution prevention and control, and worked hard to achieve sustainable development. In 2019, the province's highway mileage reached 280,325 kilometers, with a total passenger volume of 670 million person times and freight volume of 3.65 billion tons by railway, highway and waterway. In 2019, the total tourism revenue was 1108.73 billion yuan and 938.093 million domestic and foreign tourists were received. In 2019, the comprehensive index of ambient air quality in Shandong Province was 5.42. The map of Shandong Province is shown in Figure 1 below.

Figure 1: Shandong province bitmap.

Data sources
The data in this paper comes from Shandong Statistical Yearbook, statistical yearbooks and statistical bulletins of different districts and cities. For some missing data, interpolation method is used to supplement them. Due to the serious lack of ecological data in 2019, this paper selected the data of 16 districts and cities in Shandong Province from 2004 to 2018 to study.

MODEL AND METHODS

Construction of index system
This paper takes 16 districts and cities in Shandong Province as the research objects, and constructs the coupling coordination model of three subsystems: transportation, tourism and ecological environment. Following the principles of availability of data, representativeness, scientificity and integrity of indicators, and referring to previous scholars' research, 15 indicators were selected from three aspects of transportation, tourism and ecological environment, and the indicator system shown in Table 1 was constructed. Among them, the larger the value corresponding to the positive index, the better, and the smaller the value corresponding to the negative index, the better.

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Table 1: Index System and Weight of Coupling Coordination Degree of Transportation-Tourism-Ecological Environment in Shandong Province.

System	Evaluating indicator	Unit	Weight coefficient	Nature
Traffic system	Highway mileage	km	0.2380	Positive index
	Highway density	km/100km^2	0.2368	Positive index
	Passenger volume	10,000 people	0.1641	Positive index
	Freight Volume	10,000 tons	0.2458	Positive index
	Number of public transport vehicles.	Vehicle	0.1153	Positive index
Tourism system	Number of inbound tourists	10,000 people	0.2022	Positive index
	Number of domestic tourists	10,000 people	0.2067	Positive index
	Inbound tourism income.	10,000 dollars	0.1999	Positive index
	Domestic tourism income.	RMB100mn	0.2132	Positive index
	Proportion of tourism revenue in GDP	%	0.1780	Positive index
Ecosystem	Industrial wastewater discharge	10,000 tons	0.2108	Negative index
	Industrial CO$_{fenchen}$ discharge	tons	0.2456	Negative index
	Industrial dust emission.	tons	0.2424	Negative index
	Harmless treatment capacity of domestic waste	10,000 tons	0.1337	Positive index
	Greening coverage rate of built-up area.	%	0.1675	Positive index

Coupling coordination model

The coupling coordination degree originates from the capacity coupling coefficient model in physics [8], which reflects the degree of mutual cooperation between systems [9]. In this paper, the coupling coordination model [10] is used for reference to construct a function reflecting the coordinated development of the three systems of transportation, tourism and ecological environment.

$$U_i = \sum_{j=1}^{n} w_{ij} \cdot x'_{ij} \quad (i = 1, 2, 3) \tag{1}$$

$$C = 3\left[\frac{U_1 \cdot U_2 \cdot U_3}{(U_1 + U_2 + U_3)} \right]^{\frac{1}{3}} \tag{2}$$

$$T = \beta_1 U_1 + \beta_2 U_2 + \beta_3 U_3 \tag{3}$$

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

U_1, U_2, U_3 represent the evaluation indexes of transportation system, tourism system and ecological environment system respectively. w_{1j}, w_{2j}, w_{3j} represent the index weights of transportation, tourism and ecological environment. It is calculated by entropy weighting method [11]. x_{1j}, x_{2j}, x_{3j} represent the index value of transportation, tourism and ecological environment through dimensionless quantitative treatment [12]. C represents coupling. T represents coordination. D represents coupling coordination degree. β_1, β_2, β_3 represents undetermined coefficient $\beta_1 + \beta_2 + \beta_3 = 1$. The division criteria of coupling coordination degree are shown in Table 2.

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Table 2: Classification of coupling coordination degree.

