

Research on the Coordinated Development of Beijing-Tianjin-Hebei Port-Hinterland Economy

Hongqi Hui¹, Yunqi Hao^{2,*}

^{1,2}School of economics and management, Hebei University of science and technology, Shijiazhuang, China

*Corresponding author. Email: 1354743249@qq.com

ABSTRACT

In order to accurately measure the degree of coordinated development between the ports of Beijing-Tianjin-Hebei and the regional economy, this paper analyzes the mutual influence between the two based on the econometric model, and uses variable parameter membership functions to calculate the degree of coordination between ports and cities. Taking the four ports of Qinhuangdao Port, Tangshan Port, Huanghua Port, Tianjin Port and their immediate hinterland as the research objects, data from 2007 to 2018 as a sample, 12 indicators selected for empirical research. The study concludes that the Beijing-Tianjin-Hebei ports have a long-term relationship with the hinterland economy; Qinhuangdao and Tianjin port cities have a low coordination degree or even inconsistencies; Tangshan and Cangzhou port cities have a stable coordination degree and a good development momentum. Finally, three targeted improvement measures are proposed to provide important practical value for strengthening the joint development of Beijing-Tianjin-Hebei Port and City.

Keywords: measurement model, membership function, coordinated development

1. INTRODUCTION

As an important economic circle in the country, the Bohai Rim Economic Circle plays an irreplaceable role. The construction of the Xiongan New District has pushed the Beijing-Tianjin-Hebei Metropolitan Circle to a higher level of development. As the eastern coastal area, the development of ports in Beijing-Tianjin-Hebei It also plays a pivotal role. According to statistics from the Ministry of Transport of China, among coastal ports in 2019, Tangshan Port in Hebei Province has a total throughput of 665.74 million tons, ranking third in the country; Huanghua Port has a throughput of 287.61 million tons, ranking tenth; Qinhuangdao Port has a throughput of 218.8 million tons, ranking tenth 5. Tianjin Port handled 492.2 million tons, ranking sixth. In general, Tianjin-Hebei ports have a total throughput of 1,655.3 million tons, accounting for about 40% of the throughput of the Bohai Rim Economic Circle and 18% of the national coastal port throughput, which is similar to last year. However, the economic development of Tianjin and Hebei has been sluggish in recent years. How to make good use of the port, strengthen the linkage between the port and the city, and expand the trade economy is a question that needs urgent consideration. For regions, properly handling the relationship between port development and economic growth will help attract capital and expand the scale of port development, which will drive economic growth in foreign trade, and will also bring greater benefits to regional employment and industrial structure transformation; Nationally, exploring the relationship between ports and the economy is conducive to increasing overseas trade and transportation, achieving

deeper reforms and opening up, and consolidating the status of a maritime power and the world's second largest economy. Therefore, studying the objective connection between ports and economic development and discovering its shortcomings will have practical guiding significance for a period of time in the future.

2. LITERATURE REVIEW

Many domestic experts and scholars have conducted various studies on the relationship between the port and the hinterland. Experts and scholars have studied the connection between port logistics and the hinterland the most: Guo Zixue et al. (2019) [1] Taking Tangshan Port as an example, they studied the relationship between port logistics and the coordinated development of the economy, and believed that the improvement of port logistics and economic coordination depends on each The interaction of subsystems. Zhou Ning (2016) [2], Yang Yan (2017) [3], Li Daqing (2017) [4] In the context of national development strategies such as the One Belt One Road, they analyzed the policy support for the development of port logistics and believed that port logistics is This mutual promotion and mutual support exists in the hinterland. Researchers not only start with port logistics, but also conduct research from the entire port area or port-related industries: Wang Bailing et al. (2018) [5] through macro studies, found some problems in the integration of my country's port resources, and believed that there are only resources Only by rationally integrating the division of

labor can the overall coordination of the port and the hinterland be achieved. Li Fengyue et al. (2016) [6] took Keihin Port and Hanshin Port in Japan as the research objects and found that the manufacturing industry in the port area of Japan has a significant effect on local economic development, providing development ideas for the industrial linkage between my country's ports and hinterland. In terms of the coordinated development of ports and the economy, Ye Lei et al. (2018) [7], Meng Feirong et al. (2017) [8], Zhu Yan (2015) [9] and other scholars conducted case studies on different regions and proposed corresponding Countermeasures.

