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How port logistics competitiveness evolves among major ports in China and Europe (1998-2018)

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How port logistics competitiveness evolves among major ports in China and Europe (1998-2018)

Shanghai, Ningbo Zhoushan, Guangzhou, Rotterdam, Antwerp

By

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views and are not necessarily endorsed by the University.

(Signature):…………………………

(Date):　　　…………………………

Supervised by

Professor Chen Yang

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ABSTRACT

Title of research paper: **How port logistics competitiveness evolves among major ports in China and Europe (1998-2018)——Shanghai, Ningbo Zhoushan, Guangzhou, Rotterdam, Antwerp**

Degree: **MSc**

Port, an important hub and node of the international land-ocean logistics channels, is not only a coupling link for water transport and distribution centre for goods, but also plays an increasingly important role in the modern international production, trade and transport system. It undertakes the transhipment and storage of goods, and serves as a resource allocation platform, as well as a comprehensive logistics centre for international trade, rather than a water transport hub with a single function. To meet higher requirements, the port must not only complete its functions of loading, unloading and transit, but also mine its distribution function as an important node of the logistics chain, so as to provide logistics value-added services actively.

At present, the studies at home and abroad mainly focus on the perspectives such as influencing factors of port logistics, construction of the evaluation indicator system of port logistics competitiveness, and evaluation methods. The studies up to now have been mainly carried out in static manner, the evaluation indicator system is not comprehensive enough, and the quantitative analysis has been only adopted in a small number of the studies. Therefore, in this paper, the evaluation indicators were rescreened, the entropy weight analysis method was introduced, and a new evaluation system was established to evaluate the logistics competitiveness of major ports in China and Europe from 1998 to 2018, presenting a process of dynamic changes.

First, the research background and significance of the paper were mainly introduced at the beginning of this paper, and then the domestic and foreign literature concerning the port logistics was sorted out and summarized. Second, the definition of port logistics competitiveness was given, its characteristics were summarized, and related theories of competitiveness was introduced. In line with the principles of science, consistency and comparability, the evaluation indicator system of port logistics competitiveness was established in combination with the influencing factors and development status of port logistics. With the logistics competitiveness of China's ports as the main research objectives, Port of Shanghai, Port of Ningbo Zhoushan, Port of Guangzhou, Port of Rotterdam and Port of Antwerp were selected in line with certain standards. The original indicator data of these ports were collected, and the entropy weight analysis method was used for empirical analysis, the logistics competitiveness of China's ports was evaluated, and the existing strengths and weaknesses were clearly stated. The research results suggested that the logistics competitiveness of China's ports went through a continuous increase from 1998 to 2018, and the comprehensive rankings of these ports have been continuously lifted. The advantages in the supply capacity of port logistics and the economic conditions in the port hinterland have laid a dominant position in the logistics competitiveness of China's ports. The lack of staying power for port logistics development restricted to a certain extent the development of China's port logistics. Finally, proper suggestions for the development of China's port logistics were put forward for reference on the basis of the results of empirical analysis.

KEYWORDS: Port, Evaluation indicator system, Port logistics competitiveness, Entropy weight method

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1 Background

China's foreign trade turnover goes up year by year as both the economic globalization and the specialization of international division of labour constantly deepen. Throughout history, waterway transport accounts for the largest proportion of international trade, raising requirements on ports - the infrastructure for water transport, for which the highest priority should be given to the development and optimization of port logistics.

As the shipping causes mushroomed in China, great progress has also been made in the infrastructure and scale of ports. It is easy to discover by comparing the cargo throughput, container throughput, berth number and other data of ports from 1998 to 2018 that great progress has been made in the port causes in the past two decades. As the port throughput of China goes up year by year, many Chinese ports have been listed in the rank of international throughput ports, and played an increasingly important role in the growth of the national economy.

To provide a better reference for port construction, two main ports in Europe - Port of Rotterdam in the Netherlands, Port of Antwerp in Belgium, and three main ports in China - Port of Shanghai, Port of Ningbo Zhoushan and Port of Guangzhou were selected for study in this paper. 15 port indicators of them in 1998, 2003, 2008, 2013 and 2018 were compared to study on the port logistics competitiveness, explore the evolution history of China's hub ports in the past two decades and analyse the reasons for the development of our ports. In addition, the strengths and weaknesses of China's ports and international advanced ports were discussed to provide a reference for the development of China's ports.

Purpose of research

Port logistics competitiveness is affected by more than one indicator. In this paper, 15 indicators that may properly reflect the port logistics competitiveness were selected, and divided into four groups of indicators, including Economic level of port hinterland, Supply capacity of port logistics, Port logistics demand scale and Port logistics development potential, and then the scores of ports were calculated by means of TOPSIS entropy weight for ranking the logistics competitiveness of each port. This study is carried out to find out the reasons for the great progress of China's ports in the past two decades from the changes in the scores of various groups of indicators, and to analyse the aspects in which China's ports have made progress. A selective analysis on indicators that have a greater impact on the port logistics competitiveness was carried out, and a comparison was made to with the development of foreign advanced ports to find out our strengths and weaknesses, thereby putting forward proper measures for the future development of Chinese ports.

2 Literature Review

Five major port groups have sprung up in China with the rapid growth of China's economy and the continuous strengthening of ship trade, and Chinese scholars have also been committed to comprehensive port studies. Its main research content includes resource coordination and cooperation, and most of them have studied the evaluation of port competitiveness from a multi-factor perspective.

With regard to research on the influencing factors of port logistics competitiveness, Jing. Li and Jing. Lu (2008) concluded that the influencing factors mainly involved the following four aspects: economic input-output ratio, industrial structure, supporting auxiliary capacity and macro economy surroundings. An indicator framework was constructed on the basis of these four influencing factors, and the analytic hierarchy process was introduced for empirical analysis. According to the empirical analysis results, the indicator framework was closely linked with the empirical analysis, which may not only promote the growth of the local economy, but also hinder the growth of the regional economy to some extent. Khalid Bicho and Richard Gray (2004) put forward a new perspective to study the ports from the supply chain management system, and they believed that logistics information, logistics operations, and port operation management competencies were important factors that affect competitiveness. Therefore, an indicator system was constructed on this basis. H. Craig Davis (2004) analysed the influencing factors of regional port logistics with a critical and suggestive method, and discovered in studies that it was the port infrastructure that influenced the regional port logistics, rather than the economic effect of marginal changes of service volume related to such infrastructure. Wayne K. Talley (2014) carried out a clustering analysis on the port logistics from three aspects of port logistics scale, facilities and potential, and proposed to establish a port logistics service chain to enhance competitiveness.

With regard to the research on evaluation system and method, Yong. Geng (2013) mainly focused on the infrastructure in the hardware indicator in his research on the evaluation indicators of port logistics, and obtained the contribution rate of infrastructure to port logistics after calculation and analysis using the entropy weight method, and proposed to enhance infrastructure planning and expand investment based on the results. Gang. Zhao (2006) built an evaluation system on the basis of an analysis of the major inland ports in Jiangsu, and the fuzzy comprehensive evaluation method was introduced to evaluate logistics competitiveness. Xu. Li (2014) evaluated the port logistics competitiveness in the Bohai Rim region using entropy weight analysis, and proposed the suggestions for improvement.

Entropy, a concept in physics that is generally used for describing the uniformity of spatial distribution, was first referred to by C.E.Shannon in information research in 1948. Up to now, it has been widely used in social engineering technology. According to the meaning of information entropy, it can be used for measuring the degree of variation in the amount of information measured. If the information system is arranged more orderly, its information entropy value will be lower; On the contrary, if the information system is arranged more disorderly, the information entropy value will be higher. By virtue of such features of information entropy, the degree of disorder of the indicator was evaluated in the entropy weight to measure the weight that the indicator should account for in the evaluation indicator system.

The weight value of the entropy weight method is determined by the amount of information displayed by different indicators, the amount of information carried by which is determined by comparing their intensity. It is discovered that the entropy weight method is more objective and rational.

TOPSIS was originally put forward by C. L. Hwang and Hwang and K. Yoon in 1981. Its application principle is to calculate the optimal solution and the worst solution for each evaluation object, solve the distance between the two solutions and then sort them. It is the best case where the evaluated object is far from the worst solution and close to the optimal solution. Conversely, it is the worst solution. The attribute value that participates in the evaluation of each optimal solution is the optimal value in the group of evaluation indicators, and the attribute value of each worst solution also corresponds to the worst value.

The port system is a complex comprehensive system in which multiple disciplines and research fields are integrated and crossed, plus an array of influencing factor for the port logistics competitiveness, posing huge challenge and great practical significance to the research. Most of the previous researches on the port logistics competitiveness were based on the data of different ports for one year, presenting the static results. However, the research in this paper was based on the data of the past two decades, presenting the process of dynamic changes. An evaluation model of port logistics competitiveness was established, and the entropy weight method and TOPSIS were selected for quantitative analysis on the data of port logistics competitiveness. First, the entropy weight method was introduced to enhance the objectiveness of quantitative data evaluation. Second, the port data was collected through multiple channels to calculate the optimal solution of each indicator under the guidance of the TOPSIS, which endowed the subjective rationality to such analysis and research.

3 Case Background

3.1 Port location

Port of Shanghai, a port in Shanghai, China, residing in the central section of the coastline of Mainland China and at the estuary of the Yangtze River, accesses to the north-south coast of China and the world ocean, and then runs through the Yangtze River Basin, inland rivers in Jiangsu, Zhejiang and Anhui provinces, and Taihu Lake Basin.

By 2005, the water area of Port of Shanghai was 3620.2 km^2, including 3580 km^2 of the water area of the Yangtze Estuary, 33 km^2 of the water area of Huangpu River, and 7.2 km^2 of the port land area. The port land area was composed of the port area on south bank of the Yangtze Estuary, the port area on north bank of Hangzhou Bay, the port area of Huangpu River, and the deep-water port area of Yangshan.

Port of Ningbo Zhoushan, is a first-class port open to the outside world in Ningbo City and Zhoushan City, Zhejiang Province, China, residing in the central section of the coastline of Mainland China and in the south flank of the "Yangtze River Economic Belt". As a significant component to Shanghai international shipping centre, it is the core carrier to serve the Yangtze River Economic Belt and build the Zhoushan River-Ocean Through Transport Service Centre, and is an important support for the construction of the Zhejiang Marine Economic Development Demonstration Plot and the New Area of Zhoushan Islands.

Port of Guangzhou resides in the Pearl River Estuary and the Pearl River Delta, Guangzhou City, Guangdong Province, China.

According to comprehensive information in 2017, Port of Guangzhou is composed of seaports and inland ports, covering the four major port areas (Inner Port Area, Huangpu Port Area, Xinsha Port Area, and Nansha Port Area), Anchorage of Pearl River Estuary, as well as three inland port areas in Guangzhou (Panyu, Wuhe and Xintang).

Port of Rotterdam resides at the estuary of the Rhine and Maas, flowing to the North Sea in the west, and derived from the Rhine and Danube rivers in the east. It can access to Caspian Sea, and is known as "Eurosport". The port area covers 100km^2 approximately, with 42km of wharf in total length, 22km of the deepest draft, and it can accommodate 545kt super-large oil tanker. The infrastructure of the port area is owned by the municipal government of Rotterdam, and the daily port affairs were under the of control the Port of Rotterdam Authority. Companies may lease the infrastructure of the port area to develop their businesses. With the European economic regeneration and the establishment of the common market after the World War II, the Port of Rotterdam developed rapidly by right of its predominant geological location.

Port of Antwerp, the largest seaport in Belgium, resides on the north side of Antwerp, on the lower reach of the Scheldt River, and 68-89km from the estuary. The Port has a vast hinterland. Its railway network is 960km in length and its road network 276.5km in length, accessing to the European railway network and highway network, respectively. The Port of Antwerp leads to the North Sea via the Scheldt River, and its river section is impacted by the tides, with a tidal range of 4.5-5m. The Port is set with 6 entry locks. The existing area of the Port of Antwerp is mainly set on the right bank of Scheldt River, and most of the berths are set in the excavated basins. Up to the year 2000, the total area of the port and industrial area was 140.55km^2, with 127.20km of available coastline, and about 800 berths had been set in the port.

The locations of Port of Rotterdam in the Netherlands, Port of Antwerp in Belgium, Port of Shanghai, Port of Ningbo Zhoushan and Port of Guangzhou in China are shown in Figure 1.

