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The Impact of Port Integration on the Pattern of Chinese Port

by

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Abstract

With the astonishing development of China's economy, Chinese ports are experiencing rapid changes. As far as transport capacity is concerned, Chinese ports have absolute advantages in the maritime industry. The operation form and development strategy of Chinese ports also escalate along with the economic and policy changes. In recent years, some adjacent ports have been integrated due to policy and market factors, and most of the cases about integration are successful. At present, almost all coastal provinces and cities in China are fully promoting the integration of ports in the region. In the next few years, "one province one port" is likely to become the basic mode of port development in China.

Chinese ports are divided into five clusters. We merge the southeastern coastal port cluster, the Pearl River Delta port cluster and the southwestern coastal port cluster into the South China Sea port cluster. In this paper, Chinese ports are re-divided into three clusters: Bohai port clusters, Yangtze River Delta port clusters and South China Sea port clusters.

Through SPA, we analyze the changes of the overall transport capacity of the three port groups before and after integration, the performance of the internal traffic types of each port, the performance of the integrated ports in different traffic types and the change of diversity of the ports before and after integration.

Key words: port integration, port cluster, SPA, PPA, PDA

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Chapter 1 Introduction

Influenced by the policy of reform and opening, the growth rate of China's GDP is astonishing. Especially in the late 1980s, a large number of international capitals poured into the Chinese market, which directly enhances the market's demand for Chinese port services (Notteboom & Yang, 2017). After that, China has gradually become one of the most important import and export countries in the world. According to the 2017 trade statistics published by the World Trade Organization (WTO), the total amount of China's trade limited to goods (the total import and export) was $4.105 trillion, which took the first place in the world.

Geographically, most of China's territory is adjacent to its neighbors. There are 34 Administrative Regions in China, of which only 14 administrative regions are coastal. So, the trade load of every unit of China's coastline is very large. Therefore, impacted by two factors, policy and geography, the rapid development of Chinese ports in the past decades is understandable. Since 2011, China has occupied at least 7 positions in the top 10 ports of the world, whether counted by loading and unloading containers or by weight.

From the late 1980s to the beginning of 21st century, the change of China's port pattern was very small, and there was no large-scale integration of large ports. China's Ministry of Communications promulgated the port law in 2003, changing the jurisdiction of China's coastal ports from the central government to provincial government where the port is located (Wang & Oliver, 2004). In the same year, the Ministry of transportation proposed a plan for coastal ports to speed up the integration of resources. Since then, China's port industry has undergone large-scale integration, involving about 40 ports. Especially in 2005-2006, two years, 16 port enterprises have been integrated, reaching a peak in the history of China's port development. The integrated pattern basically laid the general model of China's ports at present and has greatly changed the distribution of the original structure. After this integration, the number of Chinese port enterprises declined sharply, followed by the sharp drop in the port authorities. But it is important to note that, after such a large-scale port integration, the original port is not abolished, and most of the ports are integrated into new units. (Wang & Ducruet 2015)

The implementation of this law has directly changed the pattern of Chinese port development. After that, the market mechanism had brought a greater impact on the development of Chinese port enterprises. On the one hand, Chinese port enterprises pay more attention to profitability, thus enhancing their business efficiency. On the other hand, after reducing the overall macroeconomic regulation and control, the competition between ports in the provinces has become increasingly fierce. This point foreshadows the integration and competition of Chinese ports in the future.

In the late 80s, Ports are integrated at the city level, which means that the pre-integrated ports are in the same city (the earliest case is Guangzhou Port was merged with Huangpu Port in 1987). Later, the integration of port was developed to the level of adjacent cities (for example, Yantai Port was merged with Penglai Port in 2005). A major action which impacts on China's port integration deeply is the integration of Ningbo port and Zhoushan port in 2006. After integration, Ningbo-Zhoushan Port became the largest port in the world (calculated by tonnage) and became the first port in the world shipping history to break through 10 million tons of annual throughput in 2017. The successful port integration formed a demonstration effect: many port enterprises regard integration as a key strategy for the development.

It is worth mentioning that in the process of integration of these ports, except for the merger of port companies and the capital cooperation between enterprises, some port enterprises have formed the port strategic alliance. This form enriches the mode of port cooperation in China. For example, in 1997, the Ministry of communications advocated Shanghai, Jiangsu and Zhejiang to form the port group of Shanghai.

With the flourishing of import and export trade, many capitals are flowed into port construction in China, which has led to a preliminary overcapacity situation in the Chinese port pattern. Port integration is an efficient way to optimize the allocation of resources to reduce excessive construction and investment. At present, many Chinese port enterprises are carrying out resources integration in provinces.

In the process of inter-provincial port integration, we want to study its impact on China's ports, such as the impact on the relative relationship between ports in the region, the impact on traffic types and the impact on diversity. So, in this thesis, the main question of this thesis is whether port integration affects port performance. The sub-questions are how the integrated ports behave under different traffic categories, whether their internal share is related to the external share and growth rate, and whether the integration has an impact on the diversity of the ports. The second chapter introduces the mainstream views and developments in related fields. The third chapter introduces the research methods of thesis and the reasons for selection. The fourth chapter introduces the main ports and integration status of each port cluster. The fifth chapter to the seventh chapter carries on the analysis to three port clusters respectively. The conclusion of the thesis is in the eighth chapter.

Chapter 2 Literature Review

The study of port integration involves many concepts, and in recent years, many mature views have been put forward on port integration in China. The introduction of these viewpoints and concepts helps readers to understand the causes and discussions of this thesis.

First of all, port integration is divided into many categories. These terms will be used in the later chapters. Secondly, the development process of China's port integration can reveal the cause and context of China's port integration and can accurately explain the composition of the ports in research. In the end, China has implemented many policies related to trade and port development in recent years. These policies have a role to promote the integration of China's ports, and these policies are also mentioned in the later chapters on the integration of development. Therefore, we will introduce and explain some of viewpoints and theory of these areas in this chapter.

2.1 Type of Port Integration

Generally speaking, port integration is a broad concept. It includes both the integration of port assets and port administration. Sometimes it also includes the unity of the region and the unification of standards, such as the Port Alliance (Notteboom & Winkelmans, 2001).

The basic integration of port can be divided into vertical integration and horizontal integration (Stonehouse, 2004). The integration of vertical integration refers to the integration of different logistics sectors in the port area, for example, the port operation company, in addition to operating the shipping and loading business, also takes into account the business of highway transportation and storage. Horizontal integration generally refers to the cooperation of different ports in the region, such as sharing or loading and unloading services on routes (Notteboom et al, 2009).

From the point of view of port operators, port integration is divided into internal integration and external integration (Li & Oh, 2010). The internal integration of ports refers to the integration of different operators in the same port. The external integration of ports refers to the integration of operators between different ports. Whether it is the internal or external integration of the port, the purpose of the integrated operators is to increase their market share in the region and have obtained the corresponding market advantages (Huo et al, 2018).

Brooks et al (2009) put forward a constructive classification of port cooperation. They divide port cooperation into four categories according to their activities, namely, market

and business development, operations, administrative and regular. They further divided the four categories into two types: formal and informal. This classification method is very detailed for port cooperation analysis.

Wang et al (2015) believe that port integration can be divided into four models according to different driving factors: government-driven, market-driven, government & market driven and strategic alliance. In this thesis, we mainly adopt this classification method. Although many other classification methods have their own advantages, the change of China's port pattern is mostly determined by economic and social development and related policies. The factors that drive port integration will affect the characteristics of port integration. Therefore, in view of China's ports, this method can reflect the nature of integration and historical context, more suitable for our intention of port analysis.

2.1.1 Government-driven Model

Port is not only an operational company, but also a political unit in some historical periods. Because the port authority also belongs to the functional department of the local government. If the port belongs to the port authority, the overall arrangement for the development and construction of the port is actually decided by the government. Port integration is an important decision for the long-term planning of the port, so the integration plan for such ports is made by the government. In addition, the port integration involves multiple operations, and the coordinated work is complicated. Therefore, the integration of the ports driven by the government is very common, such as the integration of New York port and New Jersey port. Government-driven integration will form a new port authority and cancel some original port authorities before the merger. From the administrative structure and personnel administration, this approach can effectively streamline the structure, reduce the process time and the communication loss between the different port offices and improve their work efficiency by layoffs.