Coupling coordination degree	[0,0.2)	[0.2,0.4)	[0.4,0.6)	[0.6,0.8)	[0.8,1]
Coordination level	Serious maladjustment	Mild maladjustment	Primary coordination	Good coordination	High quality coordination

Vector autoregression model

In order to further analyze the dynamic interaction among transportation, tourism and ecosystem, this paper constructs a vector autoregressive model (VAR) [13] to calculate and analyze the interaction among the three systems. The model is constructed as follows:

$$Y_t = \alpha + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \qquad (5)$$

α is n×1 constant vector. p represents lag order. A_p Represents n×n coefficient matrix. ε_t represents error term. Y_t represents number of homovariance stationary random processes composed of n×1 vectors. Y_{t-p} is the i-order lag vector of the Y_t vector.

ANALYSIS

Coupling coordination analysis

Using the coupling coordination model, the coupling coordination degree of the three systems of transportation, tourism and ecological environment in all districts and cities of Shandong Province from 2004 to 2018 was calculated.

Figure 2-Figure 5 selects four typical cities, Weifang City, Qingdao City, Dongying City and Dezhou City, to analyze the coupling and coordinated development. Figure 2 shows that the coupling coordination degree of the three systems in Weifang increased at a relatively fast speed from 2004 to 2018. In 2004, it was in a state of mild maladjustment, but with the passage of time, it reached a state of good coordination in 2018, which indicated that the coupling and coordination among the three systems were developing well. The coupling coordination degree of Qingdao is slowly rising, and the coupling coordination degree of the three has changed from primary coordination to good coordination (Figure 3). Figure 4 shows that Dongying City has been in an out-of-balance state from 2004 to 2017, because its transportation and tourism development are relatively lagging behind. It can be seen from Figure 5 that the coupling coordination degree of Dezhou has been on the rise from 2004 to 2008, and its coupling coordination degree has not fluctuated much since 2008, indicating that the development of the three systems is relatively stable.
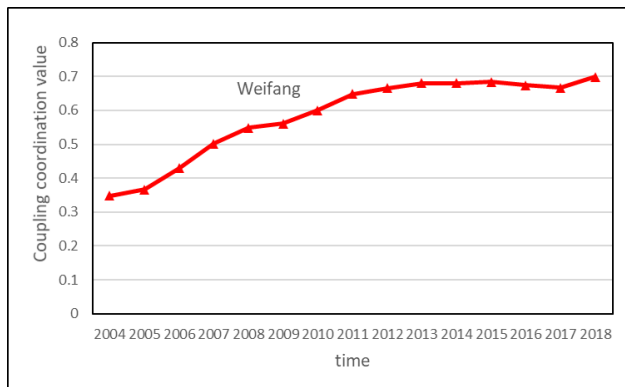

Figure 2. Change trend of coupling coordination degree in Weifang City from 2004 to 2018.
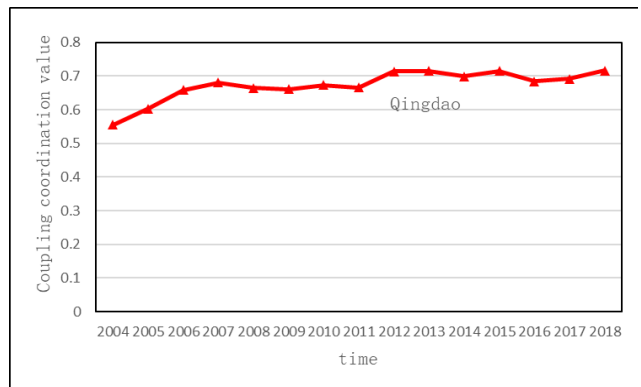

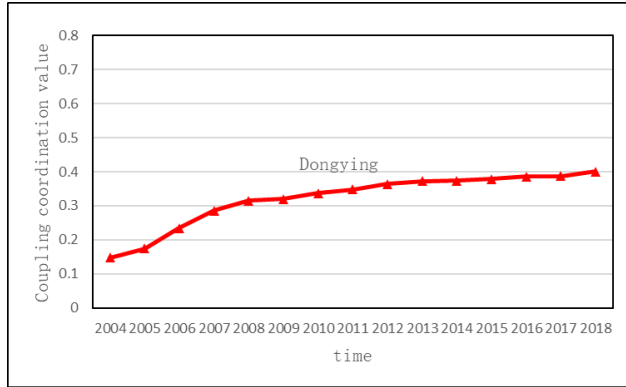*Figure 3. Change trend of coupling coordination degree in Qingdao City from 2004 to 2018.*