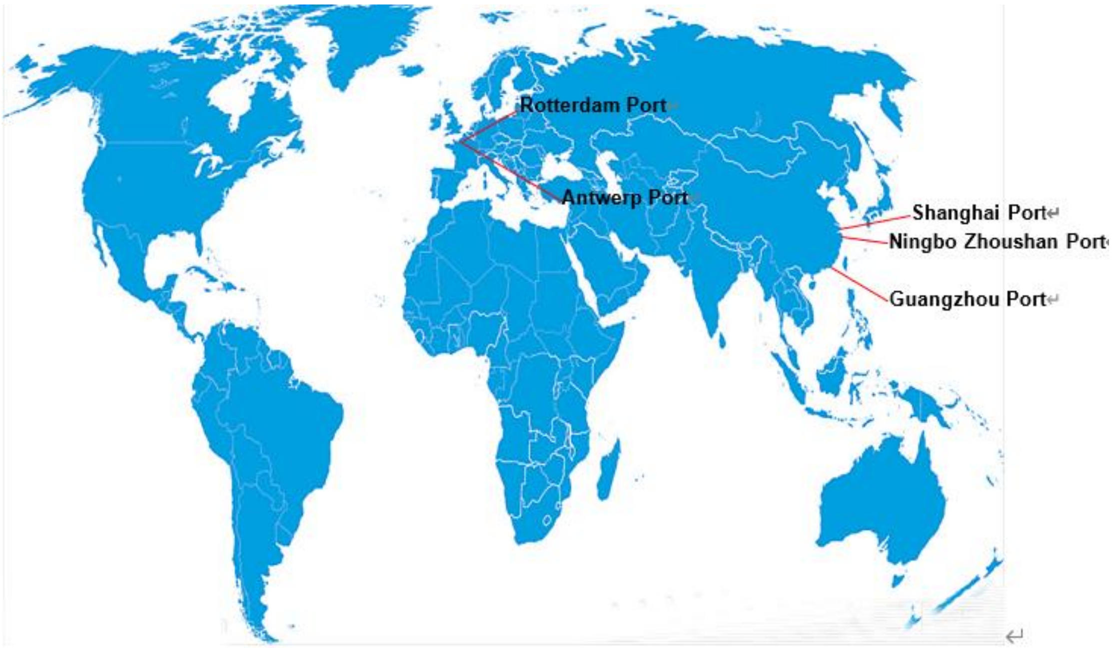


Figure 1 Locations of Ports

3.2 Changes in port data

Port throughput is an important quantitative indicator that reflects the results of port production and operation activities, and its compositions of flow direction, quantity and physical classifications are the most direct embodiments of the port position, role and influence in the international and interregional water transportation chain, as well as a quantitative reference basis for measuring the construction and development of countries, regions and cities. The port throughput may clearly report the quantity of cargoes that enter or leave the port area through the waterway and loaded and unloaded during the reporting period, reflecting the scale and capacity of the port. Figures 2-1 to 2-11 plotted the changes in the cargo throughput and container throughput and their growth rate of these major ports from 1998 to 2018, presenting the evolution of these major ports in an intuitive form.

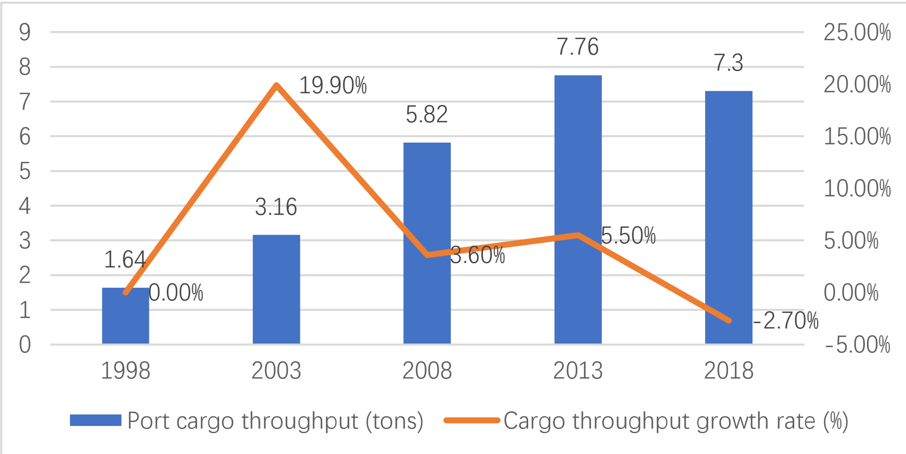


Figure 2-1 Changes in cargo throughput and growth rate of Port of Shanghai

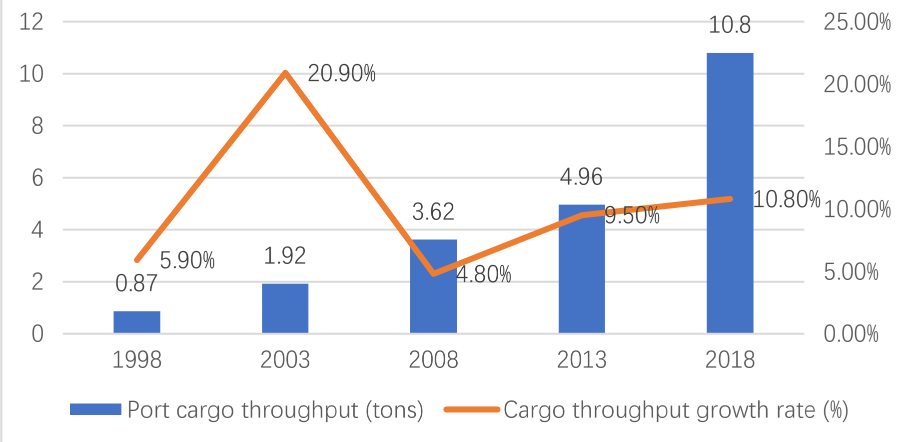


Figure 2-2 Changes in cargo throughput and growth rate of Port of Ningbo Zhoushan

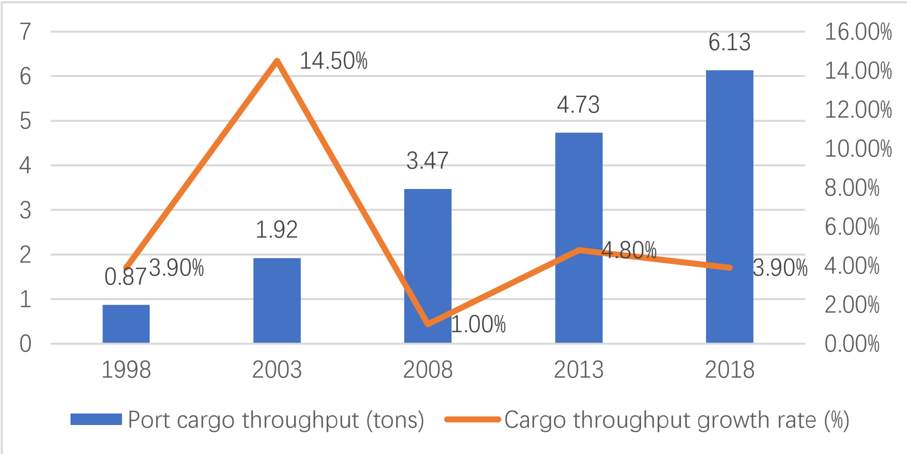


Figure 2-3 Changes in cargo throughput and growth rate of Port of Guangzhou

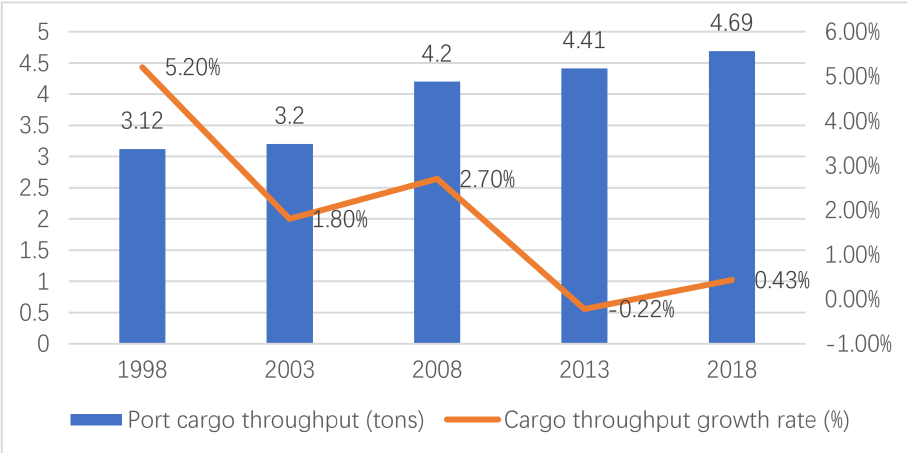


Figure 2-4 Changes in cargo throughput and growth rate of Port of Rotterdam

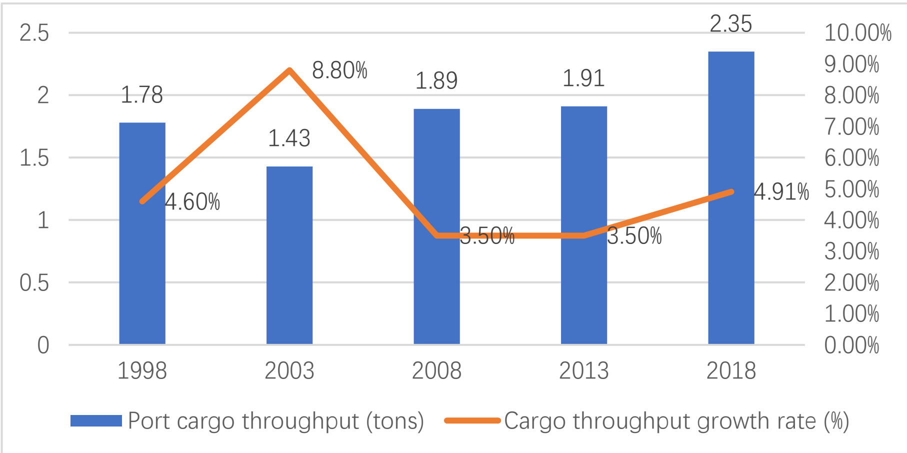


Figure 2-5 Changes in cargo throughput and growth rate of Port of Antwerp

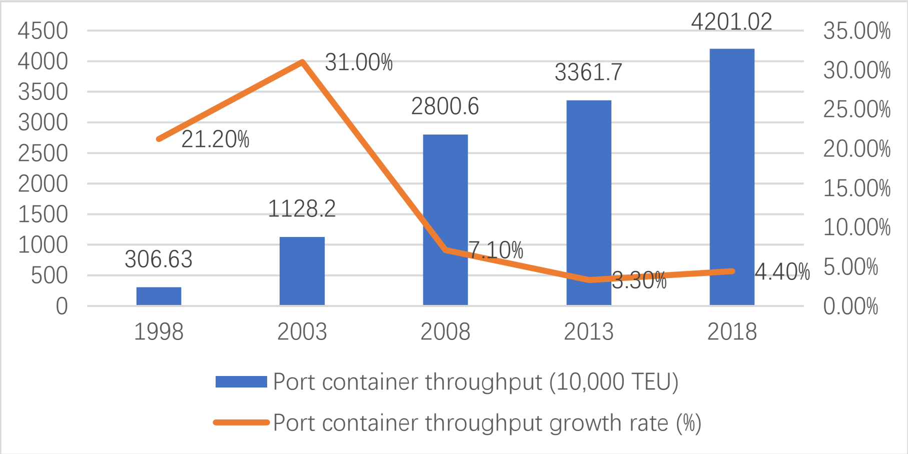


Figure 2-6 Changes in container throughput and growth rate of Port of Shanghai

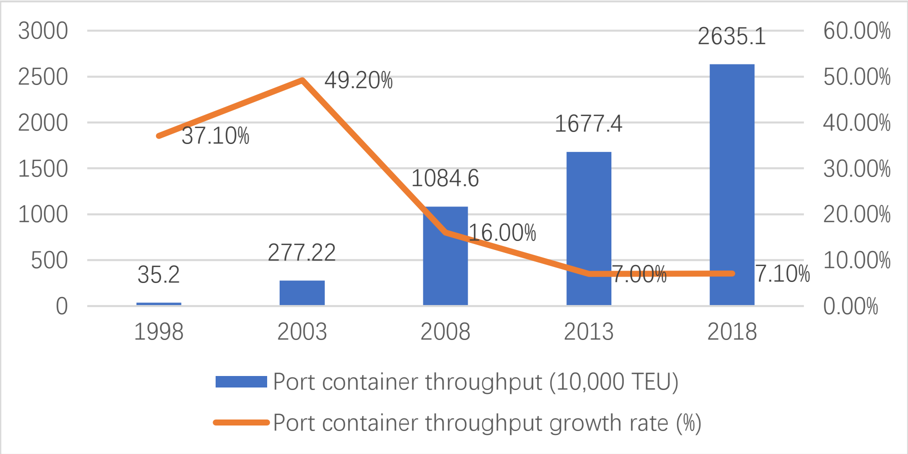


Figure 2-7 Changes in container throughput and growth rate of Port of Ningbo Zhoushan