This pattern is common in the integration of province in China. The provincial government will directly release the integration instructions or put forward the overall integration plan and the ports will be integrated by the regional terminals themselves. The provincial government is well aware of the traffic situation in this province, so the rectification plan is feasible and can solve the present problem. More importantly, port integration will also be designed for road and rail transport besides the port area. These problems can be dealt with by the provincial government's traffic functional departments, so as to further optimize the logistics lines. The advantage of government-driven integration is to reduce the vicious competition in the neighboring areas of the province or the different investors in the same area. In some port areas in China, the main source of the adjacent ports is almost the same and overlap level of the hinterland and logistics network is very high, and that is the same as the wharf built

by different contributors in the same port area, in which are obvious malignant competition, such as reducing the port fee to a great extent. The integration plan introduced by the provincial government can solve this problem effectively.

2.1.2 Market-driven Model

Because of the promulgation of the port law, the pattern of China's ports has changed dramatically. The development of Chinese ports is influenced by the market mechanism. Moreover, investors from Chinese port enterprises are diversifying. A lot of non-governmental capital is poured into the construction of port enterprises. With the diversification of capital investment in port enterprises, financial operation has also become part of the operation of port enterprises. When considering investment return and financial risk, investors usually measure whether the port integration plan can achieve the above purpose. Market-driven integration can reduce the financial risk of investors to a certain extent. After all, if the holder only injects capital into a single port, the success or failure of the port will directly affect the investment. On the other hand, when the port is integrated by market, its capital source will be more diversified, and the stability of port enterprises' capital will be increased. More types of capital investment will also reduce the monopoly of the original port enterprises due to the single capital model. (Notteboom, 2002). Although the ports of small scale integration have had these advantages, their capital advantages still have space for improvement because of insufficient integration. If the surrounding ports are with higher level of integration, the port of small scale integration will temporarily lose its competitive advantage and make the return of investors worse. At present, market-driven integration has gradually become the mainstream of China's port integration because it meets the needs of current Chinese current market environment. The limitation of this approach is that it will increase the internal competition of the port after integration, and the different contributors will pay more attention to the return on their own investment and ignore the overall integration scheme, resulting in the repeated construction of the integrated port and the unnecessary internal competition loss. Therefore, this mode will play a greater role in the long-distance port integration mode because the integrated ports have no incentive competition due to the different regions.

2.1.3 Government & Market-driven Model

This model is a combination of the former two models, which is mainly manifested in the financial integration of the port by the local government as the capital investor, rather than the simple administrative intervention. The advantage of this model is that it is not only influenced by the market but also improves the efficiency of operation, and it shows the superiority of the policy when it receives the macro regulation and control of the state. However, due to the limitation of government assets in the actual capital operation, this mode is not common in China's port integration. The most

influential representatives are the integration of Shanghai port and Yangshan port. (Wang & Ducruet, 2012). Due to the water depth and other reasons, Shanghai port is in urgent need of expanding the port size, especially the construction of deep-water ports. However, due to the influence of hydrological conditions in Shanghai, Shanghai port needs to integrate with Yangshan Port, which is closer by distance. However, due to the administrative factor, Shanghai is a municipality directly under the central government and Yangshan Port belongs to Zhejiang province. In this way, the simple government driven integration is not suitable. At the same time, because the scale of the construction and the scope of the project are very large, it is difficult for the general capital operation companies to evolve into the construction of high investment. The Shanghai municipal government promoted the integration as a sponsor, which avoided administrative embarrassment and Shortage of funds. Furthermore, the integration of Yantai Port in 2005, the combination of Dalian Port and Jinzhou Port in 2006 and Asset reorganization in Tianjin port in 2010 are all in line with this model. But there is no longer a large-scale port integration that fits this model.

2.1.4 Strategic Alliances

The development of Chinese ports in the past 20 years is very rapid, which includes a lot of changes in the supply of goods and logistics routes. This has also led to a rapid change in the relationship between ports in China. An important change of traffic categories or regional policy will make cooperation of ports become a fierce competition, and vice versa. Because of the rapidity of change, thorough administrative integration and capital integration do not apply to all kinds of situations. After all, the integrated port group is lack of response speed to deal with the new changes. Strategic alliances become very useful during this period, because the response time of alliance formation and dissolution is much faster than that of complete integration model. In addition, in response to changes, the alliance has more influence because it has more members, both in alliance and to other alliances, which will enhance the stability of the alliance. The production of this model has also promoted the regional standardization of Chinese ports, thus ensuring the quality of service in the rapid change and avoiding the dumping tendency resulting from fierce competition. For example, in order to enhance the competitiveness of the container ports in the Yangtze River Delta, strategic alliances were formed in Shanghai, Jiangsu and Zhejiang, including ports of Ningbo, Zhoushan, Shanghai, Nantong, Zhangjiagang, Zhenjiang and Nanjing. This pattern has been used several times in areas of major river entrances to the sea. The alliance of these ports has greatly affected the transport condition of feeders in the related river, so that the inland river shipping network in the area has been optimized.

2.2 The Development of Chinese Ports' Pattern

The changes in the form of Chinese ports are mainly divided into three phases (Cullinane and Wang, 2007).

The first phase is from 1979 to 1984. At this phase, all ports in China were managed by the local port authority, all of which belong to the Ministry of communications of China. In other words, the Ministry of communications controlled all the Chinese ports, and the contents of the jurisdiction are also comprehensive, such as operation, co-ordination and construction. The relationship between Chinese ports was completely parallel. In addition, because fiscal revenue and decision-making power do not belong to local governments or capital institutions, Chinese ports showed obvious characteristics of regionalization. This has greatly weakened the competitiveness of ports, making the development of China's ports generally in the form of decision-making as a combination. Because China was in the early stage of reform and opening up, the overall economic situation was not as prosperous as it is now. Influenced by the overall policy at that time, the number of private capital institutions and the capital stock were limited, which is not enough for large-scale investment in ports. Therefore, the development of Chinese ports was not very fast at this stage, especially due to the lack of sufficient funds for infrastructure construction.

The second phase is from 1984 to 2004. In 1984, there was an important milestone in this period, that is, the Tianjin Port Authority was governed by the Tianjin municipal government rather than the Ministry of communications. Moreover, as an important symbol of administration, Tianjin port pilot station is also incorporated into the Tianjin port administration and managed by the Tianjin municipal government. This activity marks a new stage in the development of China's ports. In the following years, all ports in China except the port of Qinhuangdao were managed by the local port authority and the government completed the decentralization process of China's ports. Each port has greater freedom in operation and management, thus its operational efficiency has also been improved. Although the port authorities are still in the state-owned status, the de-administration has made them more likely to pay attention to the profit and the future of the port than ever. At this stage, with the deepening of reform and opening up policy, China's rules and regulations on the market are becoming more and more perfect. More powerful private capital appeared in China's port development investment, and it is worth noting that international capital has already appeared in these private capitals. This has further enhanced the capital diversity of China's port development and paved the way for the internationalization of Chinese ports. Of course, the share of private capital (including international capital) can't exceed 50% of the overall port company during this period, which means that the decision-making power of port development is still in the government. In order to increase revenue, local governments have intensified the operation of ports. For earning the source of goods, there is obvious competition among the neighboring ports. The merger and alliance of Chinese ports in the ending of this period is beginning to see signs.

The third phase is after 2004. The beginning of this period is the promulgation of China's Port Law in 2004. The law terminates the existence of the port authority and the operation right of port is converted to local port group company. The implementation of this plan is the first time that China's port management institutions have completely separated their managerial and administrative powers in the Chinese port development history. In this way, the possibility of administrative intervention faced by Chinese port enterprises will be very low. Although China's port enterprises will get less support from the government and less advantage from the overall macro strategy, since then, the Chinese port enterprises have had the right of autonomy in order to give full play to their own advantages. The law also broke the original requirement that private capital should not hold more than 50% in port, so that the operation rights of Chinese port enterprises no longer have to be owned by the state. This greatly stimulated private capital and even international capital injection into China's port construction, making China's port development enter a golden period. In addition to the injection of capital, different forms of controlling parties also carry out different ways of management of Chinese port enterprises, and the management mode of Chinese ports has also begun to diversify. These changes have greatly increased the competitiveness of various ports in China. After that, the pattern of China's ports has been constantly changing, and the integration of the ports is constantly emerging.

