Competitiveness analysis of China's main coastal ports

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Abstract: As a big trading power, China's main mode of transportation of international trade goods is sea transportation. Ports play an important role in China's economic development. Therefore, improving the competitiveness of coastal ports is an urgent problem facing the society at present. This paper selects 12 relevant indexes to establish a relatively comprehensive evaluation index system, and uses factor analysis and cluster analysis to evaluate and rank the competitiveness of China's 30 major coastal ports.

1. Introduction

Port is the gathering point and hub of water and land transportation, the distribution center of import and export of industrial and agricultural products and foreign trade products, and the important node of logistics. With the continuous innovation of transportation mode and the rapid development of science and technology, ports play an increasingly important role in driving the economy, with increasingly rich functions and more important status and role. Meanwhile, the competition among ports is also increasingly fierce.

In recent years, with the rapid development of China's economy and the promotion of "the Belt and Road Initiative", China's coastal ports have also been greatly developed. China has more than 18,000 kilometers of coastline, with superior natural conditions. With the introduction of the policy of reformation and opening, the human conditions are also excellent. By the end of 2017, the number of China's coastal ports has reached 150, the number of production of specialized berths has come to 5830, and the number of berths of ten thousand ton class and above has reached 1948. The cargo of China’s coastal port has reached 9 billion tons. It is clear that a port group with a reasonable layout and clear division has been formed and a professional transport system has been established including bulk cargo, containers and so on. Coastal ports are important infrastructure for Chinese modernization construction, economic development and social progress. Therefore, it is of great significance to evaluate the competitiveness of ports and put forward suggestions for improving the transport system, promoting the continuous development of Chinese international trade and enhancing the competitiveness of Chinese economy.

2. Literature references

2.1 Overseas research status

Haezendonck, etc. established an evaluation model of port competitiveness, which was evaluated by five indexes, namely, port reputation and reliability, cargo production, productivity, service level and hinterland traffic conditions. Jose, etc. proposed eight indexes to evaluate port competitiveness, namely the port operation efficiency, port tariff, reliability, factors of choosing port hinterland, ease, degree of service differentiation, channel depth, adaptability to external environment.

2.2 Domestic research status

The modernization of China's ports started late. In the 1990s, with the rapid development of Chinese economy and international trade, Chinese scholars began to study port competitiveness.

2.2.1 Research on the establishment of port competitiveness evaluation indicators system

Lv et al. summarized the factors affecting the competitiveness of ports market into six indexes: operating conditions, service level, port environment, container throughput and growth rate, equipment conditions and modern management. Li divided the factors into three categories: internal factors, external factors and social factors.

2.2.2 Subjective methods to evaluate port competitiveness

Zou et al. made a horizontal comparison and evaluation of the competitiveness of Port of Shanghai, Port of HongKong, Port of KaoHsiung, Port of Busan, Port of Singapore and Port of Kobe by using expert marking, and obtained the comprehensive scores.

2.2.3 Statistical methods to evaluate port competitiveness

Li established an evaluation model by using improved BP-neural network and RBF neural network, and analyzed the competitiveness of 15 coastal ports in China. Wang used principal component analysis to evaluate the competitiveness of Port of Qingdao, Port of Yantai and Port of Rizhao.

In conclusion, the methods of port competitiveness evaluation at home and abroad are mature. Although the research on port competitiveness in China started relatively late, the research progresses rapidly. However, most studies are conducted for the comparison and evaluation of a single port or several ports in a certain region. As a result, the sample structure is too simple.

3. Assessment methods

3.1 Factor analysis

If there are many dimensions (indicators or variables) of the sample, the statistical analysis will be complicated. Factor analysis can group variables according to the correlation and find out the hidden representative factors. That is to say, the number of variables can be reduced by reducing the dimension, and the original huge and complicated calculation can be changed into a simple calculation with only a few representative and unrelated main factors. On the other hand, factor analysis also has the advantage of obtaining final comparable scores without subjectively assigning weights to indicators. Therefore, this paper adopts factor analysis to compare the competitiveness level of China's coastal ports above a certain size in 2017.

3.2 Cluster analysis

Cluster analysis is an important method to classify research samples or indicators in multivariate statistical analysis. It refers to the analysis process of grouping the collection of physical or abstract objects into multiple classes composed of similar objects.