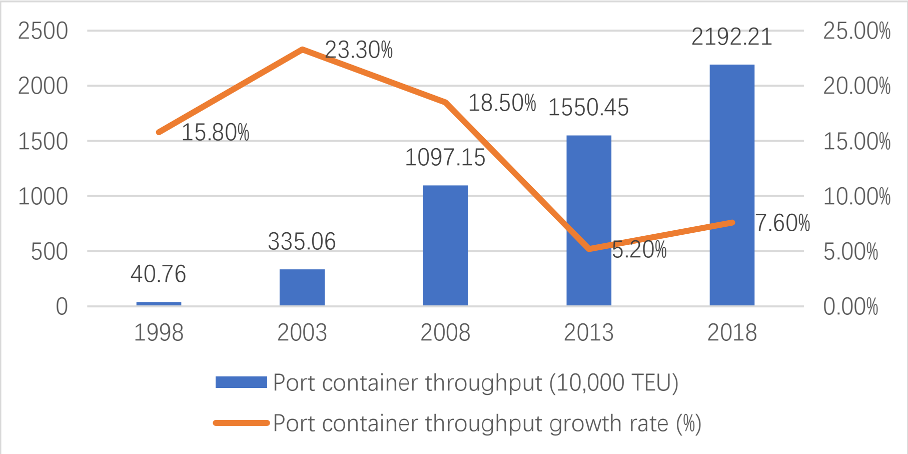


Figure 2-8 Changes in container throughput and growth rate of Port of Guangzhou

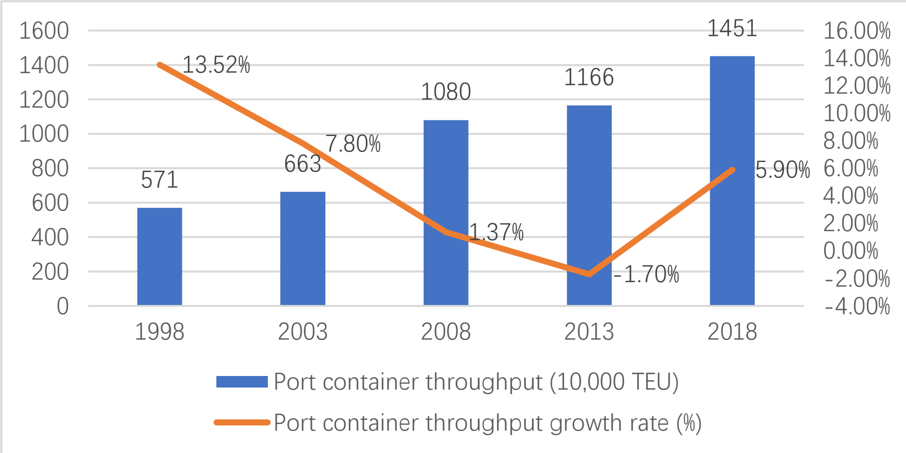


Figure 2-9 Changes in container throughput and growth rate at the Port of Rotterdam

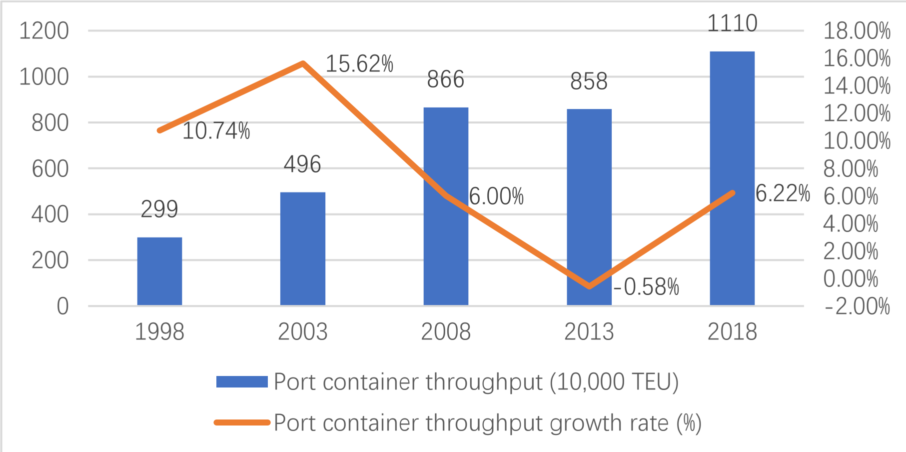


Figure 2-10 Changes in container throughput and growth rate of Port of Antwerp

Port logistics, comprehensive logistics system under a special form, serves as an irreplaceable important node in the logistics process to complete the basic logistics services and derivative value-added services in the entire supply chain system. Modern logistics, an advanced organization method and management technology, is considered to be the "third profit source" for enterprises after widening sales and raising productivity, playing an important role in the national economy and social development. To develop the modern logistics in ports is a requirement for ports to enhance their competitiveness, meet higher demands of customers, promote linkages between port areas and port economic growth, strengthen the connection between port cities and hinterland, and drive the regional economic development. China's modern port logistics is still in its infancy of development. But the rapidly growing demands for port logistics, especially the rapidly growing import and export trades since China's accession to the WTO, pose increasingly demands for port logistics (above 90% of international trade is completed by port transport). Therefore, Figure 3-12 plotted the changes in the total GDP of port cities, and Figures 3-13 and 3-14 plotted the changes in the import and export of port cities and their growth rates respectively, which are important indicators for studying the port logistics competitiveness. It can be seen that the GDP and foreign trade import and export volume of the port city are positively correlated to port throughput in data.

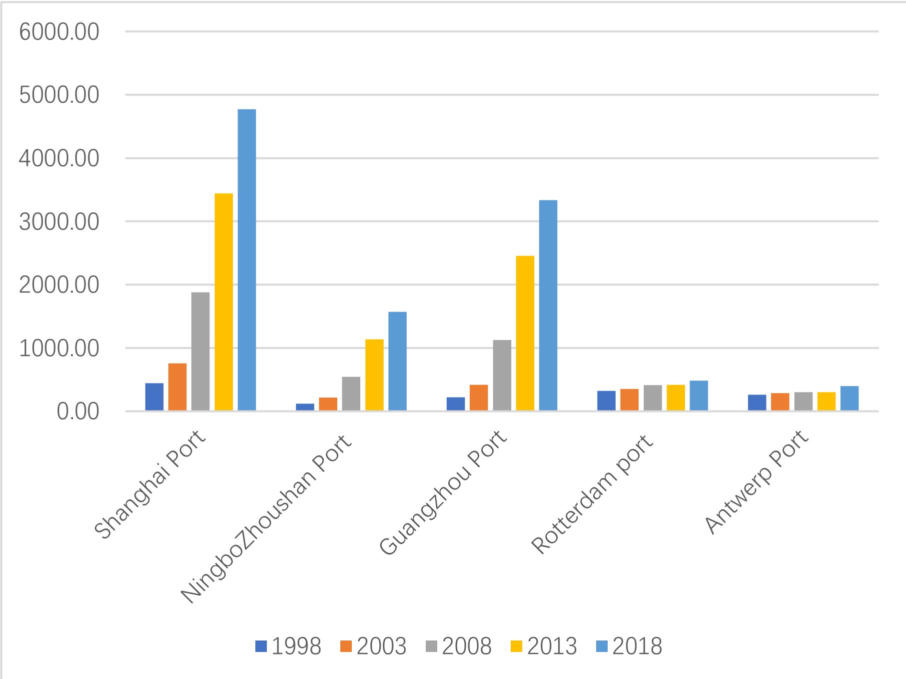


Figure 2-11 City GDP ($100 million)

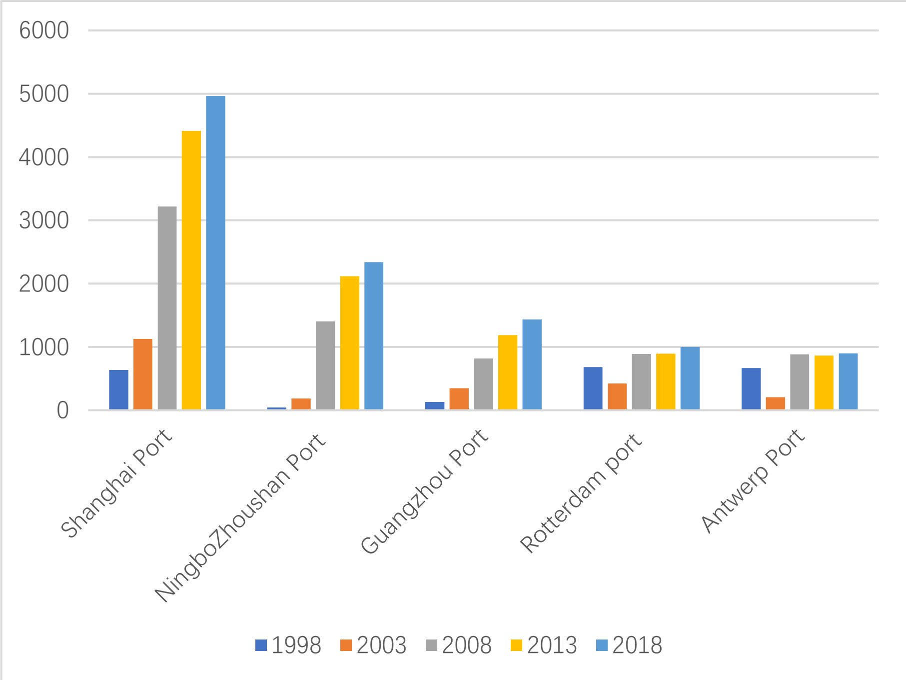


Figure 2-12 City foreign trade import and export ($100 million)

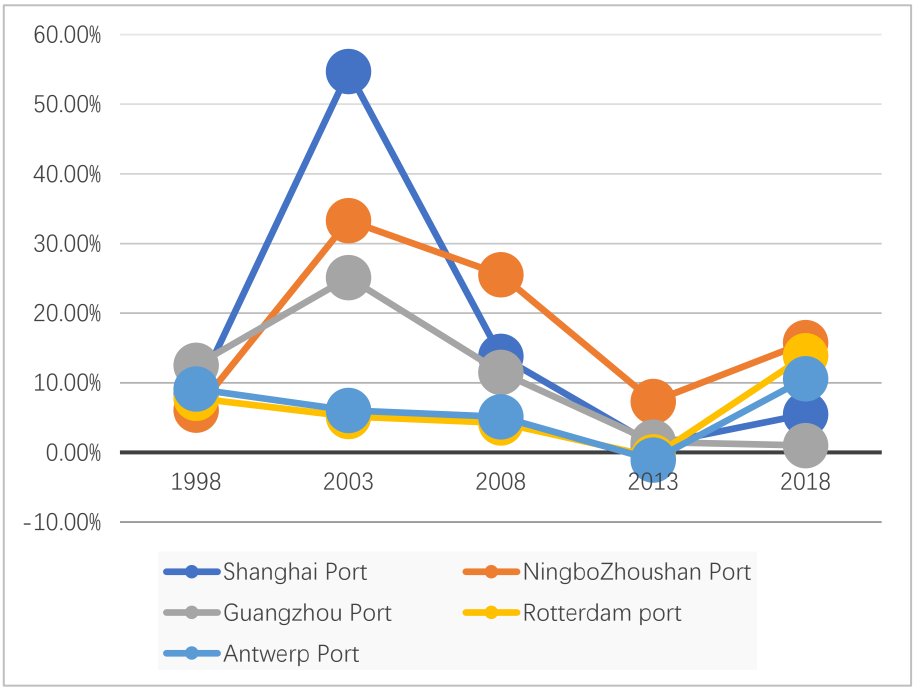


Figure 2-13 Growth rate of import and export volume of urban foreign trade ($100 million)

As shown in the figure, the throughputs of Port of Shanghai and Port of Ningbo Zhoushan are much higher than other large ports in China, with an average of about 500 million tons, and the throughput of these two ports exceeded 600 million tons in 2010, followed by Port of Guangzhou that has a throughput of more than 300 million tons. From the perspective of change tendency, the throughput of major ports in China, such as Port of Shanghai, Port of Ningbo Zhoushan, also declined in 2009 under the possible impact of the financial crisis. But the throughput quickly picked up, especially Port of Shanghai, surpassing Port of Ningbo Zhoushan to become the world's largest port in throughput.