2.3 Policies and Strategies that Have Significant Impact on Port Integration

2.3.1 One Belt One Road (OBOR)

One Belt One Road (OBOR) was proposed by China between September 2013 and October, aimed at promoting economic cooperation between the West of the Pacific and the Baltic Sea, and accelerating the development of economically backward Asian countries through infrastructure investment. (Kennedy & Park, 2015). One Belt refers to the land Silk Road Economic Belt, and One Road refers to the twenty-first Century Maritime Silk Road. The route of One Belt is from Xi'an, China to Duisburg, Germany, which passes through Kazakhstan, Iran, Turkey, Romania and Czech. Through Duisburg, One Belt is connected to the main European ports, such as Rotterdam, Antwerp and Hamburg and confluence with One Road in Venice, Italy. One Road begins in Quanzhou port in Fujian, China. Through Guangzhou, Beihai and Haikou, it runs into Southeast Asia, and then reaches Greece through India and the Mediterranean. Finally, it joins with One Belt in Venice. The area also includes six economic corridors, involving more than 60 countries and 4.4 billion people. (Notteboom & Yang, 2017)

Despite the rapid development, China's ports still have some obvious disadvantages.

The operation mode of Chinese port enterprises is very monotonous, and most of them remain in the main business of port loading and unloading. This development model makes Chinese ports limited to the industrial and commercial resources in the hinterland. Once the strategic structure of the hinterland is adjusted, the port will be greatly affected. The world's most influential ports, such as London and Rotterdam, have also made outstanding achievements in shipping services, shipping finance and insurance. The development of these fields enhances the port's ability to resist risks rather than relying solely on the trade capacity of the hinterland. Furthermore, the relationship between China's ports and inland areas is still not strong enough, and there is no obvious driving force to advance the economic development of the inland areas. In China, multimodal transport involving maritime transport is not as frequently used as the mainstream European port. It also proves that the Chinese port has not made a great contribution to the inland areas in the construction of the logistics network (Zgjtb.com, 2016).

OBOR enhanced cooperation between Chinese ports and international ports and enhanced the information exchange capacity of Chinese ports. In the process of internationalization, Chinese ports will also rely on OBOR to expand their own business scope, such as finance, law and so on, so as to improve their sustainable development. Moreover, OBOR has strengthened the links between China's ports and inland areas, especially the construction of 6 economic corridors, which directly linked the logistics lines with the economic development, making the port and the inland areas an economic and ecological whole. More importantly, OBOR integrates China's ports into the entire large logistics network, which makes the port's hinterland transport line clearer, promotes the integration of China's ports, and also exacerbates the competition for more optimized logistics lines in some ports. The overall pattern of China's ports has also changed greatly.

2.3.2 The Promotion of the Free Trade Area

Free Trade Zone (FTA) transactions can get a certain degree of tariff relief, which can enhance the local economic activity (Tiefenbrun, 2012). In order to promote economic development and speed up the internationalization of coastal areas, the Chinese government planned to establish a free trade area in some coastal cities in China in 2013. In September, Shanghai became China's first free trade area, which included four regions: Waigaoqiao Free Trade Area, Waigaoqiao Free Trade Logistics Park, Yangshan Free Trade Zone and Pudong airport free trade area. The first three regions are all in Shanghai port. In April 2015, the Chinese State Council further liberalized three free trade zones, namely, Guangdong, Tianjin and Fujian. Guangzhou free trade area consists of four regions, namely Zhuhai, Qianhai, Shekou and Nansha. Coincidentally, the first three regions are also port areas, and the three regions are integrated into the Guangzhou port by plan.

These four free trade zones have different functions. As the largest port of container throughput in China, Shanghai's trade area has become an important combination point and weathervane of China's foreign trade transactions. The Tianjin free trade zone mainly connects foreign trade between Japan and South Korea, and its influence is mainly in Northeast Asia. The Fujian free trade zone is near Taiwan, China. It plays an important role in promoting the economic development of Taiwan Strait. The trade in the Guangdong free trade zone is mainly aimed at Hongkong, and thus impacts Southeast Asia. From the perspective of geographical economy, the selection of these FTA is targeted, and the trade contents are different. This kind of pertinence is very similar to the different types of ports in different regions of China. The construction of China's free trade area has not only attracted international capital and flourished market, but also enhanced the international level of the ports in which the region is located. The mode of operation and the service level of international capital in China's free trade area provide valuable experience for Chinese ports and trade enterprises (Notteboom & Yang, 2017). Moreover, the international enterprises in the FTA have further enriched the diversity of these port cities and promoted the comprehensive competitiveness of the ports.

The establishment of the FTA reflects the Chinese government's idea of developing regional economy. And in reality, these FTA not only promoted the local economy, but also significantly promoted the development of hinterland. After the promulgation of the port law, Chinese port enterprises have no longer developed as a whole port cluster, but the free trade area has made the ports more closely linked in the same region. The decision makers of these ports should consider their situation in the port cluster so as to win their greater interests in the free trade area. All these promoted the integration of China's ports from a market perspective.

Chapter 3 Methodology

The research method used in this thesis is Strategic Positioning Analysis for Seaports (SPA). This research method can clearly analyze port growth, market share and diversification (Haezendonck et al, 2006).

This study will be done through three steps. First of all, statistical analysis is carried out on the parameters of the port concerned. Then the data is predicted for the integrated port. Finally, we evaluate and consider the rationality of the integration policy.

SPA will be divided into three different methods.

(1) Product portfolio analysis (PPA)
(2) Shift-share analysis (SSA) and
(3) Product diversification analysis (PDA)

Because, in this paper, we focus on the performance of ports in share and growth, and the diversity of ports before and after integration, we only choose PPA and PDA, and give up SSA, which pays more attention to the changing trend of ports.

In SPA, we divide Chinese ports into three clusters: Bohai Sea Port Cluster, Yangtze River Delta Port Cluster and South China Sea Port Group. Bohai Sea Port Cluster includes four ports, namely, Liaoning, Hebei, Shandong and Tianjin. The Yangtze River Delta Port Cluster involves three regions: Jiangsu, Zhejiang and Shanghai. In the analysis, four areas, which are Fujian, Guangdong, Guangxi and Hainan, are defined into the South China Sea Port Cluster group. In the study, we define the traffic category as four types, namely, containers (CO), dry bulk (DB), liquid bulk (LB) and passengers (PA).

In the analysis, there are two important indicators, that is, share and growth. The data of these two indicators are based on China's port statistics from 2014 to 2016, all from the China Port Yearbook. It should be emphasized that in analysis, the unit of two parameters of share and growth is ‘%’.

3.1 Reasons for Selection of Methodology

In the study of port integration, there are three kinds of research methods are commonly used. They are game theory, GDP prediction and SPA.

Game theory is widely used in papers related to China's port integration. For example, Zhuang et al (2014) published “A Game Theory Analysis of Port Specialization-

Implications to the Chinese Port Industry", Chen et al (2018) published "Strategic Investment in Enhancing Port-Hinterland Container Transportation Network Resilience: A Network Game Theory Approach" and Jiang et al (2018) published "Prediction Model of Port Throughput Based on Game Theory and Multimedia Bayesian Regression". Those authors can clearly analyze the competition and cooperation between ports before and after integration through game theory. Many scholars in their own papers change the parameters of the game model to imitate the integration process, in order to obtain logical results. These analyses fully demonstrate the gains and losses of ports after integration. The limitation of this research method is the number of subjects. When there are more than two subjects, the research process of game theory becomes very complex, even difficult to draw clear conclusions. There are many ports in this thesis, so game theory is not applicable.