Figure 4. Change trend of coupling coordination degree in Dongying City from 2004 to 2018.
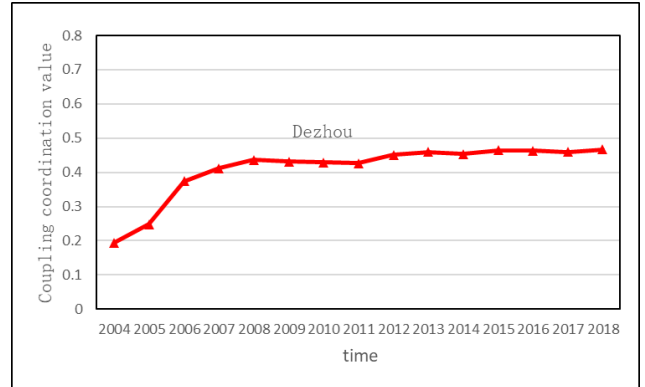

Figure 5. Change trend of coupling coordination degree in Dezhou City from 2004 to 2018.

Figure 6 selected four typical years in 2005, 2010, 2015 and 2018 to analyze the coupling coordination degree of the three systems of transportation, tourism and ecology. It can be seen from Figure 6 that the coupling coordination degree of Qingdao, Yantai, Weifang and Linyi has been at a high level. Among them, Qingdao has the highest degree of coupling coordination, reaching 0.716, which means good coordination. In 2010, the coupling coordination degree of all districts and cities in Shandong Province was greatly improved compared with that in 2005. From 2015 to 2018, the degree of coupling coordination tends to be stable, and all 16 districts and cities in Shandong Province have achieved primary coordination or good coordination. The coupling coordination degree of Dongying City is relatively low, and it has just reached the primary coordination state.
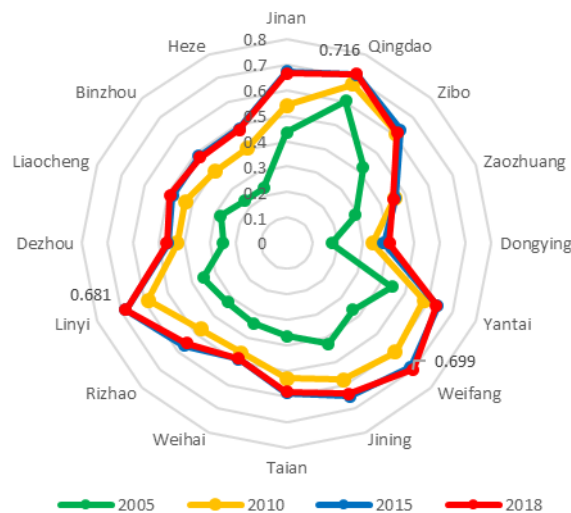

Figure 6: Coupling coordination degree of each district and city in Shandong Province in 2005, 2010, 2015 and 2018.

Interactive relationship analysis

1. Unit root test and determination of optimal lag order

In order to ensure the reliability of the regression results, the unit root test is carried out for the comprehensive indexes of transportation (JT), tourism (LY) and ecosystem (ST). Through the test, it is found that JT, LY and ST have passed the significance level test of 5% after the first-order difference. Therefore, it is considered that JT, LY and ST are first-order single integers and the sequence is stable. The VAR model is established and the optimal lag order is determined to be order 5.

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2. Cointegration test

JT, LY and ST are single integers of the same order and reach a stationary sequence after the first-order difference. Therefore, Johansen cointegration test is selected [14]. The P values of Johansen cointegration test results are less than 0.1, indicating that the original hypothesis of "no cointegration relationship" is rejected and that there is a cointegration relationship, that is, there is a long-term stable equilibrium relationship between the three variables.