4. Empirical analysis

4.1 Data sources

Referring to the China port yearbook 2018, this paper chooses 30 ports above a certain size to analyze the competitiveness, including Port of Dandong, Port of Dalian, Port of Yingkou, Port of Jinzhou, Port of Qinhuangdao, Port of Huanghua, Port of Tangshan, Port of Tianjin, Port of Yantai, Port of Weihai, Port of Qingdao, Port of Rizhao, Port of Shanghai, Port of Lianyungang, Port of Yancheng, Port of Ningbo-Zhoushan, Port of Taizhou, Port of Wenzhou, Port of Fuzhou, Port of

Quanzhou, Port of Xiamen, Port of Shantou, Port of Huizhou, Port of Shenzhen, Port of Guangzhou, Port of Zhuhai, Port of Zhanjiang, Port of Beibu gulf , Port of Haikou, and Port of Yangpu.

Based on relevant literature, this paper selects 12 evaluation indexes, including cargo throughput(X1), foreign trade cargo throughput(X2), container throughput(X3), the length of the dock(X4), the number of berths(X5), GDP(X6), gross output value of tertiary industry(X7), total import and export(X8), FDI(X9), GDP growth rate(X10), import and export growth rate(X11), FDI growth rate of port hinterland(X12). Data of first five indicators are derived from China port yearbook 2018 and National Statistics Bureau. Data of rest indicators are derived from statistical yearbook of each city.

4.2 Factor analysis

Each index, namely X=(X1, X2..., X12) has different units of measurement. If the raw data is simply analyzed, dimensional errors can be generated. In order to eliminate the impacts of dimensions on the empirical results, it is necessary to standardize raw data, namely:

$$Z(X_i) = \frac{X_i - \mu_{X_i}}{\sigma_{X_i}}$$

μ_{X_i} represents the estimated expectation value of port competitiveness index sample, which is replaced by the sample mean; σ_{X_i} represents the estimated volatility of the port competitiveness index sample, which is replaced by sample standard deviation.

Factor analysis requires correlation among variables. Bartlett test of spericity and KMO test can be carried out by SPSS24. And the stronger the correlation is, the closer the KMO value is to 1. Generally, factor analysis can be conducted when the KMO value is greater than 0.6. The KMO value test result of sample data is 0.764, which is larger than the given standard, so it is suitable for factor analysis. The significance of Bartlett test of spericity is 0.000, which is less than 0.05, so the null hypothesis is rejected, indicating that there is a significant correlation among the 12 indicators, which can be reduced by factor analysis.

Generally speaking, the common factors of variables with a degree of commonness exceeding 0.75 have strong explanatory ability to each variable. According to the calculation, the commonness of variables basically exceeds 0.75, indicating that the factor analysis effect is good.

Then, calculate the correlation coefficient matrix among the variables of port competitiveness, and the contributing rate of cumulative sums of squares and scree plot can be obtained. The eigenvalues of the first three common factors are all greater than 1. Therefore, this paper uses the first three common factors to replace twelve competitiveness variables. Intuitive errors will occur if observing the scree plot only, so it is necessary to calculate the contributing rate of cumulative sums of squares. The contributing rate of squares of the first three common factors is 58.837%, 11.738% and 11.033%, respectively, and the contributing rate of cumulative sums of squares is as high as 81.607%, which indicates that the variance degree of 81.607% among the 12 competitiveness indicators can be explained by the first three common factors. Moreover, the eigenvalues of the first three common factors are all greater than 1, respectively 7.060, 1.409 and 1.324. Therefore, common factors F1, F2 and F3 can be obtained.

In the component matrix without rotation, it may appear that a factor variable has a high load on many variables, making the logical significance of the factor not obvious. Therefore, it is necessary to rotate the component matrix to make the meaning of the factor clearer. First factor reflects the cargo throughput(X1), foreign trade cargo throughput(X2), container throughput(X3), the length of the dock(X4), the number of berths(X5), GDP(X6), gross output value of tertiary industry(X7), total import and export(X8), FDI(X9), referred to as factor of cargo throughput and level of economic development. The second factor reflects import and export growth rate(X11), FDI growth rate of port hinterland(X12), which is called the factor of foreign trade development potential. The third factor reflects GDP growth rate(X10), which is called the factor of economic development potential.

Using SPSS24, component score coefficient matrix can be obtained. And the comprehensive score of ports is further calculated, as shown in table 1.