In the literature review, we introduced the close relationship between China's port development and regional economic development. According to this theory, some scholars predict the change of port integration by predicting the GDP changes in the area. For example, Zhao et al (2005) published "The Analysis of Correlation between Logistics and GDP" and Liu et al (2006) published "Analysis of the Dynamic Relation between Logistics Development and GDP Growth in China". In these articles, port development is well predicted, which indicates the potential performance of the port after integration. But the research objects of this paper are divided according to the port clusters, so these ports have the same or similar economic hinterland. Therefore, it is difficult for GDP in the region to reflect the gap among the ports of the same cluster. We do not choose to use GDP prediction. In SPA, the number of subjects is unlimited, and the main research parameters are directly related to the performance of the port. This is the reason why we chose SPA as the research method of this paper.

We chose two methods of SPA, that is, PPA and PDA. PPA can measure the performance of the port before and after integration, and subdivide the research scenarios into different traffic types, which makes the research results comprehensive and detailed. In PDA, we can analyze the types of integration based on the changes of HHI index after port integration, because the changes of the integrated port with different traffic types will be much smaller than that with same traffic type.

3.2 Product Portfolio Analysis

In this link, we mainly adopt the "Growth-share matrix". The main reason for adopting this method is that it can effectively analyze the relative changes and relative advantages of ports in the competitive environment. Moreover, the presentation of this method is very intuitive. At the same time, data collection is also convenient in this method, because most of the parameters can be directly retrieved from China Port Year Book. Because of the data used in competitive environment, the conclusion

of this method is very extensive (Haezendonck et al, 2000).

The Boston matrix can be divided into 4 quadrants, from the first quadrant to the fourth quadrant, namely, ‘Star’, ‘Question Marks’, ‘Dogs’ and ‘Cash Cows’. However, the Boston matrix analysis of the port enterprises is different from that of the general enterprises. Therefore, the naming of the four quadrants is not in line with the actual situation of the port enterprises. Haezendonck et al (2000) renamed the quadrants. In the first quadrant, the word ‘Star’ is appropriate. After minor adjustment, it is changed to "Star Performer". 'Cash Cow' is completely out of line with port conditions, because high market share and low growth do not bring huge cash flows to enterprises in the port industry. It is changed to ‘Mature leader’, which is more in line with its characteristics. The name "Dog" is not suitable, so it is changed to ‘Minor Performer’. In the second quadrant, 'Question Mark' is not able to annotate the other three groups in the port enterprise environment, so it is changed to 'High Potential'.

Although the operation and development of the port enterprises also belong to the industrial enterprise development category, the market share has little influence on the growth in the port industry because of its industry particularity. This is that the research result of Boston matrix is not as obvious as that of other commercial enterprises in the port industry. However, because of the economic impact of this study before and after the integration, the market share of the ports in each region is particularly important, which is directly related to the impact of integration on the regional internal relations. Therefore, Boston matrix, especially with the two indicators of growth and market share, is still of great significance in this study.

Considering the particularity of the port enterprises and the research direction of this paper, that is, the changes before and after the port integration, the PPA will be divided into four stages to analyze the data.

In the first level, we study the total traffic situation of ports in port cluster before and after integration. Two indicators, market share and growth rate, are the actual performance of port enterprises in the region. In this level, we not only analyze the relative situation of each port before and after integration, but also analyze the impact of integration on these ports. In the analysis chart, the abscissa is the share of the port of total traffic in the area, and the ordinate is increased. The unit is '% '.

In the second level, the data of each port in each integrated area are analyzed. At this level, we mainly analyze the weight of three types of transportation (container, dry bulk and liquid bulk) in the integrated port to analyze the inherent performance of the port on different types of traffic. In the analysis chart, the horizontal and vertical coordinates are respectively the share and growth of traffic type in this port with the unit is '% '.

In the third level, the integrated ports are studied in different traffic types (container, dry bulk, liquid bulk and passenger) in the port cluster. This stage also embodies the

particularity of the port enterprises. Different from the general enterprise, the comparability of the different kinds of goods in the port enterprises is low, and the market category is different. Comparably, the difference of the different goods in the general enterprise is small, and the market involved is very close. This stage of research can analyze the advantages and disadvantages of traffic category of each port, and the impact of integration on the changes of these sources. In the analysis chart, the abscissa is the share of each integrated port in different traffic types in the cluster, the abscissa and the unit are the same as in the second stage.

The fourth level, that is, the last level, will be further narrowed on the basis of the second and third stage. In this level, we analyze the internal share and growth of each transport type in each port within the region. Compared with the third level, the abscissa and the ordinate are same as that in level 3. The result of the measurement is the performance of the port's internal development in the samples. The internal traffic share of port is also shown at this stage, which is the radius of the graph in the analysis diagram. The level's ordinate is still the growth and the unit is ‘%’.

The four stages, in the course of research, are gradually progressive relations, and the meticulous of the analysis is gradually escalating. In other words, the fourth phase of the research results is the most detailed. However, these four stages represent the analysis of different purposes. The analysis of the first three stages is not only the matting of the last stage, but also the analysis of the whole port and the different types of goods, which is also of reference value.

3.3 Product Diversification Analysis

The last link in SPA is the Product Diversification Analysis (PDA) analysis. At this stage, the weight of each type of traffic is measured and the diversity of the entire port is evaluated. The research method we used in one stage is Hirshman–Herfindahl index (HHI). Among the many methods of diversity analysis, HHI is the most common method used. It can accurately show the density of the samples. The density will be distinctly distinguished because of the numerical value of the square of the sampled data. When applied to ports, we can evaluate the diversity of traffic types in this port.

When the research result is 1, it proves that the port has only one mode of transportation, that is, its traffic diversity is low to the extreme. When the results of the study approached 0, it showed that the port had a lot of traffic types and the development of each type of transportation is extremely average, that is, high diversity. When the port is highly diversified, its stability can be improved, and it can be developed in different directions. If the port does not have diversity, its operators will be completely controlled by this mode of transportation and lose the autonomy in the market.

In PDA, our research objects are the ports before and after integration in cluster. We not only analyze the diversity of ports before and after integration, but also analyze the impact of integration on port diversity. The degree of change of HHI index before and after integration means the optimization of different traffic types in the process of integration.

Chapter 4 Chinese Port Clusters and Their Main Ports and Integration

The Ministry of Communications of China promulgated the National Coastal Port Layout Plan, in which Chinese ports are divided into five groups, namely Bohai Sea cluster, Yangtze River Delta cluster, Southeast Coastal cluster, Pearl River Delta cluster and Southwest Coastal cluster (Gov.cn, 2018), as Fig 1.

Figure 1 Map of Chinese 5 Clusters

Source: image.baidu.com

The latter three port clusters have similar economic hinterland and close geographical position. Therefore, we define them as South China Sea cluster. So, in this thesis, Chinese ports are re-divided into three port groups, namely Bohai Sea cluster, Yangtze River Delta cluster and South China Sea cluster, as Fig 2.

Figure 2 Map of Chinese 3 Clusters

Source: image.baidu.com

With the success of Ningbo-Zhoushan Port, more and more decision makers regard integration to expand resources as the first choice of development strategy, the Ministry of Communications is also promoting the further integration of Chinese ports. The pattern of "one province one port" is gradually forming in China's maritime industry.

4.1 Bohai Sea cluster

Bohai Sea port cluster is mainly composed of coastal ports of Liaoning, Tianjin, Hebei and Shandong, serving the social and economic development of the coastal and inland areas of northern China (Fig 3). As an important source of energy and raw material production base in China, the region is rich in coal and mineral resources in its hinterland. At the same time, Northeast and North China are also important heavy chemical industrial bases in China. Because of the high proportion of the first industry and the second industry, such as mining, metallurgy and petrochemical, Bohai sea port cluster has a strong transportation capacity in dry bulk and liquid bulk.

Figure 3 Map of Bohai Sea Cluster

Source: map.baidu.com

4.1.1 Liaoning Port Integration

Liaoning is the northernmost coastal province of China, and also the gateway to Northeast of China (including Heilongjiang, Jilin and Liaoning) and East of Inner Mongolia Autonomous Region. Liaoning is on the coast of Bohai Sea and Yellow Sea, and its coastline is about two thousand kilometers. There are six ports in Liaoning, of which two are key ports, namely, Dalian Port and Yingkou port, and four secondary ports, namely, Jinzhou port, Dandong port, Panjin port and Huludao port (Wu & Yang, 2018).