In recent years, Port of Shanghai developed rapidly and made an array of achievements. In 2009, Port of Shanghai became the world's largest port in cargo throughput (592.05 million tons). In 2010, Port of Shanghai continued its success, and achieved a high growth of 16.27% in container throughput, topping among the world's container ports. The Port has achieved a continuous growth in cargo throughput for more than two decades, but its growth rate since 2010 has not been as quick as before. In 2014, its cargo throughput dropped for the first time, to 75.529 million tons, a decrease by 2.64% from the previous year. In 2015, its cargo throughput continued to drop, with a decreasing amplitude of 5.17%. In 2016, its cargo throughput continued to drop, with an amplitude of 2.2%, lower than that in 2015 to some extent. The Yangshan Phase IV was completed in December 2017, and it is the world's largest high-tech automated terminal with full automation realized in container loading, unloading, stacking, and transhipment. In the same year, the container throughput of Port of Shanghai exceeded 40 million boxes, accessing to the coastline of international ports.

In 2017, Port of Ningbo Zhoushan realized an annual throughput of more than 1 billion tons, and became the world's first major port with annual cargo throughput exceeding 1 billion tons, ranking first in the world for 10 consecutive years.

In 2018, Port of Guangzhou achieved cargo throughput of 480 million tons and container volume of 19.03 million TEU respectively, and the entire port completed cargo throughput of 612 million tons and container volume of 21.91 million TEU, an increase of 3.7% and 7.6% year-on-year respectively, ranking the fourth among the coastal ports in China and fifth in the world.

In 2008, the cargo throughput of the Port of Rotterdam increased by 2.7% compared with 2007, reaching a record 420 million tons. As announced by the Port of Rotterdam Authority, the total volume of dry bulk imports and exports handled at the port in 2008 increased by nearly 4% year-on-year, reaching 94 million tons; the liquid bulk cargo increased to 194 million tons, by 3.5%.

General cargo, including containers, rose to 133 million tons, slightly by 1% year-on-year, of which total container weight increased by 2.5% to 108 million tons. Its volume of containers was 10.83 million, basically equalling to that in 2007. In view of classification by import and export, the volume of imported goods at the Port of

Rotterdam in 2008 increased to 312 million tons, by 4% year-on-year; Its exports dropped to 108 million tons, by 0.5%.

The Port of Rotterdam achieved the highest throughput in 1998, and its average throughput in the three years from 2008 to 2010 was around 400 million tons, followed by Port of Antwerp. From the perspective of throughput changes, the throughput of the two European ports decreased in 2009 and rebounded in 2010, which may be related to the 2008 global financial crisis. Therefore, it can be seen that the economy exerted a relatively large impact on port throughput in a lagged manner to some extent.

Port acts as a transhipment centre for import and export goods, and its throughput may be influenced by the port location, hinterland, global economic and political environment, which will also affect the port logistics competitiveness because the throughput is an important output indicator of the port.

The influence of the world economic and political environments on port is most directly manifested in the total amount of international trade. Efthimios E. Mitropoulos, the Secretary General of the International Maritime Organization, pointed out that more than 90% of the current international trade was carried out by sea transport. Therefore, the international trade exerts a direct influence on the overall efficiency of coastal ports.

In addition to the world economic and political environment, the economic environment of the port hinterland will also affect the port throughput, the economic level of which exerted an important impact on the port cargo supply, thereby affecting the port throughput. Jinhe. Xu, Fengjiao. Gao, Ping. Zhang, et al., with a case study on Taicang Port, Port of Shanghai and Nanjing Port, proved that GDP of the port hinterland has a significant influence on port throughput. With the enhancement in city GDP, the port cargo and container throughputs also increase gradually.

It can be seen from the figure that the port throughput of China's ports was significantly positively correlated to the total foreign trade in the region where the port is located, probably because the total foreign trade may exert an influence on the throughput of the port output indicator. The port may predict its throughput based on the total regional foreign trade and take corresponding measures.

4 Research design and data collection

All of the five ports studied in this paper are listed in top 20 largest ports in the world in throughput, the data of which are comparable.

The Southeast Asian suffered a financial crisis around 1998, and Thailand was hard hit by the crisis, which spread to Malaysia, Singapore, Japan and South Korea, China and other places in short time. The currencies of Thailand, Indonesia, South Korea and other Asian countries depreciated sharply, leading to a sharp fall in price of the major stock markets in Asia. Many foreign trade companies in Asia were hit and closed down, the workers were unemployed, and the social economy was in a depression, ending the rapid development of Asian economy. The economies of some Asian economic powers started to get stuck in a stagnancy, and China's economy, even the world economy, has undergone major adjustments, posing a new starting point for economy development. The process of change was analysed from this new starting point. As a matter of fact, China started its real structural adjustment of economy in 1998. Therefore, the port data for the past two decades from 1998 to 2018 were selected in this paper for analysis.

4.1. Research method of the paper

The port system is a complex comprehensive system in which multiple disciplines and research fields are integrated and crossed, plus an array of influencing factor for the port logistics competitiveness, posing huge challenge and great practical significance to the research. In this paper, a port logistics competitiveness evaluation model was established. The entropy weight method and TOPSIS were introduced for quantitative analysis on port data and qualitative analysis on expert opinions of port logistics competitiveness. First, the entropy weight method was introduced to improve the objectiveness of quantitative data evaluation. Second, the port data was collected through multiple channels to calculate the optimal solution of each indicator under the guidance of the TOPSIS, which endowed the subjective rationality to such analysis and research.

The study in this paper was carried out in four steps. First, the relevant theoretical content, definition and connotation were clarified through reading the relevant literatures of the port logistics competitiveness, providing research ideas, methods and models for this paper. Second, on the basis of summarizing previous research results, and the logistics development status of Port of Shanghai, a port logistics competitiveness evaluation indicator system was constructed according to the principles of science, consistency and comparability. Third, five comparable ports were selected for evaluation and research according to certain standards. The original indicator data of the five ports in 1998, 2003, 2008, 2013 and 2018 were collected, and an empirical analysis was carried out by means of the TOPSIS entropy weight, to evaluate the port logistics competitiveness of China and make clear its existing strengths and weaknesses. Finally, measures and suggestions were put forward for specific problems on the basis of empirical analysis.

4.2. Principles for establishment of the evaluation system

The effectiveness of evaluating the port logistics competitiveness depends on whether the evaluation system is scientific and reasonable. Therefore, the process of constructing the evaluation system must follow the applicable principles, and its influencing factors must be considered in all aspects, by which, the existing problems may be further analysed and reasonable guidance and suggestions may be put forward. Port is an important infrastructure for foreign trade and a window for foreign exchange and trade in the city where the port is located, so it is of great significance to GDP of the city. The port logistics, a type of logistics service that relies on the port, involves many industries and operating processes, and it has developed a relatively complete logistics supply chain system. Therefore, the influencing factors were analysed firstly in this paper to evaluate the port logistics competitiveness. The principles below were complied with:
(1) Principle of purpose. Each indicator should be designed and selected oriented to the ultimate purpose. Any deviation from this principle may make the evaluation results meaningless. The port logistics competitiveness was evaluated in this for two purposes - to help analyse the competitiveness of various ports and the gap among them, and to make clear the port's strengths and weaknesses in competition based on analysis on the influencing factors of port logistics competitiveness, so as to provide suggestions for enhancing the port logistics competitiveness.
(2) Principle of science. The indicator system should be set based on the specific characteristics of the port logistics activities studied and the economic development level of the region, which may objectively reflect the current status of port logistics development, and draw on the results of previous studies to improve the accuracy of selected indicators.
(3) Principle of consistency. For the purpose of complete and scientific evaluation, the differences of the ports should be taken into full consideration when selecting the evaluation indicators, which should be uniform in calibre and common in characteristics.
(4) Principle of pertinence. There are relatively many indicators for selection due to the large amount of measurement angles and consideration factors, but not all of them are representative. Therefore, the main indicators must be selected in combination with the specific characteristics and the actual situation of the port being studied, and the specific analysis of specific issues should be made, so as to improve the effectiveness of the evaluation indicators.
(5) Principle of operability. For the purpose of effective evaluation, the data of the selected indicators should be collected effectively, have the possibility of actual operation, a reasonable quantity and appropriate content.
(6) Principle of development. The development of the port is not invariable all the time.

In the process of building an evaluation system, it is necessary to not only measure the past and current development status of the port, but also construct certain indicators to measure its development potential according to the existing characteristics and development trends, so as to establish a dynamic evaluation system to make a complete evaluation on port logistics competitiveness.

Selection of specific indicators for the evaluation system

The port is a huge and complicated transportation system that involves many enterprises and departments, and it may be influenced by factors such as economic environment, competitive environment, geographical environment and historical development. Therefore, there are many environmental factors that affect the port logistics competitiveness. In this paper, the influencing factors of port throughput and competitiveness were sorted out based on existing literature, and the environmental factors that affect port efficiency were summarized from the perspectives of economic politics, government planning, infrastructure and development potential.

The port is also an important infrastructure for foreign trade, and a window for the foreign communication and trade of the city where the port is located, which is of great significance to the GDP of the city. Port logistics is a kind of logistics service relying on the port. It involves many industries and has many operation processes, forming a set of relatively perfect logistics supply chain system. Therefore, in order to evaluate the competitiveness of port logistics, this paper begins with the analysis of its influencing factors:

(1) Economic conditions of port hinterland

The economic level of the port hinterland may be considered through indicators, mainly including specific data indicators such as GDP, proportion of industrial structure and total trade in the area where the port is located. Port hinterland refers to the scope of area that a port can radiate. Generally speaking, the higher the economic development level of the hinterland, the more it can create a good environment for the development of logistics in the region. First, the developed hinterland economy may attract the gathering of port-based industries and increase the demand for logistics, which may ensure the sufficient and stable supply of goods to a certain extent. Second, the developed hinterland economy may promote the growth of the foreign trade economy, attract the affiliation of large ships, and increase the port cargo transit volume, thus driving the demand for logistics. Therefore, a good level of economic development in the hinterland poses an important safeguard for logistics development, and the role of these indicators will be further amplified in the context of free trade zone. Therefore, the economic level of the port hinterland can be reflected by its urban GDP, the foreign trade import and export volume and other indicators of the hinterland city.

(2) Supply capacity of port logistics

The supply capacity of port logistics refers to the natural condition basis of the area where the port is located, including the number of port berths and draft conditions. In order to further improve the shipping efficiency and reduce the transportation cost at present, the upsized and specialized ships have become a new direction for the development of port logistics, which proposes higher requirements on the construction of the channel water depth and the number of berths. The two have become indispensable elements for improving the port logistics competitiveness in the new situation, and must be attached with enough importance. For this reason, we should follow the development trend and strengthen the construction of deep-water ports and berths as early as possible, with a view to taking up a seat in future competition. Therefore, indicators such as berth length, number of berths in the port, and water depth of the main channel were selected to reflect the competitiveness of port logistics.

(3) Demand conditions for port logistics

Port logistics is an important link of the logistics process that provide logistics services through the distribution and transfer of goods or containers. In this paper, the port logistics was studied in the context of the free trade zone. Due to the obvious regional advantages and convenient trade conditions of the free trade zone, the port import and export trade will be stimulated to a certain extent, which will increase the port cargo transit volume, bringing opportunities to the development of port logistics. As one of strengths of port logistics in a free trade zone it is an important criterion for measuring its competitiveness. Therefore, the port logistics demand capacity was measured by selecting indicators such as port cargo throughput and port container international transit volume.

(4) Port development potential

The port logistics system is not invariable all the time, and its various elements in the system will be constantly changing with the development of social economy. Therefore, the port logistics should not only look at the present, but also look to the future, and evaluate the port logistics competitiveness in a dynamic manner. The indicator of Port logistics development potential is evaluated from a dynamic perspective. The current measurement indicators are mainly static evaluation, but we need to respond more accurately with more comprehensive and reflective indicators in the face of the constantly changing new environment and new situation. Therefore, it is necessary to focus not only on the selection of current port service capacity data indicators, but also on the sustainable development potential of the port service capacity (mainly the increase rate of throughput) and the economic conditions in the port hinterland in considering the port development potential.

According to the above analysis, a three-grade indicator evaluation system was established based on the factors that affect the development of port logistics. The three grades of the evaluation system correspond to the respective indicator system. The first-grade indicator is the port logistics competitiveness, used for measuring the comprehensive port logistics competitiveness. The second-grade indicator covers four aspects, that is, the economic level of the port hinterland, the supply capacity of port logistics, the demand scale of port logistics demand, and the port development potential. Finally, the third-grade indicator is selected to evaluate and analyse 15 quantitative indicators, including water depth of main channel, number of container routes, growth rate of foreign trade in and out of cities and City GDP growth rate (as shown in Table 3).