Quantitative research using mathematical models to solve port-city coordination issues: Yang Liuxing et al. (2016)[10], Xiong Yongqing et al. (2017)[11] Using econometric models, the study found that port throughput best reflects port development and GDP best reflects The level of economic development, and there is a dynamic relationship and interaction mechanism between the two. Cao Feng (2019)[12], Cao Bingru et al. (2019)[13] use panel data, gravity model, Haken model to study the relationship between the port and the hinterland economy, and conclude that the increase in port throughput contributes to the foreign trade economy The development of foreign trade economy will promote the construction of ports, so the promotion between systems is considered to be a two-way and virtuous circle.

To sum up, a large number of literature studies have concluded that the port and the hinterland are closely related, and there is a coupling and synergy relationship. The port-city linkage can promote the common development of both parties. For the Beijing-Tianjin-Hebei port group in the literature, there are few comparative studies among similar ports, and the coordination degree model used is relatively single. Therefore, based on the existing research, this paper uses an econometric model to empirically study the relationship between the Beijing-Tianjin-Hebei ports and the hinterland economy. Use the coordination model of membership function to analyze the coordination degree between Beijing-Tianjin-Hebei ports and hinterland, and put forward corresponding countermeasures and suggestions based on the actual development of the ports.

3. MODEL ESTABLISHMENT

3.1. Measurement Model

The vector autoregressive model (VAR) is the most important application in econometrics and an important tool for solving time series problems. This model can be used to analyze and predict the relationship between time series that have a certain connection, and it can also analyze the relationship between variables Therefore, the model is suitable for the study of the relationship between the port and the hinterland.

3.2. Coordination Model

At present, most scholars are not very rigorous in calculating the coordination degree of the composite system of the port and hinterland, because they ignore the influence of the development of a single system on the complex system. In this paper, the θ parameter is added to the coordination degree model, which can more accurately reflect the impact of the change of a single system on the entire system, that is, only when any subsystem has development in the same year, can the entire composite system be truly coordinated in that year.

3.2.1. Calculation of the order degree of the order parameter of the subsystem

Because the unit of each order parameter is not uniform, the data needs to be dimensionless processed: $R_i = \frac{e_{ji} - \bar{e}_{ji}}{\sigma_i}$, where \bar{e}_{ji} is the mean and σ_i is the standard deviation. Define the order degree of the order parameter of the subsystem:

$$X_{ij} = \begin{cases} \frac{x_{ij} - \beta_{ij}}{\alpha_{ij} - \beta_{ij}}, x_{ij} \text{ has a positive effect} \\ \frac{\alpha_{ij} - \beta_{ij}}{\alpha_{ij} - \beta_{ij}}, x_{ij} \text{ has a negative effect} \end{cases} \quad (1)$$

X_{ij} is the order degree of the order parameter of the subsystem, x_{ij} is the standardized value of the i index, and α_{ij}, β_{ij} belongs to the upper limit and lower limit of the i index of the subsystem respectively.

3.2.2. Subsystem order degree calculation

In this paper, the entropy method and linear weighting method are used to calculate the order degree of the subsystem:

$$X_i = \sum_{j=1}^n \omega X_{ij} \quad (2)$$

X_i is the order degree of subsystem, and ω is the weight

3.2.3. Calculation of coordination degree of composite system

At the initial t_0 . Let the order degree of the subsystems in

the composite system be $X_1^0, X_2^0 \dots X_n^0$; When the

system evolves to t_1 , the order of the subsystem becomes $X_1^1, X_2^1 \dots X_n^1$. If $X_1^1 \geq X_1^0, X_2^1 \geq X_2^0 \dots X_n^1 \geq X_n^0$ are established at the same time, then this composite system is called coordinated development, and the calculation formula is:

$$T(t) = \theta \sqrt{|[X_1^1 - X_1^0][X_2^1 - X_2^0] \dots [X_n^1 - X_n^0]|} \tag{3}$$

$$\theta = \frac{\min[X_n^1 - X_n^0]}{|\min[X_n^1 - X_n^0]|} \neq 0$$

The main function of the adjustment parameter θ is that if and only when $X_n^1 \geq X_n^0$ is established, that is, the order of each subsystem at t_1 is greater than the order at time t_0 , the entire composite system can be truly coordinated, and θ is added. It can effectively prevent the "false coordination" of the composite system.