The State-owned Assets Supervision and Administration Commission (SASAC) of Liaoning, the SASAC of Dalian, the national capital committee of Yingkou and the China Merchants Group confirmed the agreement on the cooperation clause of the Liaoning port resources integration and signature in Beijing in March 20, 2017 (Baijiahao.baidu.com, 2018)

Liaoning and China Merchants Group jointly signed the "Liaoning Provincial People's government and China Merchants Group's agreement on the confirmation of Liaoning

port integration clause". Dalian City, Yingkou City, China Merchants Group jointly signed the Dalian Municipal People's government, the Yingkou people's government and the China Merchants Group on the Liaoning port integration agreement. Shenyang and China Merchants port jointly signed the Shenyang port investment framework agreement.

The signing of the agreement involves reorganization and integration, equity investment, investment and public welfare asset arrangement. This is another major progress of Liaoning port integration after the three listed companies of Dalian Port, Jinzhou port and Yingkou port in June 2017 revealed that the Liaoning provincial government and the China Merchants Group signed the "port cooperation framework agreement". After the reorganization is completed, Liaoning's Panjin port, Dandong port and Huludao port will also be integrated into stages.

4.1.1.1 Dalian Port

At present, the operator of Dalian Port is the Dalian Port Corporation Limited, which was founded in April 2003. It is a state-owned company formed by the former Dalian Port Authority as the main body after the separation of government and enterprise. Dalian Port is the center of the Northwest Pacific and an important port for the Northeast Asian economic circle. The water area within the port boundary is 346 square kilometers and the land area is nearly 14 square kilometers; the existing railway special line is more than 160 kilometers, the warehouse is more than 30 million square meters, and the cargo yard is 1 million 800 thousand square meters (China Ports Journal Press, 2016). It owns nearly 80 modern specialized berths, such as containers, crude oil, finished oil, grain, coal, mineral products, goods and goods. There are 40 berths above 10000 tons.

4.1.1.2 Yingkou Port

Yingkou port is an important comprehensive hub port in the country. Yingkou port is operated by Yingkou port Limited by Share Ltd, under the jurisdiction of Yingkou port area, Bayuquan port area, Fairman island port area, Panjin port area, marine red port area, Suizhong stone river port area and Huludao willow ditch port area (China Ports Journal Press, 2014). It has 61 production berths, including container, rolling car, coal, grain, grain, ore, large equipment, finished oil and liquid chemicals and crude oil. The maximum berth is 200-thousand-ton Grade Ore berth and 300-thousand-ton crude oil berth, and the container terminal can be docked with fifth generation container ships. Yingkou port has established shipping business relations with more than 140 ports in more than 50 countries and regions. The main goods for loading and unloading are: container, automobile, grain, steel, ore, coal, coal, crude oil, finished oil, liquid chemical

products, chemical fertilizer, wood, non-ore, mechanical equipment, fruit, vegetable and so on. Among them, domestic container, imported ore, import fertilizer, export steel and export non-ore handling capacity are the top of the Northeast ports (China Ports Journal Press, 2015).

4.1.2 Hebei Port Integration

Hebei is located in the junction of two major economic zones in North China and Northeast China, and has major ports for transportation of steel, ore, coal and crude oil. The port hinterland covers a wide range, including most parts of North China and northwest and northeast parts, and the economic structure is dominated by heavy industry. In addition, the port coal resources in the province are distributed in northern Shanxi, Western Inner Mongolia, Ningxia, northern Shaanxi, and Hebei, Beijing and other places. Hebei has three ports, namely Qinhuangdao port, Tangshan port and Huanghua port (Csi.com, 2019).

The port integration in Hebei province has been carried out very early. In 2009, the Hebei Port Group Company Limited, approved by the Provincial Committee of the Hebei Provincial Committee and the provincial government, according to the law of the company and other laws stipulated in the law of the company, was set up by the province owned wholly owned port group according to the requirements of the modern enterprise system. The state assets supervision and Administration Commission of the people's Government of Hebei province fulfilled the responsibility of the investor, which was the construction and development of the port. The Hebei port group has 64 berths (including 2 test berths). The annual design capacity is 3.095 million tons, mainly in Qinhuangdao port, Tangshan Caofeidian port and Cangzhou Huanghua port (Porthebei.com, 2018).

4.1.2.1 Qinhuangdao Port

Qinhuangdao port, which is operated by the Qinhuangdao Port Co., Ltd of the Hebei port group, is a comprehensive international trade port based on energy transportation. It is the largest coal port and dry bulk port in the world today. Qinhuangdao port is divided into two ports, Eastport and Westport. The Eastport area is dominated by energy transportation and has a world-class modern coal terminal. The Westport area is mainly grocery and container handling, with advanced equipment and container terminals. There are 50 berths in Qinhuangdao port (including 2 trial run berths), which can discharge 150 thousand tons of vessels and the design capacity is 2.26 million tons per year. Among them, the annual design and passing capacity of the coal is 1.9455 million tons, the annual design and passing capacity of the groceries is 14 million 800 thousand tons, the annual design of petroleum and chemical products is

17 million tons, and the year of the container is designed to pass the 750 thousand standard containers (Porthebei.com, 2018). Qinhuangdao port is located in the two major economic zones of North China and Northeast China. It is the main port for the transportation of coal and crude oil in China. It is also the distribution port of other import and export goods, which is called the energy transport hub. In recent years, Qinhuangdao port is developing into a multifunctional, comprehensive and modern port. The import goods structure of Qinhuangdao port is mainly imported from domestic goods, which accounts for 0.2% of the total quantity of goods, accounting for 71.5% of the total amount of coal and crude oil. The import of foreign trade is mainly wheat, ore, wood, steel, fertilizer, sugar, cement and other goods, accounting for 5.1% of the total; the main goods exported from foreign trade are coal. Carbon, crude oil, non-metallic ore, iron and steel, grain and other groceries account for 23.2% of the total (China Ports Journal Press, 2015).

4.1.2.2 Tangshan Port

Tangshan port is located in the southeast coast of Tangshan City, Hebei province. It is an important regional port in the coastal area of China. It is an important part of the specialized transportation system of energy and raw materials, and one of the important windows of economic development and opening to the outside world in Hebei, Beijing, North and northwest parts of China (China Ports Journal Press, 2016). Tangshan port has three port areas, namely Caofeidian port area, Jingtang port Area and Fengnan port area. The Hebei Port group has a total of 6 berths in the Caofeidian port area to develop, build and operate modern ore terminals, with a capacity of 65 million 500 thousand tons per year (Porthebei.com, 2018). A total of 6 ports in Jingtang Port area are planned and constructed, and 6 functional areas, such as container terminal operation area, liquid bulk cargo operation area, dry bulk operation area, grocery wharf operation area, general cargo wharf operation area and comprehensive logistics area, are gradually formed. (China Ports Journal Press, 2016). Fengnan port project will be planned to build 6 1~2-ton grade grocery berths, four 40 thousand-ton multi-purpose berths and 5~7 million-ton bulk berths. After the completion of the project, the annual throughput of the District of Feng Nan port can reach 20 million 500 thousand tons (China Ports Journal Press, 2016).

4.1.2.3 Huanghua Port

Huanghua port is located on the Bohai coast of Huanghua, Hebei province. It is located at the junction of Hebei and Shandong two provinces and is located in the central part of the Bohai economic circle. In August 18, 2010, the Huanghua comprehensive port was opened. The hinterland of Huanghua can extend to south of Shanxi, northwest of Shandong, north of Henan, Shaanxi, Inner Mongolia and other parts (China Ports

Journal Press, 2016). Huanghua port has 2 general bulk grocery berths, 2 general bulk berths and 4 multipurpose berths, with an annual design capacity of 18 million tons, of which 2 multipurpose berths have opened container routes, and the annual capacity of 900 thousand standard boxes is designed. The hydraulic structure has the condition of berthing 100 thousand tons ship (Porthebei.com, 2018).