Port logistics competitiveness	Economic level of port hinterland	City GDP ($100 million)
		Urban tertiary industries ($100 million)
		City foreign trade import and export volume ($100 million)
		The added value of tertiary industries accounts for the proportion of urban GDP (%)
	Supply capacity of port logistics	Berth length (km)
		Port berth (pcs)
		Number of 10,000dwt port berths (pcs)
		Water depth of main channel (m)

	Port logistics demand scale	Port cargo throughput (100 million tons)
		Port container throughput (10,000 TEU)
		Number of container routes
	Port logistics development potential	City GDP growth rate (%)
		Port container throughput growth rate (%)
		Cargo throughput growth rate (%)
		Growth rate of foreign trade in and out of cities (%)

Table 1 The indicator system of port logistics competitiveness

The specific meanings of the evaluation indicators are as follows:

(1) Port hinterland conditions

Urban GDP refers to the annual GDP of the city where the port is located, in RMB 100 million.

The total value of tertiary industries refers to the total output value of tertiary industries in the city where the port is located, in RMB 100 million.

The city's foreign trade import and export volume refers to the total value of port import and export trade realized in the year of the port city, in RMB 100 million

The added value of tertiary industries to the proportion of urban GDP refers to the ratio of the annual tertiary industries added value of the port city to the urban GDP, in RMB 100 million

(2) Supply capacity of port logistics

The number of 10,000dwt berths in a port refers to the total number of 10,000dwt berths that can be berthed in the coastal area of the port area, in pcs.
The berth length refers to the length along the shore of the wharf where the ship is parked, in m.
The number of berths in a port refers to the total number of berths that can be docked along the coast in the port area, in pcs.
Main channel water depth mainly refers to the deepest main channel water depth, in m.
(3) Demand scale of port logistics
Port cargo throughput refers to the weight of cargo that enters and exits the port area via waterways and has been loaded and unloaded during the year, in 10,000 tons.
Port container throughput refers to the number of standard containers transported out of water, imported into the port area, and loaded and unloaded during the year, in 10,000 TEU.
The number of container routes refers to the number of container liner routes in ports during the year, in pcs.
(4) Port development potential
GDP growth rate of the port city mainly refers to the annual GDP growth rate of the port city relative to the previous year's GDP, in (%).
Port cargo throughput growth rate refers to the proportion of the increase in cargo throughput in the current year to the cargo throughput in the previous year, in %.
Port container throughput growth rate refers to the proportion of container throughput growth this year to the container throughput of the previous year, in %.
The growth rate of the city's foreign trade import and export volume mainly refers to the growth rate of the total amount of goods actually entering and leaving our country's borders relative to the previous year in the city where the port is located, in %.

4.3. Evaluation model based on entropy weight TOPSIS

4.3.1. Introduction to entropy weight TOPSIS

The TOPSIS is an objective weighting analysis method generally used in multi-objective decision analysis. An optimal solution and a worst solution in were assumed in the plan to define the positive and negative ideal solutions, respectively. Then the distance between the optimal solution and the worst solution of each scheme will be separately calculated to determine which is better. According to the calculation, in general, the smaller the information entropy of the indicator, the greater the information it provides, and the higher the weight accordingly. However, their objective credibility is higher that than in fuzzy analysis and other more subjective methods. The specific operation steps are as follows.

(1) Establish judgment matrix A:

$$A = (a_j)_{n\times m} \quad (1)$$

(2) Normalize and process matrix A to matrix B:

$$B = (b_{ij})_{n\times m} \quad (2)$$

Where, $b_{ij} = \frac{a_{ij}}{\left[\sum_{i=0}^{n} a_{ij}^2\right]^{\frac{1}{2}}}$, i=1,2, …,n; j=1, 2, …, m.

(3) Calculate the evaluation indicator entropy e_j:

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

Where, p is the proportion of the i-th plan to be evaluated under the j-th indicator, $p_{ij} = \frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}}$

(4) Calculate the evaluation indicator entropy weight matrix W, where

$$w_j = \frac{1-e_j}{m-\sum_{i=1}^{n} e_j} \quad (4)$$

(5) Find the evaluation indicator weight set R, where

$$r_j = w_j b_{ij} \quad (5)$$

(6) Calculate the positive and negative ideal solutions Q_+ and Q_-:
$Q_+ = (r1^+, r2^+, \ldots, r_j^+)$

$$Q_- = (r1^-, r2^-, \ldots, r_j^-) \quad (6)$$

Where, $r_j^+ = max_{1\ll i\ll n} r_{ij}$, $r_j^- = min_{1\ll i\ll n} r_{ij}$

(7) Calculate the distance D+ and D− of each scheme from Q+ and Q−:

$$D_+ = \sqrt{\sum_{j=1}^{n}\left(r_{ij} - r_j^+\right)^2}$$

$$D_- = \sqrt{\sum_{j=1}^{n}\left(r_{ij} - r_j^-\right)^2} \quad (7)$$

(8) Calculate the relative closeness (evaluation indicator) of each solution to the ideal solution C_j:

$$C_j = D_-/(D_+ + D_-) \quad (8)$$

(9) Compare and rank the evaluation indicator. Larger evaluation indicator means it is closer to the ideal plan, its competitiveness is greater; otherwise, its competitiveness is smaller.

4.3.2. Explanation of evaluation model for port logistics competitiveness

First, a matrix A_j was established for each of the five secondary indicators in the port logistics evaluation system, where the rows of the matrix refer to different ports and the columns refer to the sub-indicators in each secondary indicator; the matrix was processed for standardization to get the matrix B_j; the weight R_j of the second-grade indicator and the third-grade indicator was calculated according to the steps of the above formulas (1)-(5); the evaluation indicator C_j of the secondary evaluation indicator was calculated according to formulas (6)-(8); and the five secondary indicators were ranked among different ports according to the evaluation indicators.
Second, a new matrix A was re-established for the evaluation indicators C_j of the five secondary indicators. The rows of the matrix refer to the ports, and the columns refer to the evaluation indicators of the five secondary indicators. Recalculation was performed in the above order to get the comprehensive evaluation index C of each port logistics, and then the comprehensive ranking of the port logistics competitiveness was determined.
Third, an analysis was made on the basis of the first two steps, the comprehensive competitiveness of port logistics was determined based on the ranking results in the second step, and then the gaps of different port logistics and the reasons for these gaps were analysed; The second-grade indicators of each port logistics competitiveness were specifically analysed based on the ranking results of the first step, and subdivided into the third-grade indicator a_{ij} under the second-grade indicator by the size of its contribution to the port logistics competitiveness, so as to analysing the key factors that influence the port logistics competitiveness.

5 Discussion

The original data sheet for the relevant data selected in this paper is shown in Table 1. The data sourced from the statistical bulletins of Shanghai, Zhoushan and Guangzhou from 1998 to 2019, Shanghai Maritime Safety Administration of PRC, 2004, 2014, 2009 and 2019 *China Ports Yearbook*, statistical data and yearbooks of National Bureau of Statistics (http://www.stats.gov.cn/), Data Custom on China Port Network (http://www.chinaports.com/), Clarkson, Shipping Network, Google, and the Port Authority, as well as the *Port Containerization Yearbook*.
This paper intends to evaluate the port logistics competitiveness of major ports in China and Europe, and Port of Rotterdam in the Netherlands, Port of Antwerp in

Belgium, and Port of Shanghai, Port of Ningbo Zhoushan and Port of Guangzhou in China were selected as the evaluation objects. The TOPSIS was introduced to evaluate the port logistics competitiveness of Port of Shanghai according to the data from 1998 to 2018 of their indicators. According to the TOPSIS, the data of each port in 1998, 2003, 2008, 2013 and 2018 were substituted into the formula for calculation to obtain the weights of Supply capacity of port logistics, port logistics demand capacity and other indicators for each year and the weights of specific indicators, such as city GDP, berth length, cargo throughput, and growth rate of city foreign trade import and export, and then the average of the five year was calculated, so as to measure the factors that exerted the greatest influence on the port logistics competitiveness. According to the final calculated results, the average weight of the Supply capacity of port logistics was 0.30608, the average weight of the Economic level of port hinterland was 0.29726, the average weight of the Port logistics demand scale was 0.20472, and the average weight of the Port logistics development potential was 0.20198. It can be seen that the supply capacity of port logistics exerted the greatest influence on the port logistics competitiveness, followed by the economic level of the port hinterland with a weak weight gap, it is precisely because of these two points that Chinese ports have achieved great development. The competitiveness of port logistics has been greatly improved. While the demand capacity and development potential weight were small, will a weak effect. It was discovered in subdivision that in the hinterland economy, the weights of the city's foreign trade imports and exports for five years were 0.1306, 0.1414, 0.1811, 0.0886, and 0.1072, respectively, accounting for nearly 50% of the Economic level of port hinterland, the second-grade indicator. Their weights in urban GDP were 0.0387, 0.0534, 0.1106, 0.0826, and 0.0864, respectively, suggesting that the influence of the two was greater, and the influence of the remaining three indicators was relatively small.

See Table 2 for the weight of the second-grade and third-grade evaluation indicators. Figures 4-1 to 4-5 plotted the scores and trend graphs of the four indicators such as Supply capacity of port logistics, and Figure 4-6 plotted the comprehensive logistics capacity scores of each port.

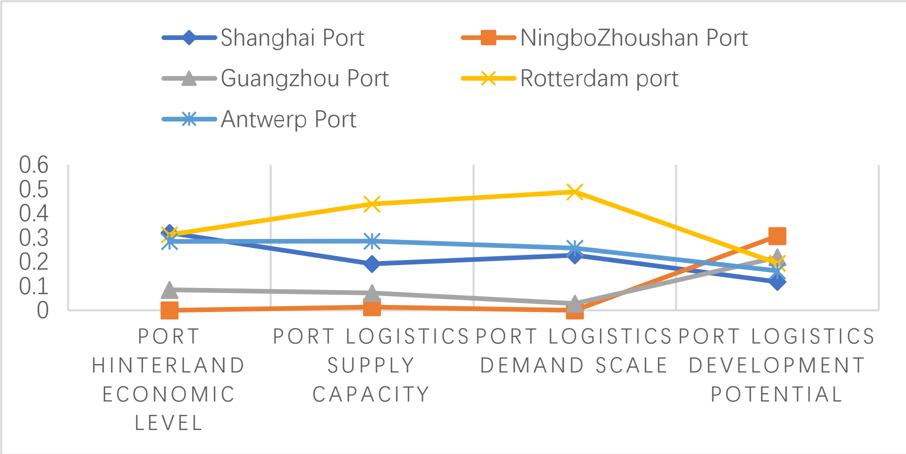


Figure 3-1 Second-grade indicator weights in the evaluation system of port logistics competitiveness（1998）

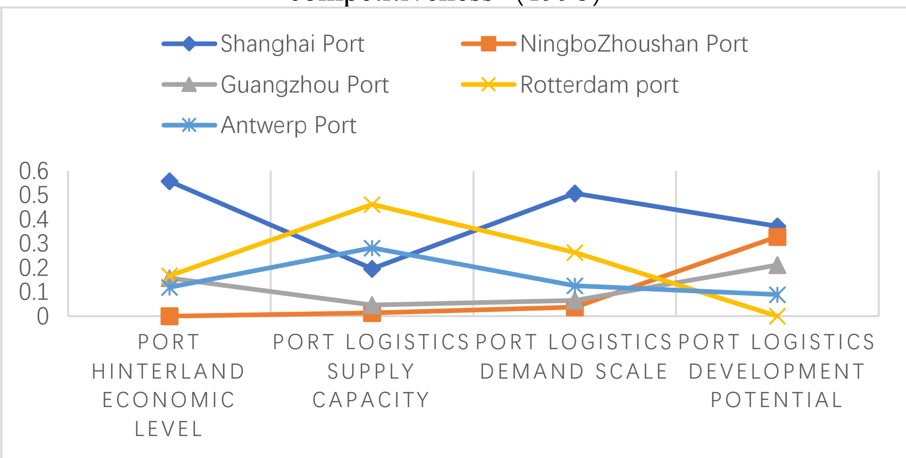


Figure 3-2 Second-grade indicator weights in the evaluation system of port logistics competitiveness（2003）