Table 1 Unit root test

Sequence	ADF test value	Critical value (5%)	P value	Difference times	Conclusion
LNTTL	-2.351855	-3.508508	0.3990	0	unstable
LNGDP	-6.531463	-3.510740	0.0000	0	unstable
D(LNTTL)	-1.718433	-4.165756	0.7273	1	stable
D(LNGDP)	-6.430365	-2.926622	0.0000	1	stable

4.1.2. Cointegration, causality test

The results show that the Prob value of None is less than 0.05, which indicates that the null hypothesis is rejected, indicating that there is at least one cointegration relationship between port logistics and the hinterland; the Prob value of Atmost1 is greater than 0.05, which indicates

Table 2 Cointegration test results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.807227	20.90545	15.49471	0.0069
Atmost1*	0.358730	4.443052	3.841466	0.0350

Tracetest indicates 2 cointegrating eqn(s) at the 0.05 level

4. EMPIRICAL RESEARCH

4.1. Measurement Model Calculation

In order to analyze the causal relationship between the Beijing-Tianjin-Hebei ports and the hinterland, the throughput (TTL), which represents the development level of the port, and the GDP, which represents the development level of the hinterland, are selected as indicators for quantitative analysis [10-11].

4.1.1. ADF unit root test

Take the logarithm to obtain LNTTL and LNGDP respectively. The test results show that at the 5% level of significance, the original sequence LNTTL and LNGDP are non-stationary sequences, while the first-order difference sequence is a stationary sequence (Table 1), which finally shows that the model is stable.

that there is at least one cointegration relationship that accepts the null hypothesis (Table 2); The Granger causality test of the variables (Table 3) found that the P values are all below 0.05, indicating that the port throughput and the hinterland economy have a long-term relationship and a two-way causal relationship. Changes in either side will affect the other.

Table 3 Granger Causality Test Table

Dependent variable:LNGDP			
Exclusion	Chi-square statistics	df	Prob.
LNTTL	9.112438	1	0.0025
Dependent variable:LNTTL			
Exclusion	Chi-square statistics	df	Prob.
LNGT	101.8953	1	0.0000

4.1.3. Impulse response diagram

Impulse response is used to analyze the impact of a variable and the current and future impact of other related

variables. This model selects 12 periods as the research, representing 12 months (Figure 1).

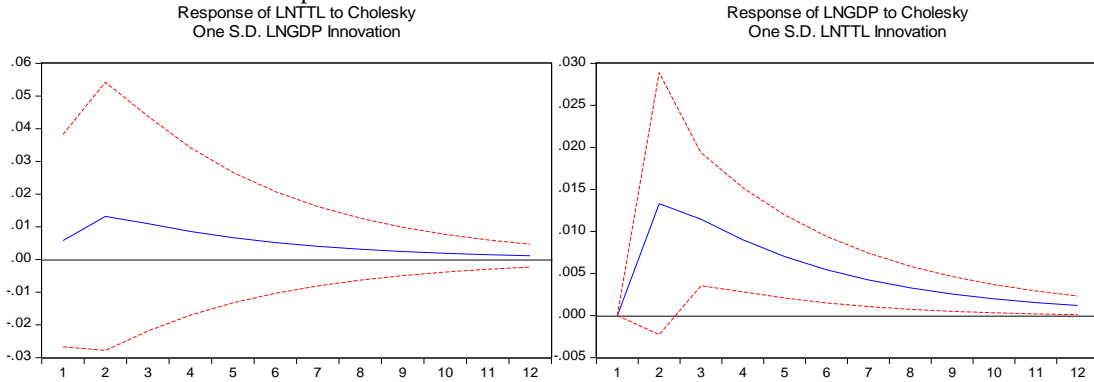


Figure 1 Impulse response function graph

On the left is the impact of GDP shock on throughput. The impact increased from the first period and reached its peak in the second period. Then, as the number of periods increased, the response weakened and gradually stabilized. On the right is the impact of throughput shocks

on GDP. The impulse mechanism is similar to that on the left. The early response starts to increase and reaches its peak, and then gradually stabilizes as the number of periods increases.

4.1.4. Analysis of variance

Variance decomposition reflects the degree of different impacts on endogenous variables, and can more clearly see

the changing trends and connections between variables (Table 4).