4.1.3 Shandong Port Integration

Shandong province is located in the eastern coastal area of China and in the lower reaches of the Yellow River. Shandong includes two parts of the peninsula and the inland, the Shandong peninsula is prominent in Bohai Sea and the Yellow Sea, and the inland part is bordering on the four provinces of Hebei, Henan, Anhui and Jiangsu from north to south. Shandong Peninsula has more than 3000 km coastline, accounting for 1/6 of China's coastline, ranking second in China (Gov.cn, 2018). There are seven ports in Shandong, namely Binzhou port, Dongying port, Weifang port, Yantai port, Weihai port, Qingdao port and Rizhao port.

For port integration, Shandong will carry out the "three step" strategy. In the first step, in March 2018, Shandong high speed group holdings, integrating Binzhou port, Dongying port and Weifang port, formed Shandong Bohai Bay Port Group. In the integration, the three ports in principle keep the legal person of the main body of production and management unchanged, the labor relations of the employees are unchanged, the port code qualification is unchanged, and the port location tax collection system is unchanged (Wallstreetcn.com, 2018). The second step is that Qingdao port and Weihai port, which are currently preparing for listing, will be annexed by Qingdao port after completion of the listing. The third step is to integrate the four ports of Qingdao port, Bohai bay port, Yantai port and Rizhao Port into a provincial port group when the conditions are ripe (Finance.sina.com.cn, 2018).

4.1.3.1 Qingdao Port

Qingdao port is located in the Bohai Bay Port Group along the Chinese coast, the Yangtze River Delta port group and the heartland of the Japanese and Korean port groups. It mainly engaged in container, crude oil, iron ore, coal, grain and other import and export goods such as loading and unloading, storage, transfer, allocation and other logistics services and international passenger service (Qdport.com, 2018). Qingdao port consists of four port areas, namely Qingdao grandport area, Huangdao oil port area, Qianwan port area and Dongjiakou port area. Among them, the Qianwan port has a container terminal that can dock the world's largest 21 thousand TEU container ship, two of the world's most advanced container fully automated berths have been put into commercial operation, and the Dongjiakou port has the world's largest 400-

thousand-ton ore terminal, 450-thousand-tonne crude oil terminal. Huangdao oil port is full of functions and perfect supporting facilities. It is the largest oil transportation, transfer and storage base in the coastal areas of China, and Grand Port has a special wharf that can dock the world's largest 227-thousand-tona grade cruise ship. Cruise Passenger Center, carnival, Royal Caribbean, Mediterranean and other cruise giant companies have been settled (Qdport.com, 2018).

4.1.3.2 Yantai Port

Yantai port, located at the core of the international economic circle of Northeast Asia, is one of the 25 important ports in China's coastal areas. It is an important hub of the Chinese coastal south-to-north channel and the important node of the new Eurasian Continental Bridge between Europe and South Korea and Japan. It is also an important node of the twenty-first Century Maritime Silk Road by the national "One Belt One Road" strategy. It has four areas, namely Zhifuwan port area, Westport area, Longkou port area and Penglai port area, with 107 berths of all kinds, including 68 deep water berths with ten thousand tons and above, the total length of Quay coastline is 21734 meters, the railway special line is 61.3 kilometers, and the total area of the storage yard is 8 million 981 thousand square meters (Yantaiport.com.cn, 2018).

4.1.3.3 Rizhao Port

Rizhao port is the major coastal port in China, the key hub of the "One Belt One Road" and the eastern bridgehead of the new Eurasian Continental Bridge. It now owns the Shijiu port area and the Lanshan port area, with 58 production berths, with annual throughput exceeding 3 million tons (Rzport.com, 2018). Rizhao port is an important port for China's central and western regions, as well as the Central Asian, Western Asian countries and the Sino Russian economic corridor. Rizhao port can reach central Asia, Western Asian countries and Rotterdam, Holland by road. Rizhao Port has 5 oil pipelines leading to Luoyang, Henan, with an annual capacity of over 1 billion tons, which is directly connected to crude oil terminals and petrochemical enterprises. Rizhao Port has formed a comprehensive transport pattern integrating shipping, railways, highways, pipelines, belts and other modes of transportation, and convenient transportation (Rzport.com, 2018).

4.1.4 Tianjin Port Integration

Tianjin port, located in the west end of Bohai Bay, is located in the new area of Tianjin Binhai New Area. It stands back to the newly established Xiongan new area in China, radiates the inland hinterland of northeast, North and northwest, connects Northeast

Asia and West Asia, and is the marine gateway to the area of Beijing, Tianjin and Hebei. It is the starting point of the eastern and Russian economic corridor, the important node of the New Asia Europe continental bridge, and the strategic pivot of twenty-first Century sea silk road (Ptacn.com, 2018).

Tianjin port is a world-class artificial deep-water port, and the 300-thousand-ton ship can enter and leave the port freely. In December 26, 2014, the compound navigation channel of Tianjin port was formally opened to navigation, so that the capacity of channel navigation was upgraded again on the basis of two-way navigation. Tianjin port is a comprehensive port with complete port functions. There are 176 berths for containers, ore, coal, coal, coke, crude oil and products, steel, large equipment, rolling car, liquefied natural gas, grain, international cruise ships and so on, of which 122 berths are above ten-thousand-ton class (Ptacn.com, 2018).

Tianjin port is different in this area: as a municipality directly under the central government, Tianjin is not affiliated to other provinces, so there is no possibility of interprovincial port cooperation. In 2010, Tianjin port Holding merged with Tianjin Port Group Limited (Wang et al, 2015). This integration is a government and market driven integration, but this integration involves more equity and capital, and has no obvious impact on transport capacity.

Of course, as an important part of the Beijing Tianjin Hebei region, Tianjin still has the overall planning of this area in the direction of port construction. In 2017, the office of the Ministry of transportation and transportation of China, the office of the people's Government of Tianjin, and the office of the people's Government of Hebei Province jointly issued the "work program for accelerating the coordinated development of Tianjin Hebei Port (2017 - 2020)" (Baijiahao.baidu.com, 2018).

The plan proposes to further clarify the function orientation, revise the national coastal port layout planning, improve the overall planning of the Tianjin Hebei Port, and promote the rational division of functions of the port functions. Tianjin port will be transformed into a comprehensive portal hub, focusing on containers, rolling goods and cruise ships, speeding up the gathering of modern port and shipping services and promoting the function of the shipping center. The port of Hebei is mainly transportation of bulk materials, vigorously developing the service functions of port industry and modern logistics, and effectively interacts with Tianjin port. But at present, this plan is more focused on macro planning, similar to the establishment of strategic alliances, and does not involve specific integration among ports. Therefore, in the study of entity integration, Tianjin port is still considered as a independent port.

4.2 Yangtze River Delta cluster

The Yangtze River Delta Port Group mainly involves three places: Jiangsu, Shanghai and Zhejiang. The Yangtze River Delta port cluster is the largest port group in the world, with the developed water transport network (Fig 4). The advantages of the geographic location are very obvious and are at the intersection of the north and south trunk lines and the Yangtze River trunk lines. It is not only the main channel to connect the sea trade, but also the main channel to trade with the inland market, and it also plays an important role in the strategic layout of the "One Belt and one Road" (Zgsyb.com, 2018).