From the factor F1, the Port of Shanghai ranks first and its score is much higher than other ports, because Shanghai's geographical position is superior, located in the megalopolis. The second is Port of Shenzhen, Guangzhou and Ningbo-Zhoushan. From the factor F2, Port of Zhoushan-Ningbo, Yingkou, Beibu gulf and Dalian rank high, while the port of Shanghai ranks low. The possible reason is the influence brought by the adjustment of economic development mode of Yangtze river delta region in recent years. From the factor F3, Port of Ningbo-Zhoushan and Tangshan rank high, while the Port of Shanghai does not rank high. Finally, from the comprehensive score, the three ports with the highest competitiveness are Port of Shanghai, Ningbo-Zhoushan and Guangzhou.

Table 1. the rank and score of common factor

name of port	F1	F2	F3	F	Rank	name of port	F1	F2	F3	F	Rank
Dandong	-0.591	-4.329	1.643	-0.690	30	Ningbo-Zhoushan	1.499	1.587	1.826	1.274	2
Dalian	-0.002	0.867	1.589	0.302	7	Taizhou	-0.468	0.373	-0.830	-0.318	21
Yingkou	-0.671	1.073	0.569	-0.174	13	Wenzhou	-0.424	-0.138	0.083	-0.248	17
Jinzhou	-1.071	0.816	0.839	-0.402	26	Fuzhou	-0.119	0.024	-1.134	-0.202	14
Qinghuangdao	-0.606	0.324	-0.273	-0.335	22	Quanzhou	-0.187	-0.275	-1.017	-0.264	19
huanghua	-0.791	0.599	0.965	-0.255	18	Xiamen	-0.002	0.233	-1.087	-0.103	10
Tangshan	-0.087	-0.248	1.789	0.135	8	Shantou	-0.438	-0.453	-0.791	-0.402	27
Tianjing	1.125	-0.241	0.853	0.710	5	Huizhu	-0.498	-0.028	-0.751	-0.377	23
Yantai	-0.101	-0.029	0.807	0.037	9	Shenzhen	1.848	-0.844	-1.676	0.737	4
Weihai	-0.711	0.116	-0.105	-0.401	25	Guangzhou	1.591	-0.001	0.081	0.912	3
Qingdao	0.703	0.390	0.727	0.537	6	Zhuhai	-0.217	0.170	-1.543	-0.288	20
Rizhao	-0.401	0.481	0.464	-0.110	11	Zhanjiang	-0.521	0.300	0.115	-0.243	16
Shanghai	3.588	-0.410	-0.253	1.951	1	Beibu gulf	-0.175	1.000	-1.196	-0.116	12
Lianyungang	-0.511	0.454	0.010	-0.231	15	Haikou	-0.504	-0.932	-0.655	-0.484	28
Yancheng	-0.563	-0.092	-0.521	-0.394	24	Yangpu	-0.696	-0.784	-0.529	-0.559	29

4.3 Cluster analysis

In order to classify the competitiveness of 30 coastal ports, this paper adopts cluster analysis. Using software SPSS24, systematic cluster analysis is adopted, and Squared Euclidean distance method is selected to provide measurement of heterogeneity. From the cluster analysis, the most paradigmatic relations in difference are below the level of 2. This paper divides these ports into 5 groups, high competitive port (comprehensive score is greater than or equal to 1.5), upper

intermediate competitive port (comprehensive score is between 1 and 1.5), moderate competitive port (comprehensive score is between 0.5 and 1), lower intermediate competitive port (comprehensive score is between 0 and 1) , low competitive port (comprehensive score is less than 0). The results of the cluster analysis are basically consistent with those obtained by the factor analysis mentioned above, indicating that the results of cluster analysis are in line with the above analysis conclusion.

Therefore, this paper synthesizes the above two classification methods and obtains the following classification results. The first category is high competitive port: Port of Shanghai. The second category is upper intermediate competitive port: Port of Ningbo-Zhoushan. The third category is medium competitive port: Port of Guangzhou, Shenzhen, Tianjin and Qingdao. The fourth category is lower intermediate competitive port: Port of Dalian, Tangshan, Yantai. The fifth category is low competitive port: Port of Xiamen, Rizhao, Beibu gulf, Yingkou, Fuzhou, Lianyungang, Zhanjiang, Wenzhou, Huanghua, Quanzhou, Zhuhai, Taizhou, Qinhuangdao, Huizhou, Yancheng, Weihai, Jinzhou, Shantou, Haikou, Yangpu, Dandong.

5. Conclusion

Based on the comprehensive score of the competitiveness of coastal ports and results of cluster analysis, this paper summarizes some conclusions and puts forward corresponding suggestions.