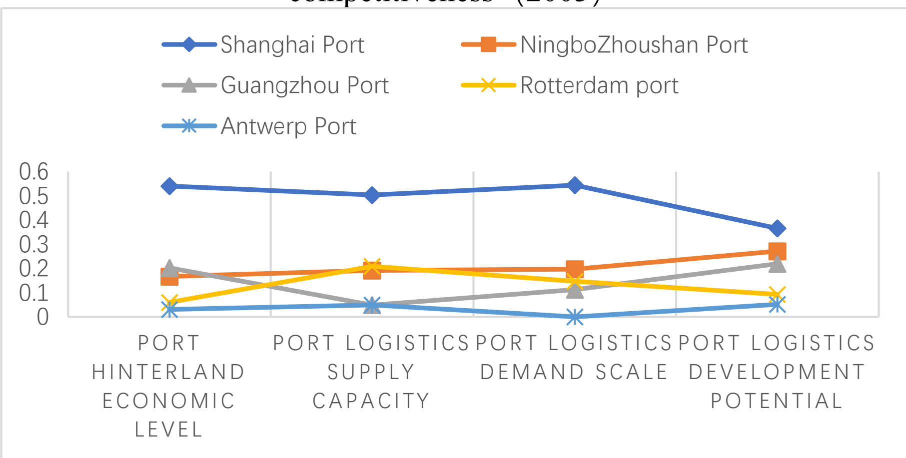


Figure 3-3 Second-grade indicator weights in the evaluation system of port logistics competitiveness（2008）

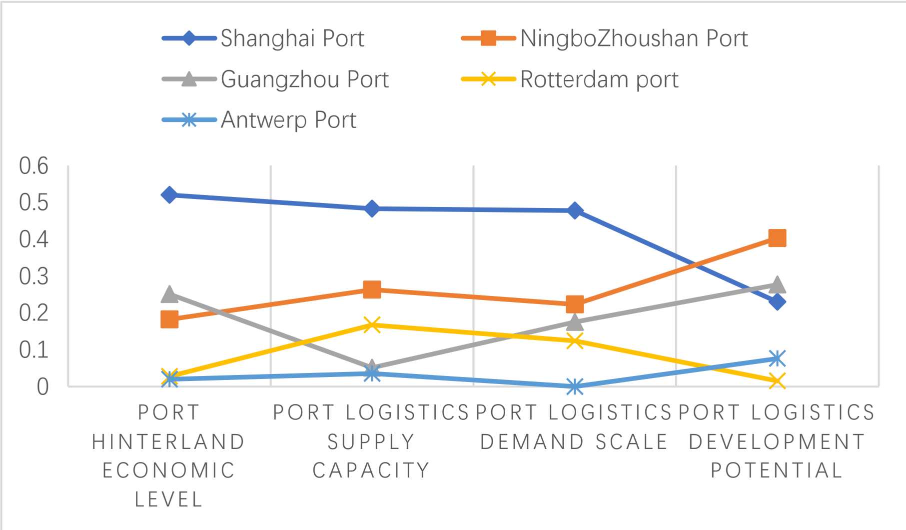


Figure 3-4 Second-grade indicator weights in the evaluation system of port logistics competitiveness（2013）

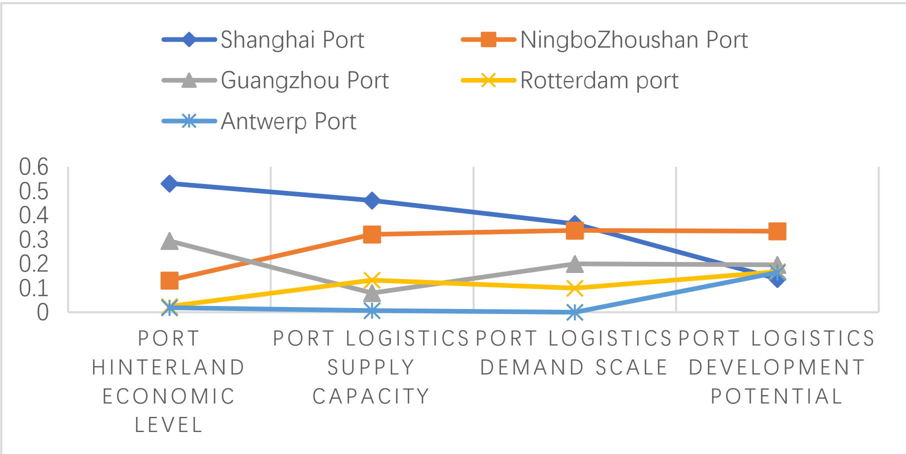
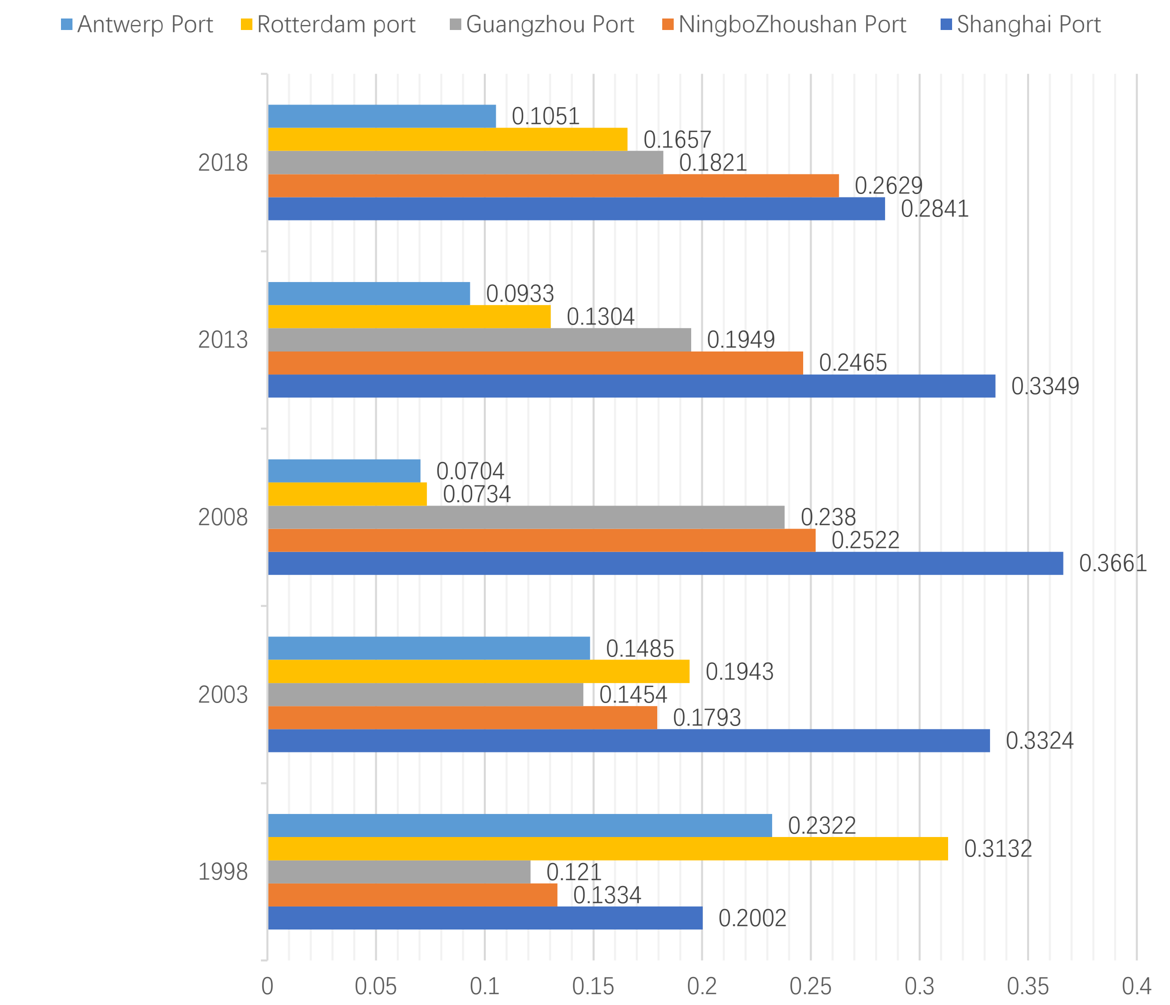


Table 3-5 Second-grade indicator weights in the evaluation system of port logistics competitiveness（2018）



	1998	2003	2008	2013	2018
Antwerp Port	0.2322	0.1485	0.0704	0.0933	0.1051
Rotterdam port	0.3132	0.1943	0.0734	0.1304	0.1657
Guangzhou Port	0.121	0.1454	0.238	0.1949	0.1821
NingboZhoushan Port	0.1334	0.1793	0.2522	0.2465	0.2629
Shanghai Port	0.2002	0.3324	0.3661	0.3349	0.2841

Figure 3-6 Comprehensive evaluation indicator of port’s logistics competitiveness

According to the results of empirical analysis, the comprehensive logistics score of Port of Shanghai increased from 0.2002 in 1998 to 0.2841 in 2018, from third to first, enjoying an absolute competitive advantage. The score of Port of Ningbo Zhoushan rose from 0.1334 in 1998 to 0.2629 in 2018, ranking from fourth to second, the gap of which with Port of Shanghai was gradually narrowing. The score ranking of Port of Guangzhou rose from the last to third. The score of Port of Rotterdam in the

Netherlands fell from 0.3132 in 1998 to 0.1657 in 2018, the ranking of which dropped from the first to the fourth. The score of Port of Antwerp in Belgium fell from 0.2322 in 1998 to 0.1051 in 2018, the ranking of which dropped from second to fifth.
According to the subdivision of secondary indicators of each port, as shown in the figure, the fluctuation of the economic curve of the port hinterland was relatively large, indicating that the score gap of each port was relatively large, which represented the competitive strength of each port in this influencing factor, as well as the great development of China's economy in the past two decades. In comparison with the hinterland economic curve, the supply capacity curve was more volatile, and the competitiveness of Port of Shanghai in this factor was very strong. Its development potential curve was flatter than the previous two curves, and the gap between the ports is very small. Port of Ningbo Zhoushan and Port of Guangzhou have obvious advantages and become a plus point that affects their comprehensive strength. The fluctuation and supply capacity of the demand capacity curve were much more moderate compared with the hinterland economy, but the fluctuation was still relatively large compared with the development potential.

Analysis on evaluation results of port logistics competitiveness:
Port, as a transportation hub and a window for foreign exchange, plays a pivotal role in promoting international trade and regional development. With the global economic integration, trade liberalization, and the rapid advancement of modern information technology and network technology, the modern logistics industry has rapidly grown into a new industry full of vitality that has unlimited potential and development space on a global scale. Acting as a node of the global comprehensive transportation network, the port is constantly expanding its functions, and no longer a simple place for goods exchange, but an important link in the international logistics chain.
After entering the 21st century, the process of economic globalization has sped up, the scientific and technological revolution has developed rapidly, the industrial structure has been continuously optimized and upgraded, and the competition in overall national strength has intensified. In order to adapt to the changes in the international situation and the needs of the rapid development of the national economy, the major ports of China are actively carrying out port development strategy research, developing and constructing port information systems, and investing a lot of money in large-scale deep-water and professional berth construction, setting off wave of the port construction.
As China is currently a developing country, both of its production and circulation and its volume of goods and imports and exports are increasing. The Netherlands and Belgium, however, are developed countries, their growth rate of production volume and trade volume is slow, and their increase in high technology and services will not cause any increase in port volume. In addition, Chin needs to add a lot of raw materials

to support its vigorous development of raw materials and foundational industries in modern times, such as the steel industry, coal industry, cement industry, and power industry, while Europe is developing their information industry, computer hardware, financial industry, and aerospace. Therefore, ports have a high degree of correlation with economic growth in China, but have a low degree of correlation with economic growth in European countries.

With the rapid growth of national economic strength and the good development trend of coastal areas in the 21st century, China's coastal port cities have seized the favourable opportunities of expanding domestic demand and foreign trade, and achieved rapid development. 2003 was an important year for Chinese ports because it witnessed that our national cargo throughput of ports reached 2.6 billion tons, ranking first in the world, and our container throughput of the port was far ahead of the world's growth rate, with a total volume of 48 million TEUs, surpassing the United States to become the first in the world. China's ports have reached a new level in terms of scale, professionalism and management level. The development of China's port industry is closely related to the development of the national economy and the reform of the national economic system. China's imports and exports have also increased significantly as its economic opening has greatly improved, and accordingly, the growth in demand will inevitably usher in the rapid development of the port industry. China's Supply capacity of port logistics has significantly improved with the continuous improvement of foreign trade. At present, China's coastline totals 33,200km, including the mainland coastline of about 18,400km. The rich coastline resources have laid a solid foundation for the development of China's port industry.

Factors influencing the development of China's port industry in the past two decades:

①Strong support from national and local policies

The port industry plays an important basic role in the development of the national economy as a major component of the country's important transportation infrastructure industry, gaining relatively high social benefits. The Chinese government attached great importance to the port industry and included it as a priority development policy with preferential policies in taxation.