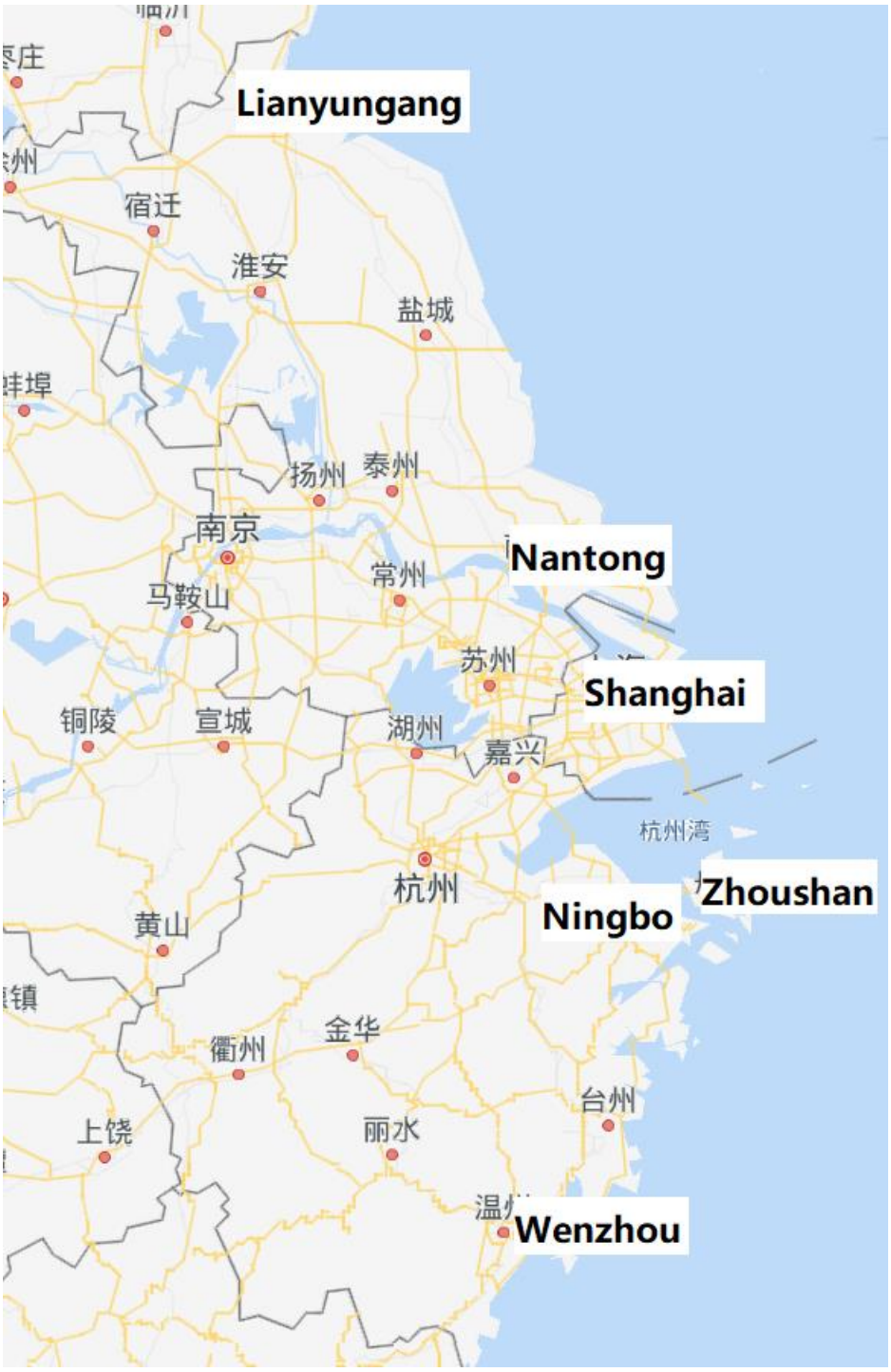

Figure 4 Map of Yangtze River Delta Cluster

Source: map.baidu.com

4.2.1 Jiangsu Port Integration

In March 2017, the provincial government of Jiangsu province and provincial government proposed that in order to increase the integration of the coastal ports along in Jiangsu province and deepen the reform requirements of the port integration, the shares of the port groups in Jiangsu province or the port enterprises should be integrated into the Jiangsu port group (Nbd.com.cn, 2018).

In May 12, 2017, the Jiangsu provincial government announced the layout plan of the coastal ports along the river in Jiangsu (2015~2030), which was regarded as the wind vane for the planning and layout of the Jiangsu port group in the future.

In the plan, it is clearly pointed out that from 2015 to 2030, Jiangsu will take a hierarchical port layout plan: the planned provincial ports are formed with Lianyungang port, Nanjing port, Zhenjiang port, Suzhou port and Nantong port as the main ports, Yangzhou port, Wuxi (Jiangyin) port, Taizhou port, Changzhou port and Yancheng port are regional important ports.

There are many ports in Jiangsu, but most of them are inland river ports. Large coastal ports include Lianyungang port and Nantong port.

4.2.1.1 Lianyungang Port

Lianyungang port is the largest seaport in Jiangsu Province, and one of the three main ports in the Yangtze River Delta port group. Lianyungang port has an obvious advantage, connecting the Yangtze River Delta, the Bohai Bay, and connecting the central and western regions of China to Central Asia and Europe through railway. It has an important strategic position in the coordinated development of China's regional economy (Lygport.com.cn, 2018).

The main operation port of Lianyungang port is composed of Mayao port area, Miaoling port area, Xugou port area, Qitai area and so on. It has formed a large and comprehensive port with complete functions of transportation organization management, transfer, loading and unloading, multimodal transport, communication information and production, life service and so on (Lygport.com.cn, 2018).

Lianyungang port has 35 types of dock berths including container, bulk grain, coke, coal, coal, ore, alumina, liquid chemical, of which there are 30 berths over ten thousand tons or more. Lianyungang port has established navigation relations with the ports of more than 160 countries and regions. It has more than 40 container and freight liner routes to Europe, the Americas, the Middle East, Northeast Asia and Southeast Asia, and opened two large passenger box liner routes to Inchon and Ping Zawa, South

Korea.

4.2.1.2 Nantong Port

Nantong port is an open port in China, the main port in China's coastal area, an important port of Shanghai international shipping center and the member of the International Port Association. The direct economic hinterland of Nantong port is part of the three cities of Nantong and Yancheng, Huaian and Taixing, with an area of about 50 thousand square kilometers, with a population of 30 million. The industrial economy is mainly composed of light textile industry, including power, machinery, electronics, chemical industry, shipbuilding and so on (Ntport.com.cn, 2018).

Nantong port has 15 berths, of which three 1000-ton-berths, four 3000-ton-berths, two 5000-ton-berths, two 25000-ton-berths, with 1941 meters quay coastline long. The new area has 427-meter-long operation area, with a total of 9 berths, of which 7 are 400-ton-freight berths, 1 is 400-ton-passenger berths and 1 is 300-ton berth (Ntport.com.cn, 2018).

4.2.2 Zhejiang Port Integration

Zhejiang has Ningbo Zhoushan port, the world's largest cargo throughput port, and has completed the integration of the main coastal ports in the province. Zhejiang has implemented the strategy of port integration in 2015. In September 2015, the former Ningbo port group and the former Zhoushan port group integrated the establishment of Ningbo Zhoushan port group, and the two ports achieved substantive integration. Subsequently, the restructuring of Ningbo port in Zhoushan port has undergone many structural adjustments and stock transfer procedures. After the reorganization of the listed companies, the controlling shareholder of the Ningbo port of the listed company will be the newly established Ningbo Zhoushan port group, which is the actual control of the SASAC of Zhejiang province (Knowler, 2015). The integrated Ningbo-zhoushan port has become the world's largest port rapidly. This integration has become a successful example of China's port integration.

In July 2017, Zhejiang port investment and operation group Co., Ltd. and Jiaxing SASAC signed the free transfer agreement of Jiaxing port assets integration. In August 2017, the Zhejiang provincial government announced that the Zhejiang port investment and operation group Co., Ltd., and the state capital committee of Taizhou and Wenzhou, respectively signed the unpaid transfer agreement between the Taizhou port and the Wenzhou port. The Zhejiang port group has basically completed the port assets integration work for 3 coastal cities of Jiaxing, Taizhou and Wenzhou, and will carry out the transfer of shares. So far, the integration work of the main coastal ports

in Zhejiang has been completed (Wm927.com, 2018).

Zhejiang's large seaport ports include Ningbo port, Zhoushan port and Wenzhou port.