Table 4 Analysis of variance table

Period	Variance decomposition of LNGDP			Variance decomposition of LNTTL		
	S.E.	LNGDP	LNTTL	S.E.	LNGDP	LNTTL
1	0.044407	100.0000	0.000000	0.054023	1.146021	98.85398
2	0.047193	92.05226	7.947738	0.066949	4.615735	95.38426
3	0.048794	87.05302	12.94698	0.073633	6.033398	93.96660

4	0.049741	84.26595	15.73405	0.077394	6.692661	93.30734
Table 4, cont						
5	0.050306	82.67573	17.32427	0.079583	7.035137	92.96486
6	0.050644	81.74753	18.25247	0.080878	7.224908	92.77509
7	0.050848	81.19794	18.80206	0.081652	7.333965	92.66604
8	0.050971	80.86973	19.13027	0.082116	7.397961	92.60204
9	0.051045	80.67273	19.32727	0.082396	7.435977	92.56402
10	0.051090	80.55411	19.44589	0.082565	7.458724	92.54128
11	0.051117	80.48255	19.51745	0.082667	7.472394	92.52761
12	0.051133	80.43934	19.56066	0.082728	7.480631	92.51937

On the left side of the table, the economy of the first period is only affected by itself. From the second period onwards, it is affected by throughput, and then grows rapidly. By the sixth period, the economy is basically stable. The economy of the whole period is affected by about 20% of the port; The throughput of the first phase was affected by the economy, and then increased until the fifth phase was

basically stable, and the port was affected by about 8% of the economy throughout the period. Through the analysis of the model, it shows that there is an inevitable connection between the port and the hinterland economy, and the influence in the early stage is gradually increasing, and the influence is basically stable in the sixth stage.

4.2. Calculation of Coordination Degree of

Composite System

Regarding the port and hinterland as a composite system, the port and hinterland are its subsystems. Each subsystem contains many order parameters, so the choice of order parameters determines the accuracy of the research

problem. This article selects 6 order parameters for each subsystem according to the scientific, accurate, and practical choices, and uses the entropy value Method to determine the weight of each order parameter (Table 5).

Table 5 Indicator system for coordinated development of ports and hinterland

Port system	Weights	Economic system	Weights
Wharf length	0.1125	GDP	0.1560
Length of production terminal	0.1149	The total retail sales of social consumer goods	0.2350
Number of 10,000-ton berths for production	0.1138	Foreign direct investment	0.1210
Number of berths for production	0.1053	GDP of the tertiary industry	0.1186
Port cargo throughput	0.2497	Whole society fixed asset investment	0.1996
Container cargo throughput	0.3038	Public budget revenue	0.1698

Take the order degree of the subsystem as the intermediate variable, apply formula (3) to calculate the synergy degree

of the composite system, and the calculation result is shown in (Figure 2)