②The rapid development of China's economy created a huge market demand for the port industry

The sustained and rapid growth of China's economy directly drove the demand for basic raw materials such as steel, petroleum, and metal ores to rise sharply, and also drove the consumption of energy such as coal and petroleum. This demand characteristic of China's basic raw materials will not change in the future for a considerable period of time, and a huge market demand for the bulk cargo business of China's port industry such as coal, oil and metal ore will be posed. China's foreign trade volume will also continue to grow as the global manufacturing centre gradually shifts to developing countries, and a stable market demand for China's port industry container business will be generated.

③ The improvement of transportation infrastructure construction created a good transportation environment for the port industry

During the 12th Five-Year Plan period, we will push forward the construction of highway, waterway, civil aviation, and postal infrastructure networks, strengthen infrastructure connections, optimize the layout of comprehensive transportation infrastructure networks, and enhance the supply capabilities of comprehensive transportation in accordance with the *National Highway Network Plan* and *Medium- and Long-Term Railway Network Plan*, the *"12th Five-Year Plan" Outline of China's National Economic and Social Development* reviewed and approved in 2011, and the *"12th Five-Year" Development Plan* issued in 2011.

It can be seen from the changes in the comprehensive competitiveness of port logistics that the competitiveness comprehensive score of Port of Shanghai has been far ahead of other ports since 2003, and enjoyed prominent leading advantages compared with all other ports, because Port of Shanghai had the most excellent basic conditions and greater advantages than the other ports in port line resources and wharf resources, which continues to reserve an unmatched role among the competition cities with the construction of new port projects like Yangshan Deepwater Port. As the leader of the Yangtze River Delta region and China's economic centre, Shanghai provides a huge development foundation and hinterland resources for Port of Shanghai in terms of economic conditions. However, Port of Shanghai has fallen behind the other two ports in terms of development potential due to the present development pattern of China. The adjustment such as change in the original development mode of the Yangtze River Delta region where Port of Shanghai is located may exert a significant influence on the development potential of Port of Shanghai. In addition, it does not have a sufficient growth momentum in the international trade. Although Port of Shanghai, as the largest port in China, boasts a profound foundation of import and export trade resources from its direct hinterland, it still needs to continue to make efforts in import and export trade and expand the import and export sources from the hinterland to increase its attractiveness. Under the condition that the current leading position of Port of Shanghai is hard to shake in the short term and a solid practical foundation has been laid, great impetus should be given unwaveringly to the design and implementation of its international shipping centre strategy. Generally speaking, the hardware infrastructure and economic base for port development should be firmly constructed by Port of Shanghai, and great efforts should be made to constantly enhance its soft power, increase its attractiveness, and vigorously expand its hinterland sources of goods and customers sources of shipping line in compliance with to the fact of China's economic restructuring; At the same time, Port of Shanghai should take the opportunity of building its own international shipping centre to enhance its international competitiveness and actively participate in international competition.

After 2008, Ningbo-Zhoushan Port ranked second in comprehensive competitiveness, with a relatively large gap from Port of Shanghai, and but it also left a large lead edge over other ports. Its supply capacity of port logistics was close to that of Port of Guangzhou, indicating that Ningbo-Zhoushan Port boasted good hardware infrastructure and economic base. Especially, the new port after merger of Port of Ningbo and Port of Zhoushan enjoys much better port coastline resources and wharf resources than before. Ningbo-Zhoushan Port should make more effort in resources integration on the basis of the new port, so as to attain breakthrough progress in terms of port operation and management system, market competition strategy and optimization of port resources. Ningbo-Zhoushan Port, residing in the south flank of the economically developed Yangtze River Delta in China, has a gap from Port of Shanghai in terms of economic base. But as the largest and strongest port in Zhejiang Province with developed economy, especially private economy, it can obtain hinterland resources easily. Benefiting from the huge economic base of Zhejiang Province, Ningbo-Zhoushan Port is provided with a stable economic base for development. Its potential advantages are not obvious due to China's economic restructuring in developed coastal areas, especially the Yangtze River Delta and the Pearl River Delta, which was relatively similar to the situation of Port of Shanghai. However, we can see that Ningbo-Zhoushan Port has a very good foreign trade development momentum, which may be caused by the merger of the new ports. that its second strongest position in competitiveness among national coastal ports is very stable. Therefore, it needs to achieve a new leap in the new era and new situation, especially with the implementation of the marine economic zone development strategy in Zhejiang Province. Generally speaking, great effort should be made to enhance the resource integration capability of Ningbo-Zhoushan Port after the merger, and attention should be paid to the coordinated development with the economic restructuring of the coastal areas on the premise of consolidating the original development hardware foundation and economic base, so as to achieve new breakthroughs in the new round of development.

Port of Guangzhou ranked third, with a huge gap with Port of Shanghai and a certain gap with Ningbo-Zhoushan Port. It can be seen from the scores of the second-grade indicators that the development base of Port of Guangzhou in port production scale, port hardware base and hinterland economic base was very good, because the economically developed Pearl River Delta where Guangzhou is located enjoys a high level of economic development and a huge economic aggregate, as well as excellent development conditions for its close distance to the international port of Hong Kong. However, its development potential of the port logistics dropped due to the financial crisis and the major transformation of China's economic development, translating into a significant negative influence on the development potential of the port, the reason of which was the same as that of Port of Shanghai and Ningbo-Zhoushan Port, but its influenced degree was much larger. Meanwhile, its foreign trade development momentum encountered severe challenges. Therefore, Port of Guangzhou should make continuous efforts to expand its hinterland, otherwise it will be easily affected to the instable local economic development. Generally speaking, Port of Guangzhou should further enhance its strain and anti-risk capabilities on the basis of the original development, optimize the customer resource structure on the basis of expanding the total customer resources, and actively deal with the new situation of international and domestic economic development.

However, we must understand that although China's port industry has made tremendous progress and the port logistics competitiveness has continued to increase from 0.2002 in 1998 to 0.2841 in 2018, we are still in the face of many problems and challenges:

① Shortage in quality coastline resource

The port coastline is a non-renewable important resource for the sustainable development of ports and a strategic resource for national economic development. It can be seen from the second-grade indicators for supply capacity of port logistics that China, one of the countries with the longest coastline in the world, does not have relatively adequate and evenly distributed deep-water coastline for the construction of various types of coastal ports with 10,000dwt and above berths.

② Aggravated industry competition

Increased investment has been put into ports in various regions in recent years. According to the evaluation system of port logistics competitiveness, it can be seen from the second-grade indicators for economic level of port hinterland that because of the development of our cities, Chinese ports had achieved great development in economic level of port hinterland. But due to the fact that many ports were relatively close in distance, with overlapped or partly crossed landward hinterlands, leading to aggravated competition among these ports. On the one hand, the aggravated competition promoted port enterprises to rely on service quality and price to compete; on the other hand, it also sped up the integration of the port industry, especially the cooperation of ports in the region to enhance the overall competitiveness.

③ Slowdown in global economic growth in the short term

From the port logistics development potential， we can see that the city GDP growth rate and growth rate of foreign trade in and out of cities showed a decline in recent years. It can be seen that the slowdown in the United States and global economic growth may get developing countries such as China stuck in the risk of reduced exports, which may lead to a slowdown in the foreign trade business of China's port industry, especially the foreign trade business of containers.

Even though the port logistics competitiveness of China has taken up the main position in the world's port logistics competitiveness ranking, it does not mean that the development level of China's ports has reached the world's leading level. Judging from the overall level of port development, European ports are among the front row in the world. Europe is the cradle of the world shipping. The Port of Rotterdam became the second largest commercial port in the Netherlands in 1600. The total tons of shipping in the whole Europe account for about 45% of the world. Europe has a very developed transportation network, with about 350,000km of railways and 4.2 million km of highway in total, which has played a very important auxiliary role in the operation of the port, and allowed its goods to be circulated in a quicker manner. The European ports are provided with the world-class equipment. For instance, the Port of Antwerp is known as the "Supermarket of Europe" due to its huge warehousing capacity. The CTA wharf in the Port of Hamburg is installed with the most advanced loading and unloading equipment and cargo management system, and known as the container wharf with the most advanced facilities in the world. Therefore, China's ports need to make improvements in these areas.

6 Conclusion

It is discovered via the empirical analysis in Chapter V that among the above four influencing factors of port logistics competitiveness, Supply capacity of port logistics and hinterland economy account for the largest weight, exerting a significant influence on logistics competitiveness. It is precisely because of the advantages in these two areas that the comprehensive strength of China's ports continues to improve.
As stated in the empirical analysis results in Chapter IV, Port of Shanghai tops in the comprehensive raking, followed by Port of Ningbo Zhoushan. In view of the geographical point, both Port of Shanghai and Port of Ningbo Zhoushan are covered in the Yangtze River Delta Port Group, which not only face the problem of overlapped economic hinterland, but also withstand the competitive pressure from the two major domestic port groups - the Pearl River Delta Port Group and the Bohai Bay Port Group, and the foreign port groups in the region also pose great challenges to them. Opportunity may accompany with the challenges. Although competition cannot be avoided, opportunities for cooperation are created. Excessive competition between the two major ports arises on issues such as repeated port infrastructure construction and

resource allocation as the total supply of goods in the region has basically stabilized, cutting down the efficiency of port resource utilization. Therefore, cooperation is the general trend for them and can also solve the problem of overlapped or partly crossed landward hinterlands. Meanwhile, the port acts as the carrier for carrying out logistics activities, and logistics is the process of transferring goods through this carrier. The port has greater cargo transit volume will enjoy more transit cargo sources and more prominent advantages in the port logistics competition. It will be increasingly important in enhancing the port logistics competitiveness. Therefore, it is of great important to develop transit business and improve the transportation system. The high degree of trade liberalization and convenience of the free trade zone may enhance port freedom and convenience, and the important role of a free trade zone in port logistics lies in its freedom and convenience. Thus, full attention should be paid to the role of freedom degree and convenience of ports in enhancing the port logistics competitiveness.

On the basis of the previous research results of port logistics competitiveness, the important factors that influence the port logistics competitiveness were summarized to construct a logistics competitiveness evaluation indicator system in this paper by sorting out the relevant theories of port competitiveness and combining them with objective reality. To study the logistics competitiveness of Port of Shanghai, 15 representative evaluation indicators were selected to analyse the data of five sample ports including Port of Shanghai from 1998 to 2018 by means of entropy weight TOPSIS, and reasonably evaluate the level and status of logistics competitiveness of Port of Shanghai. The details are as follows:

(1) The background of the research subject selected was discussed, the significance of the research was analysed based on this background, and the research methods used in the process of writing the paper were introduced in details. The definition and characteristics of port logistics competitiveness were clearly stated based on the literature review, and the theoretical methods of related research were introduced.

(2) A port logistics competitiveness evaluation system and various evaluation indicators were constructed on the basis of analysing the influencing factors of port logistics competitiveness and drawing on other scholars' articles, in which, Port of Rotterdam in the Netherlands, Port of Antwerp in Belgium, and Port of Shanghai, Port of Ningbo Zhoushan and Port of Guangzhou in China were selected as the evaluation objects.

(3) The entropy weight TOPSIS was introduced. The port logistics competitiveness level and changes in 1998, 2003, 2008, 2013 and 2018 were evaluated and analysed based on calculations. First, the weight of the four factors of port logistics competitiveness was calculated using the entropy weight analysis method. The larger weight means a greater influence. The calculation results suggested that the

influencing factors from large to small were successively Supply capacity of port logistics, port hinterland economic conditions, Port logistics demand scale and Port logistics development potential. Second, the four influencing factors were analysed in detail, the results of which suggested the Chinese ports significantly improved their competitive advantages in logistics supply capacity and economic level in the hinterland in the past two decades, laying a foundation for their increasing rising comprehensive logistics competitiveness. Finally, the comprehensive logistics competitiveness of each port evaluated was ranked, and Port of Shanghai ranked the first in the comprehensive strength. In addition, the directions for the current positioning and future development of China's ports are pointed out after clarifying the strengths and weaknesses of China's ports.

(4) Through the analysis on the empirical results of China's port logistics competitiveness, their strengths and weaknesses were discovered, and pointed references for development were made. First, to enhance the freedom and convenience of the port, to make full use of the free trade environment and preferential policies of the free trade zone, to drive the development of foreign trade, and to encourage clustering development of logistics. Second, to speed up the construction of deep-water ports and container ports, and to actively promote the construction of Yangshan deep-water ports. Third, to strengthen cooperation with neighbouring ports and achieve mutual benefit and win-win cooperation.

Fourth, to improve the capacity of gathering and transportation, to develop transit business, and to attract more ships and cargo sources.