First is the Bohai region. The Port of Tianjin has the highest comprehensive score, which is the most competitive port in Bohai region, followed by Port of Qingdao, Dalian, Tangshan and Yantai, and finally Rizhao, Yingkou, Huanghua, Qinhuangdao, Weihai, Jinzhou and Dandong. Specifically, in terms of the factors of throughput and economic development level (F1), the Port of Tianjin is obviously superior to other ports in this group. It is at the core of the coastal area around the Bohai, so its geographical advantages are obvious. In terms of the factor of foreign trade development potential (F2), Port of Yingkou is at the forefront, with huge potential of foreign trade development, which may be related to its small numbers. In terms of the factor of economic development potential (F3), most ports in this group rank high, for that they are closely related to the construction of Binhai New Area of Tianjin and Liaoning coastal economic zone.Therefore, the ports in Bohai region should seize the opportunities of China's economic restructuring.

Second is the Yangtze river delta region. Port of Shanghai and Ningbo-Zhoushan are the top two ports with the highest comprehensive scores. The comprehensive score of Port of Shanghai is well ahead of other ports, in that the score of the factor F1 is extremely high, indicating that the basic condition is the most excellent. On the other hand, its foreign trade development potential is insufficient. However, it still needs to make efforts in import and export trade. Therefore, while consolidating the hardware and economic basis, Port of Shanghai needs to continuously improve its soft power. Although the gap between Port of Ningbo-Zhoushan and Shanghai is bigger, Port of Ningbo-Zhoushan also has a big advantage to other ports. As Port of Ningbo and Port of Zhoushan merge, the port can get more coastal and wharf resources. Therefore, Port of Ningbo-Zhoushan should follow the Marine economic strategy of Zhejiang province closely and accelerate the resource integration after merging.And other ports should find new competitiveness to avoid losses.

Third is the South-east coastal region. The comprehensive scores of Port of Fuzhou, Quanzhou and Xiamen are not much different, in the middle of 30 coastal ports. Among them, Port of Xiamen ranks the top because of its obvious advantage in container service. In general, the direct economic hinterland of the three ports is small, so it is important to plan reasonably. With the construction of West-Straits Economic Area, they should make good use of their special geographical location .

Fourth is the Pearl river delta region. Port of Guangzhou and Shenzhen have higher scores and there is a fierce competition between them. Port of Shenzhen and Guangzhou are all back economically developed areas with rich hinterland resources. Therefore, the two ports must have strong strain capacity, and strive to compete on the basis of cooperation rationally. In addition, all ports in the Pearl river delta region are located in the Pearl river delta economic zone, with a good economic foundation closed to Port of Hong Kong. Therefore, they can make up for their

deficiencies by learning from experience in management, operation and service of Port of Hong Kong .

Fifth is the South-west coastal region. All ports in this group are concentrated in the middle and lower position. The hinterland resources in the South-west coastal region are poor, and the economic development level of both their direct hinterland and indirect hinterland is at a low level. What's more, the port infrastructure conditions are not perfect and port production capacity is backward. But in the factor of foreign trade development (F2), Port of Beibu gulf is top ranked among the 30 ports, indicating that the construction of Beibu gulf economic zone provides the South-west coastal areas with great opportunities. All ports in this area should take advantage of the rare opportunity to increase the intensity of port construction and strengthen hardware facilities.

At last, this paper has some shortcomings. First of all, the index system established in this paper is not perfect enough, mainly due to the difficulty of data collection. Secondly, due to the lack of understanding of the overall development level and existing problems of China's coastal ports, the conclusion of empirical analysis and suggestions in this paper may be incomplete.

References

[1] Haezendonck E, Notteboom T. The competitive advantage of seaports [J].Matitime Polycy & Management, 2002, 29: 126-145

[2] Li hongxi. Research on port logistics evaluation based on correlation -- principal component analysis [D]. Dalian university of technology, 2013.

[3] Mayer H M. Current trends in great lakes shipping [J]. Geojournal, 1978, 2 (2): 117-122.

[4] Tongzon J, Heng W. Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals) [J]. Transportation Research, Part A (Policy and Practice), 2005, 39 (5): 0-424.

[5] Wang zilong, Han zenglin. Competitiveness evaluation of major ports in bohai rim region [J]. Resources development and market, 2012, 28(3).

[6] Zou yunmei, Chen jun. Research on the type of China's coastal ports along the 21st century maritime silk road [J]. Journal of Shanghai maritime university, 2018, 39 (03): 67-71.