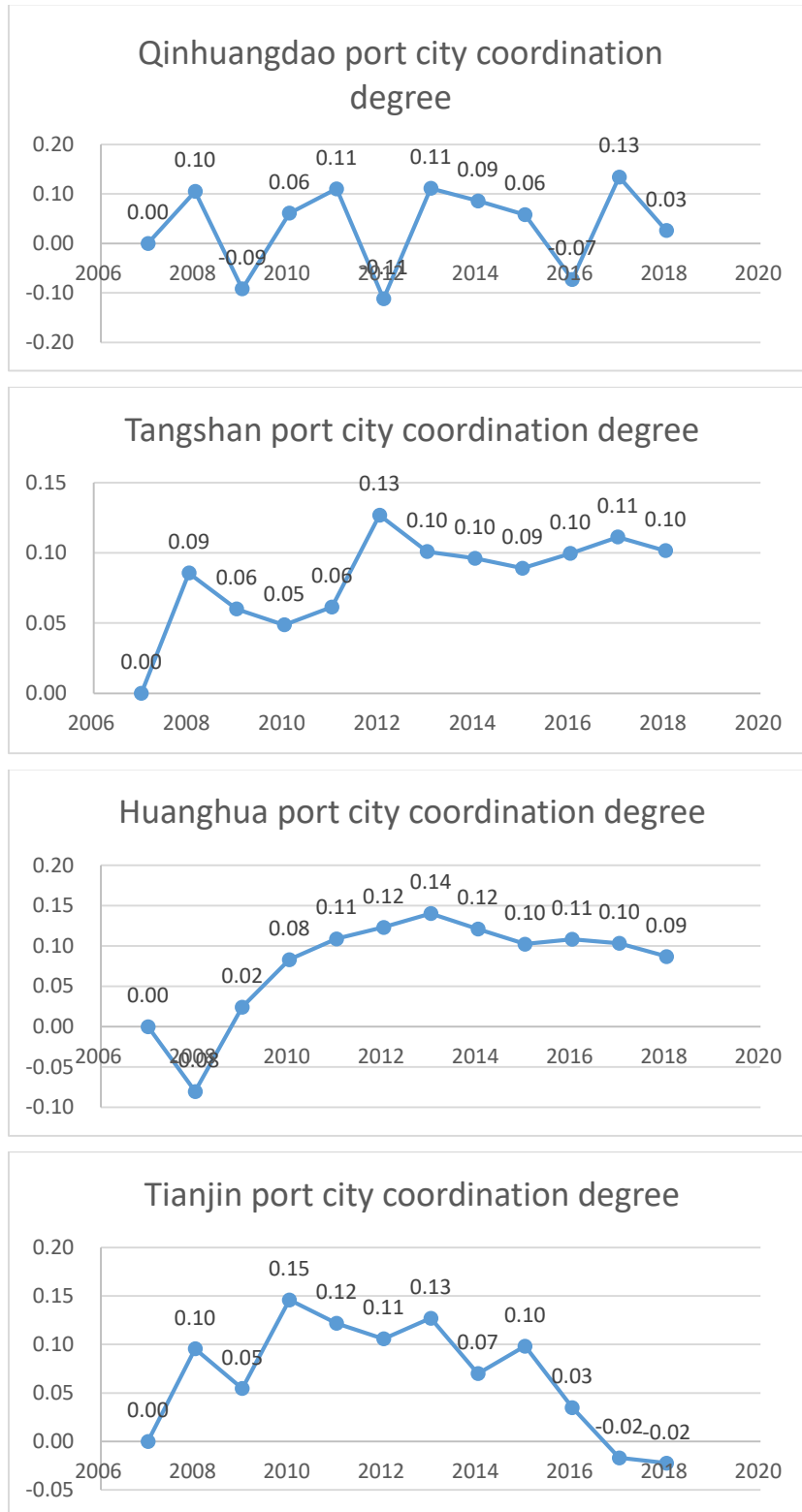


Figure 2 Port-Hinterland Economic Coordination Changes

Although the order of the subsystems has been increasing, the addition of adjustment parameters may lead to uncoordinated composite systems. This is because the function of the parameter is that only when the order of any

subsystem is greater than the order of the previous year at the same time in the next year, the entire composite system is considered to be truly coordinated. The greater the positive value, the greater the coordination degree of the

composite system; when a negative value appears, it means that a certain subsystem in the composite system has not been developed compared to the previous year, that is, the composite system is considered uncoordinated.

Qinhuangdao's coordination degree is wavy and negative, mainly due to the incoordination caused by the large economic fluctuations in the hinterland; Tangshan's coordination degree was the highest in 2012, and the coordination degree has declined since then, but it has maintained a stable trend. Uncoordinated; before 2012, the coordination degree of Cangzhou increased, and then the coordination degree began to decline; Tianjin in the past two years, the development of subsystems has been slow or even stagnant, and the phenomenon of unbalanced development has appeared, so the coordination degree has become negative. On the whole, Tianjin-Hebei port logistics and the hinterland economy have developed slowly, and both are in a state of very low coupling. The two subsystems have not shown a steady growth trend and mutual promotion. Any problem in any subsystem will have an impact on the whole, so ensuring the simultaneous development of ports and hinterland will be the focus of future research.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Research Conclusion

Qinhuangdao Port and Tianjin Port, as national-level ports, have developed slowly or even stagnated in recent years. The fluctuations and instability of the port and hinterland subsystems have led to stagnant or uncoordinated development of the composite system. Countermeasures have been taken to coordinate the development of the port and hinterland economy. Tangshan Port and Huanghua Port, as regional ports, have grown rapidly in recent years and played an increasingly important role in the hinterland, though the coordination degree is low. Active measures should be taken to improve coordination.

5.2. Countermeasures

5.2.1. Clarify the division of port functions

The Beijing-Tianjin-Hebei port is a national strategic port under the "Belt and Road" initiative and also serves as an outlet for the "Xiongan New Area". Clear division of port labor and strengthening of port cooperation are the top priorities. Affected by the national environmental protection policy, the amount of coal transported by land has declined, and the volume of the Daqin and Shenhua lines has recovered. Therefore, the coal throughput of Qinhuangdao Port and Huanghua Port has continued to rise; the eastern Hebei region is rich in mineral resources, so the

transportation of metal ore in Tangshan Port takes Larger proportion; Tianjin Port, as a comprehensive port, has more balanced cargo transportation types. Each port should carry out dislocation development in accordance with its location and policy advantages, transform from a relationship of "resource competition" to an effective interaction of "mutual benefit and win-win", so as to maximize the use of their respective resources to drive overall development.