3. Granger Causality Test

Granger causality test [15] is used to test the causality among transportation, tourism and ecological environment in Shandong Province. The results are shown in Table 3. The results show that there is a two-way causal relationship between transportation and tourism in Shandong Province, that is, tourism is the reason for the development and change of transportation, and transportation is also the reason for the development and change of tourism; There is also a two-way causal relationship between tourism and ecological environment in Shandong Province, that is, ecological environment is the reason for the development and change of tourism, and tourism is also the reason for the development and change of ecological environment; There is a one-way causal relationship between traffic and ecological environment in Shandong Province, that is, traffic is the reason for the change of ecological environment, but ecological environment is not the reason for the change of traffic development.

Table 3: Granger Causality Test Results.

Original hypothesis	F statistics	P value	Conclusion
LY is not JT's Granger reason	53.70484	0.0000	Reject the original hypothesis at the 1% test level
JT is not LY's Granger reason	31.09262	0.0000	Reject the original hypothesis at the 1% test level
ST is not JT's Granger reason	6.281458	0.2798	Accept the original hypothesis
JT is not ST's Granger reason	9.595016	0.0876	Reject the original hypothesis at the 1% test level
ST is not LY's Granger reason	17.99894	0.0029	Reject the original hypothesis at the 1% test level
LY is not ST's Granger reason	20.96320	0.0008	Reject the original hypothesis at the 1% test level

4. Impulse response analysis

The impulse response function describes the impact of the impact of one variable in the VAR model on other variables [16]. The impulse response analysis results are shown in Fig. 7, Fig. 8 and Fig. 9.
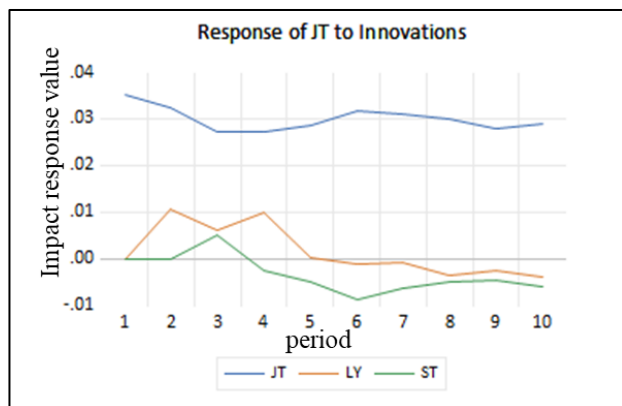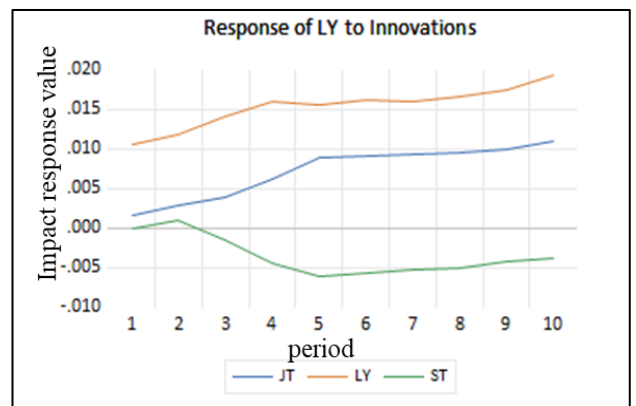

Figure 7 Response of JT to Innovations.

Figure 8 Response of LY to Innovations.

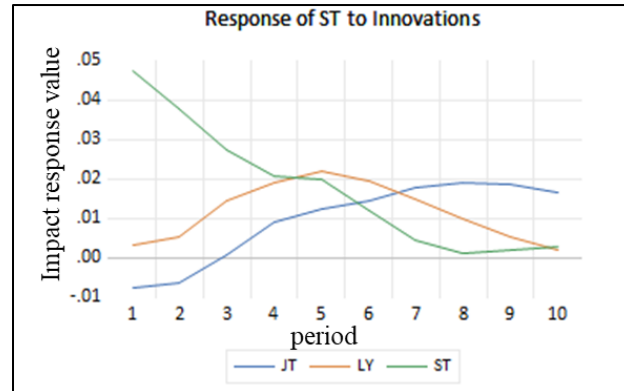Global Journal of Engineering Science and Research Management