A logistics evaluation indicator system was established in this paper, the entropy weight analysis method was introduced for the empirical analysis on the logistics competitiveness of Port of Shanghai, and corresponding development suggestions were put forward. However, the port logistics competitiveness involves many aspects, and the research on its evaluation is a complex and huge systematic work. It is not easy to obtain information, and the paper needs to be improved due to my limited level of knowledge. In addition, some qualitative indicators were not considered in the establishment of the evaluation indicator system of port logistics competitiveness due to their strongly subjective assignment, and it may be further solved and improved in the follow-up research work. The influencing factors of port logistics competitiveness will change with the economic environment and the diversity of needs. Especially, the increasing perfection of Shanghai Pilot Free Trade Zone and the implementation of the Belt and Road Initiative will exert a higher influence on the logistics competitiveness of Port of Shanghai, which poses a key research direction in the future.

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Appendix A: Raw data of each port (1998—2018)

The second-grade indicator	The third-grade indicator	Port of Shanghai	Port of Ningbo Zhoushan	Port of Guangzhou	Port of Rotterdam	Port of Antwerp
Economic level of port hinterland	City GDP ($100 million)	445.43	118.36	222.72	320	264
	Urban tertiary industry ($100 million)	212.86	41.43	111.55	227.2	190.08
	City foreign trade import and export volume ($100 million)	636.4	45.45	130.63	680.6	664

	The added value of tertiary industries accounts for the proportion of urban GDP (%)	47.8	35	50.09	71	72
Supply capacity of port logistics	Berth length (km)	23.56	7.49	13.5	40	34
	Number of port berths (one)	225	69	141	560	350
	Number of 10,000-ton berths (one)	70	20	32	85	68
	Depth of main channel (m)	12.5	16	13	21	17

Port logistics demand scale	Port cargo throughput (tons)	1.64	0.87	0.87	3.12	1.78
	Port container throughput (10,000 TEU)	306.63	35.2	40.76	571	299
	Number of container routes	42	21	32	86	78
	Urban GDP growth rate (%)	10.1	11.6	13	5.09	2.27
Port logistics development potential	Port container throughput growth rate (%)	21.2	37.1	15.8	13.52	10.74
	Cargo throughput growth rate (%)	0	5.9	3.9	5.2	4.6

	Growth rate of urban foreign trade import and export volume (%)	8.4	6.1	12.5	7.8	9.1

Table 2-1 Raw data of each port in the year 1998

The second-grade indicator	The third-grade indicator	Port of Shanghai	Port of Ningbo Zhoushan	Port of Guangzhou	Port of Rotterdam	Port of Antwerp
Economic level of port hinterland	City GDP ($100 million)	755.84	214.01	419.18	351.54	287
	Urban tertiary industry ($100 million)	366.04	78.71	224.62	681.11	638.38

	City foreign trade import and export volume ($100 million)	1123.97	188.1	349.44	421.6	206.4
	The added value of tertiary industries accounts for the proportion of urban GDP (%)	48.4	36.8	53.6	72	74
Supply capacity of port logistics	Berth length (km)	25.6	8.88	12.4	40	34
	Number of port berths (one)	215	76	122	600	380

	Number of 10,000-ton berths (one)	82	23	32	94	70
	Depth of main channel (m)	12.5	16	13	21	17
Port logistics demand scale	Port cargo throughput (tons)	3.16	1.85	1.92	3.2	1.43
	Port container throughput (10,000 TEU)	1128.2	277.22	335.06	663	496
	Number of container routes	95	60	89	91	89
	Urban GDP growth rate (%)	11.8	15.3	15	7.8	15.62

Port logistics developme nt potential	Port container throughpu t growth rate (%)	31	49.2	23.3	7.8	15.62
	Cargo throughpu t growth rate (%)	19.9	20.9	14.5	1.8	8.8
	Growth rate of urban foreign trade import and export volume (%)	54.7	33.3	25.1	5.14	6.02

Table 2-2 Raw data of each port in the year 2003

The second-grade indicator	The third-grade indicator	Port of Shanghai	Port of Ningbo Zhoushan	Port of Guangzhou	Port of Rotterdam	Port of Antwerp

Economic level of port hinterland	City GDP($100 million)	1879.03	543.77	1127.00	412	304
	Urban tertiary industry ($100 million)	1008.29	219.48	665.18	304.88	227.696
	City foreign trade import and export volume ($100 million)	3221.38	1401.9	819.52	887.4	882.63
	The added value of tertiary industries accounts for the proportion of urban GDP (%)	53.7	40.4	64.6	74	74.9

Supply capacity of port logistics	Berth length (km)	114.9	61.57	43.18	67	52.72
	Number of port berths (one)	1141	667	503	650	400
	Number of 10,000-ton berths (one)	137	94	56	99	73
	Depth of main channel (m)	14	18	16	20	16
Port logistics demand scale	Port cargo throughput (tons)	5.82	3.62	3.47	4.2	1.89
	Port container throughput (10,000 TEU)	2800.6	1084.6	1097.15	1080	866
	Number of	200	210	102	110	98

	container routes					
	Urban GDP growth rate (%)	9.7	10.1	12.3	2	1.15
Port logistics development potential	Port container throughput growth rate (%)	7.1	16	18.5	1.37	6
	Cargo throughput growth rate (%)	3.6	4.8	1	2.7	3.5
	Growth rate of urban foreign trade import and export volume (%)	13.8	25.5	11.5	4.23	5.13

Table 2-3 Raw data of each port in the year 2008

The second-grade indicator	The third-grade indicator	Port of Shanghai	Port of Ningbo Zhoushan	Port of Guangzhou	Port of Rotterdam	Port of Antwerp
Economic level of port hinterland	City GDP ($100 million)	3439.83	1135.18	2455.44	418.34	304.19
	Urban tertiary industry ($100 million)	2140.93	495.35	1586.61	320.86678	234.2263
	City foreign trade import and export volume ($100 million)	4413.98	2119	1188.88	892.4	864.5

	The added value of tertiary industries accounts for the proportion of urban GDP (%)	62.2	43.6	64.62	76.7	77
Supply capacity of port logistics	Berth length (km)	123.99	81.26	49.27	70	55
	Number of port berths (one)	1191	683	545	660	420
	Number of 10,000-ton berths (one)	170	146	68	99	75
	Depth of main channel (m)	16	17	13	21	17

Port logistics demand scale	Port cargo throughput (tons)	7.76	4.96	4.73	4.41	1.91
	Port container throughput (10,000 TEU)	3361.7	1677.4	1550.45	1166	858
	Number of container routes	220	235	150	125	105
	Urban GDP growth rate (%)	7.7	8.1	11.6	-0.7	0.3
Port logistics development potential	Port container throughput growth rate (%)	3.3	7	5.2	-1.7	-0.58
	Cargo throughput growth rate (%)	5.5	9.5	4.8	-0.22	3.5

	Growth rate of urban foreign trade import and export volume (%)	1.1	7.3	1.5	-0.62	-1.09

Table 2-4 Raw data of each port in the year 2013

The second-grade indicator	The third-grade indicator	Port of Shanghai	Port of Ningbo Zhoushan	Port of Guangzhou	Port of Rotterdam	Port of Antwerp
Economic level of port hinterland	City GDP ($100 million)	4770.78	1568.76	3337.13	486	397
	Urban tertiary industry ($100 million)	3334.74	720.00	2394.43	384.426	301.72

	City foreign trade import and export volume ($100 million)	4964.95	2338.18	1432.14	997.52	900.29
	The added value of tertiary industries accounts for the proportion of urban GDP (%)	69.9	45.9	73	79.1	76
Supply capacity of port logistics	Berth length (km)	107.23	96.84	55.28	76	57.2
	Number of port berths (one)	1054	707	556	656	450

	Number of 10,000-ton berths (one)	224	178	96	102	90
	Depth of main channel (m)	17	23	17	22	17.5
Port logistics demand scale	Port cargo throughput (tons)	7.3	10.8	6.13	4.69	2.35
	Port container throughput (10,000 TEU)	4201.02	2635.1	2192.21	1451	1110
	Number of container routes	300	250	209	150	125
	Urban GDP growth rate (%)	6.6	7	6.2	3.2	1.7

Port logistics development potential	Port container throughput growth rate (%)	4.4	7.1	7.6	5.9	6.22
	Cargo throughput growth rate (%)	-2.7	10.8	3.9	0.43	4.91
	Growth rate of urban foreign trade import and export volume (%)	5.5	15.8	1	13.9	10.6

Table 2-5 Raw data of each port in the year 2018

Appendix B: Second- and three-grade indicator weights in the evaluation system of port logistics competitiveness (1998—2018)

Port hinterland economic level	0.2432	City GDP	0.0387	Urban tertiary industry	0.0575	City foreign trade import and export	0.1306	The proportion of tertiary industry increase in urban GDP	0.0164
Port logistics supply capacity	0.23	Berth length	0.0681	Number of port berths	0.0993	Number of 10,000-ton berths	0.0538	Depth of main channel	0.0088
Port logistics demand scale	0.3514	Port cargo throughput	0.0563	Port container throughput	0.1698	Number of container routes	0.0601	Urban GDP growth rate	0.0652
Port logistics development potential	0.1755	Port container throughput growth rate	0.0493	Cargo throughput growth rate	0.1128	Growth rate of urban foreign trade import and export volume	0.0134		

Table 3-1 Second- and three-grade indicator weights in the evaluation system of port logistics competitiveness (The year 1998)

Port hinterland economic level	0.246	City GDP	0.0387	Urban tertiary industry	0.0486	City foreign trade import and export	0.1414	The proportion of tertiary industry increase in urban GDP	0.0173
Port logistics supply capacity	0.2694	Berth length	0.0681	Number of port berths	0.1266	Number of 10,000-ton berths	0.0647	Depth of main channel	0.01
Port logistics demand scale	0.1487	Port cargo throughput	0.0563	Port container throughput	0.0704	Number of container routes	0.0065	Urban GDP growth rate	0.0155
Port logistics development potential	0.3139	Port container throughput growth rate	0.0534	Cargo throughput growth rate	0.1001	Growth rate of urban foreign trade import and export volume	0.1604		

Table 3-2 Second- and three-grade indicator weights in the evaluation system of port logistics competitiveness (The year 2003)

Port hinterland economic level	0.3989	City GDP	0.1106	Urban tertiary industry	0.0953	City foreign trade import and export	0.1811	The proportion of tertiary industry increase in urban GDP	0.0119
Port logistics supply capacity	0.0937	Berth length	0.0308	Number of port berths	0.0334	Number of 10,000-ton berths	0.0258	Depth of main channel	0.0037
Port logistics demand scale	0.2425	Port cargo throughput	0.0289	Port container throughput	0.0561	Number of container routes	0.0296	Urban GDP growth rate	0.1279
Port logistics development potential	0.265	Port container throughput growth rate	0.1201	Cargo throughput growth rate	0.0469	Growth rate of urban foreign trade import and export volume	0.098		

Table 3-3 Second- and three-grade indicator weights in the evaluation system of port logistics competitiveness (The year 2008)

Port hinterland economic level	0.3023	City GDP	0.0826	Urban tertiary industry	0.093	City foreign trade import and export	0.0886	The proportion of tertiary industry increase in urban GDP	0.0381
Port logistics supply capacity	0.2688	Berth length	0.077	Number of port berths	0.0668	Number of 10,000-ton berths	0.0807	Depth of main channel	0.0443
Port logistics demand scale	0.2413	Port cargo throughput	0.0428	Port container throughput	0.0739	Number of container routes	0.0625	Urban GDP growth rate	0.0621
Port logistics development potential	0.1876	Port container throughput growth rate	0.0577	Cargo throughput growth rate	0.0428	Growth rate of urban foreign trade import and export volume	0.0871		

Table 3-4 Second- and three-grade indicator weights in the evaluation system of port logistics competitiveness (The year 2013)

Port hinterland economic level	0.3253	City GDP	0.0864	Urban tertiary industry	0.0974	City foreign trade import and export	0.1072	The proportion of tertiary industry increase in urban GDP	0.0343
Port logistics supply capacity	0.3201	Berth length	0.0755	Number of port berths	0.0615	Number of 10,000-ton berths	0.0681	Depth of main channel	0.115
Port logistics demand scale	0.219	Port cargo throughput	0.0487	Port container throughput	0.0669	Number of container routes	0.0578	Urban GDP growth rate	0.0456
Port logistics development potential	0.1354	Port container throughput growth rate	0.0398	Cargo throughput growth rate	0.0507	Growth rate of urban foreign trade import and export volume	0.0449		

Table 3-5 Second- and three-grade indicator weights in the evaluation system of port logistics competitiveness (The year 2018)