5.2.2. Promote port-hinterland industry linkage

The strengthening of ports and surrounding facilities will drive the development of port-side industries such as logistics and equipment manufacturing. The expansion and development of port-side industries will drive the optimization of the entire hinterland economic structure, which is an important way for the economic development of coastal cities. All ports should actively respond to the country's call to adapt to the "One Belt One Road" as a basis, and carry out industrial adjustments along the port and hinterland to adapt to the functions of the port. On August 26, 2019, the four free trade zones in Hebei were established, marking that Hebei will have closer ties with other regions. As a direct economic hinterland of the port, it will attract more overseas investment and the port will also face more trade exchanges. It also promotes the development of modern service industries, high-tech industries and other tertiary industries. The development of new industries will impact the existing economic structure. The hinterland should actively adjust the industrial structure under the premise of ensuring the development of advantageous industries, so that "ports are used for cities". "Building cities with ports" has gradually become a reality.

5.2.3. Exert the cluster effect

Although Hebei Port and Tianjin Port are geographically close, they belong to different operators, and it is difficult for operators to coordinate and unify for their own development needs. Intricate routes, difficult management, unsmooth information exchange, and unreasonable resource allocation have made it difficult for ports to take advantage of clusters. We should learn from the excellent experience and cases of international or domestic port clusters, accelerate the integration of port cluster resources, strengthen information exchanges while each port is responsible for what they are good at, expand their business scope and capabilities, and maximize the use of resources and equipment, Promote sustainability, and at the same time use the construction of port clusters to attract capital, promote industries, and stimulate the economy, so that both port trade and hinterland will develop "high-efficiency" and "high-quality".

REFERENCES

- [1] Guo Zixue, Zhang Yahui. Research on the coordinated development of Tangshan Port's port logistics and hinterland economy [J]. *Journal of Hebei University (Philosophy and Social Sciences Edition)*, 2019, 44(02): 80-86.
- [2] Zhou Ning. The influence mechanism of port logistics on economic growth and sustainable development countermeasures [J]. *Reform and Strategy*, 2016, 32(12): 40-42.
- [3] Yang Yan. Research on the coordinated development of Jiangsu port logistics under the national development strategy [J]. *Business Economics Research*, 2017(18): 80-81.
- [4] Li Daqing. Discussion on the coordinated development of port logistics and cities in Liaoning under the "One Belt One Road" environment [J]. *Business Economics Research*, 2017(22): 163-165.
- [5] Wang Bailing, Zhu Fangyang. The new trend of the integration of port resources in my country and its economic effects [J]. *Guangxi Social Sciences*, 2018(09): 73-77.
- [6] Li Fengyue, Li Bo. Japanese port area economic development experience and its enlightenment to my country [J]. *Pacific Journal*, 2016, 24(08): 95-104.
- [7] Ye Lei, Jiao Huafu, Cao Xianzhong. Evaluation and countermeasures of the coordinated development of port energy level and urban economy: A case study of 5 cities along the Yangtze River in Anhui Province [J]. *World Geographical Research*, 2018, 27(02): 76-84.
- [8] Meng Feirong, Gao Xiuli. Research on the Coordination Degree of Port and Direct Hinterland Economic Coupling and Its Influencing Factors: A Case Study of the Port Group around the Beibu Gulf [J]. *Geography and Geo-Information Science*, 2017, 33(06): 94 -100+127.
- [9] Zhu Yan. The role of the government in the development of the joint development of port clusters: Taking Shandong Peninsula port clusters as an example [J]. *Chinese Administration*, 2015(04): 153-154.
- [10] Yang Liuxing, Tian Guiliang, Wang Jue. An Empirical Study on the Influence of Seaports on Hinterland Based on VAR Model: Taking Lianyungang Port as an Example [J]. *Management Review*, 2016, 28(09): 250-259.
- [11] Xiong Yongqing, Xu Zhihong. Research on the interactive development mechanism of ports and port cities on the Maritime Silk Road [J]. *Finance and Economics Theory and Practice*, 2017, 38 (01): 128-133.
- [12] Cao Feng. Regional economy and port coordination under the background of "One Belt and One Road"—An empirical analysis based on the Haken model [J]. *Business Economics Research*. 2019(14): 157-160.
- [13] Cao Bingru, Fan Xin. Research on the coordinated development of port logistics and hinterland economy——Taicang Port as an example [J]. *Geography and Geo-Information Science*, 2019, 35(05): 126-132.