Figure 9 Response of ST to Innovations

It can be seen from Figure 7 that after being impacted by one unit standard deviation, the traffic in Shandong Province reached the maximum response value in phase 1, and then fluctuated and decreased, indicating that the development of traffic has a lasting impact on itself. After the positive impact of tourism, the traffic will have a positive effect, while "over tourism" will have a negative effect on the traffic. This shows that in a certain range, the development of tourism plays a certain role in promoting traffic, but "over tourism" leads to excessive traffic pressure, which will have a certain inhibitory effect on traffic. After the traffic is positively impacted by the ecological environment, it reaches the maximum response value in phase 3, and then the response value decreases and shows a negative effect. Generally speaking, the ecological environment has a certain inhibitory effect on traffic, and the inhibitory effect has a lag period.

It can be seen from figure 8 that after tourism is impacted by traffic, its response value first rises rapidly and then rises slowly, indicating that traffic plays an obvious role in promoting the development of tourism. When tourism is impacted by itself, its response value shows an upward trend. After being positively impacted by the ecological environment, tourism has no significant response in the current period, then rises, reaches a positive peak in the second period, then gradually decreases, but continues to show a negative effect. This shows that the ecological environment has an inhibitory effect on the development of tourism, and the inhibitory effect has a certain lag period.

As can be seen from Figure 9, the ecological environment of Shandong Province, after being impacted by one unit standard deviation of transportation, showed a negative effect, turned to a positive effect in phase 3 and showed an upward trend. This shows that the "public transport priority" development strategy adhered to by Shandong Province has achieved results, the travel sharing rate of public transport has increased, traffic has a promoting effect on the ecological environment, and the promoting effect has a certain lag period. The response value of ecological environment to tourism shows a trend of rising first and then decreasing, and reaches the maximum response value in phase 5, indicating that tourism has a certain promoting effect on ecological environment, and the promoting effect is getting smaller and smaller. After the ecological environment is impacted by itself, its response value decreases rapidly and reaches the minimum response value in phase 8, indicating that there is a certain inertia in the development of ecological environment.

RESULTS AND DISCUSSION

Results
This paper analyzes the coupling and coordination relationship of the three systems of transportation, tourism and ecological environment in all districts and cities of Shandong Province from 2004 to 2018, further analyzes the interactive development of the three systems, and obtains the following conclusions:
1. With the passage of time, the coupling coordination degree of transportation, tourism and ecological environment has become stronger and stronger, and has been stable year by year. The 16 districts and

cities in Shandong Province have reached the level of primary coordination or even good coordination. Among them, Qingdao has the highest coupling coordination and has achieved good coordination.

2. Through VAR model, this paper studies the interactive relationship between the three, and finds that there is a long-term and stable relationship among transportation, tourism and ecological environment in Shandong Province. Among them, there is a causal relationship between transportation and tourism, tourism and ecological environment; There is a one-way causal relationship between traffic and ecological environment.

Discission

In order to realize the coordinated development of transportation tourism ecosystem in Shandong Province from primary coordination and good coordination to high-quality coordination, the following suggestions are put forward:

1. We will promote the construction of a strong transportation Province, improve transportation infrastructure, eliminate transportation equipment with high energy consumption and low efficiency, and promote new energy and intelligent transportation technology and equipment. At the same time, we should also improve the level of transportation services, strengthen the treatment of urban traffic congestion, and reasonably guide individual motorized travel, so as to enhance people's happiness and satisfaction.

2. Seize the opportunity of tourism development. Optimize the tourism structure. Explore the tourism market. Integrate offline tourism resources through the Internet. And innovate the tourism development model. Pay attention to the protection of tourism resources. Develop tourism resources at different levels and periods, to achieve sustainable development of tourism.

3. While developing economy, we should also pay attention to the protection of ecological environment. Strengthen energy conservation and emission reduction, promote green and low-carbon development, strengthen environmental infrastructure construction, promote ecological restoration, to create a beautiful and green environment in Shandong.

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