4.2.2.1 Ningbo-zhoushan Port

The Ningbo-zhoushan port is an important container port in China, the largest iron ore transfer base and crude oil transfer base in China, the important liquid chemical storage and transportation base and the important coal and grain storage and transportation base in East China and is the national main hub ports. In 2015, the cargo throughput of Ningbo-zhoushan port exceeded 0.9 billion tons, ranking the first place in the world port for 9 years (Portnbzs.com.cn, 2018). Ningbo-zhoushan port is composed of 19 port areas, such as Zhenhai, Beilun, Yangshan and so on. There are 624 berths in existing production berths, of which there are 157 large berths above 10000 tons, with design capacity of 774 million tons, ranking first in China. The port has 118 container ocean trunk lines and the capacity of container throughput is 12 million 970 thousand. Ningbo-zhoushan port has been connected with more than 600 ports in more than 100 countries and regions in the world, and more than 230 liner routes have been opened. For Yangtze River economic belt, Ningbo-zhoushan port has undertaken 45% of the iron ore in the more than 90% of the oil transfer volume, and one third of the international shipping container volume. In China, Ningbo-zhoushan port also takes about 40% of oil, 30% of iron ore and 20% of coal reserves, which is an important commodity storage and transportation base of the country (Portnbzs.com.cn, 2018).

Ningbo port is composed of Beilun port area, Zhenhai port area, Ningbo port area, Daxie port area and Chuanshan port area. It is a multi-functional and comprehensive modern deep-water port which integrates the inland river port, estuarine port and seaport. There are 309 existing berths, of which 60 are deep-water berths above 10000 tons. There are 250-thousand-tons crude oil terminal, the sixth generation of international container berths and 50-thousand-ton liquid chemical berths. Ningbo port is Chinese main container, ore, crude oil, liquid chemical transfer storage base and is main coal, grain and other bulk grocery transfer and storage base in East China (Nbport.com.cn, 2018).

Zhoushan port is a deep-water port with the main function of water transportation in Zhejiang province. Zhoushan port has formed the basic pattern of opening up ports with different functions, centered on the three working areas in Shenjiamen area, Laotangshan area and Dinghai area. There are 54 deep-water areas in Zhoushan port, with a total length of 279.4 kilometers, accounting for 55.2% of the whole province and 18.4% in the whole country (Portzhoushan.com, 2018).

4.2.2.2 Wenzhou Port

Wenzhou port, located in the southeast coast of China, is located in the Yangtze River Delta Economic Zone, which is the leading part of Shanghai Pudong. Wenzhou port, with 350 kilometers of coastline and superior geographical location, is the central hub of coastal sea and ocean transportation in south of Zhejiang Province. It is also one of the 25 main ports in the coastal areas of China and occupies an important position in the national comprehensive transport network (Wzport.com, 2018). Wenzhou port is divided into seven port areas, including three key port areas, such as the Zhuangyuanao area, Yueqingwan area, Daxiaomendao area, and four auxiliary port areas, namely, Oujiang area, the Ruian area, the Pingyang area and the Cangnan area (Wzport.com, 2018).

4.2.3 Shanghai Port Integration

Shanghai port, located in the front of the Yangtze River Delta, is the center of the Chinese coastline and is an important hub port in the world. The direct hinterland of Shanghai port is mainly the Yangtze River Delta region, including Shanghai, southern Jiangsu and Northern Zhejiang. The Yangtze River Delta includes 15 cities, including Shanghai, Nanjing, Zhenjiang, Changzhou, Wuxi, Suzhou, Nantong, Yangzhou, Taizhou, Yancheng, Huaian, Hangzhou, Ningbo, Suzhou, Yancheng, etc., with a land area of more than 10 million square kilometers, with a population of nearly 100 million. In 2003, 15 cities in the Yangtze River Delta completed 2 trillion and 277 billion 420 million yuan in gross domestic product, accounting for 19.2% of the total GDP in the country. (Portshanghai.com.cn, 2018). The operation of Shanghai port mainly includes loading and unloading, warehousing, logistics, ship towing, pilotage, outer wheel agent, outer wheel physical goods, sea rail transport, transit service and waterway passenger service. The main commodities in Shanghai port are containers, coal, metal ores, petroleum and their products, steel, mining materials, machinery and equipment (Portshanghai.com.cn, 2018).

Shanghai port has 592 berths of various production terminals, of which 172 are berths of 10000-ton class and 42 are container berths. Shanghai port has 185 thousand square meters of warehouses and 879.1 square meters of storage yards (of which the container yard is 690.6 square meters). Shanghai port is divided into 8 regions: Yangshan Port, Changjiang Estuary port, Huangpu River port, Hangzhou bay port, Chongming Island port, Changxing Island port and Hengsha island port (China Ports Journal Press, 2017).

Shanghai participated in port integration in 1997. The Shanghai composite port was formally established in 29 in September 1997, the Shanghai composite port is centered on Shanghai, Zhejiang and Jiangsu are two wings. The container terminal berths of

the corresponding ports are combined without changing the original geographical and administrative affiliation. But the port integration belongs to the type of strategic alliance. The ports in the alliance are not physically integrated.

In the integration of this round, Shanghai port is facing the same problem as Tianjin port in Bohai port cluster. Because, among the four municipalities directly under the Central Government in China, only Tianjin and Shanghai are seaport cities. This means that Shanghai and Tianjin will not be able to join other ports in the inter provincial integration of ports. Therefore, when we were analyzing this area, Shanghai was studied as an independent port.

4.3 South China Sea cluster

The South China Sea port cluster mainly involves four provinces, namely, Fujian, Guangdong (Fig 5), Guangxi and Hainan provinces. The hinterland of the region is mainly Southern China and Southwest China. and radiates to Southeast Asia. The provinces involved in the region are developing very fast in light industry, so container trade is flourishing in the region.

Figure 5 Map of South China Sea Cluster

Source: map.baidu.com

4.3.1 Fujian Port Integration

There are six coastal ports in Fujian, namely Ningde port, Fuzhou port, Putian port, Quanzhou port, Xiamen port and Zhangzhou port. Compared with other ports in China, the development of coastal ports in Fujian province has the following characteristics. Firstly, the development of coastal ports in Fujian province is mainly concentrated in Xiamen port, Fuzhou port and Quanzhou port. The three port cargo throughput accounts for 89% of the cargo throughput of the province's port. Secondly, for the coastal ports of Fujian, many of them are individual wharves. The cargo throughput of the main port group accounts for only about 50% of the total cargo throughput of the coastal ports in the whole province (Liu, 2017).

Port integration in Fujian has been started for a long time, and gradually advancing, such as the integration of Xiamen port and Zhangzhou port, Quanzhou port and Putian port are all known as the Meizhou Bay Port, Fuzhou port group and Putian port is wholly owned and controlled by Fujian transportation group (Liu, 2017). In June 14, 2017, the state assets supervision and Management Committee of Fujian Province announced that, with the approval of the Fujian provincial government, the shares of the Fujian port shipping construction and Development Co., Ltd. were transferred to the Fujian Transportation Group Ltd without compensation. The reorganized Fujian transportation group will take advantage of the largest public terminal operator in Fujian to integrate the port shipping company as the beginning, accelerate the integration of the Fujian port, and build a large modern port service group with "leading in port, basing on Fujian, planning two sides of cross-strait and radiating One Belt One Road"(Liu, 2017).

The main ports in Fujian are Fuzhou port, Quanzhou port and Xiamen port.

4.3.1.1 Fuzhou port

Fuzhou port is located in the southeastern part of China and the west coast of the Taiwan Straits. It is one of the main ports in Chinese coastal areas, the main foreign trade port along the coast and the important port for trade between Fujian and Taiwan. The direct hinterland of Fuzhou port includes the whole part of Fuzhou and Nanping, and the vast majority of Sanming City and Ningde. The indirect hinterland includes the eastern part of Jiangxi province and the eastern part of Hunan Province, and the rain area of Sanming City in the province and the northern part of Putian (Chinaports.com, 2018). Hinterland industries include shipbuilding, metallurgy, machinery, chemical engineering, making trees, electronics, handicrafts, etc. In addition to grain and oil crops, the output of aquatic products and fruits is very abundant. Mineral resources are mainly Ye Lashi, kaolin, granite, quartz sand and so on. The main port areas of Fuzhou port are located in the estuary of Minjiang estuary, such as Taijiang port, Mawei

Port, Qingzhou port, Songmen port, Choudong port, and Gutou port area. Fuzhou port has 9443.6 meters of coastline, 67 berths of 1000 tons, and 19 deep-water berths above 10000 tons, with a maximum berthing capacity of 30 thousand ton (Chinaports.com, 2018).

4.3.1.2 Quanzhou port

Quanzhou port is located in the lower reaches of Jinjiang in the southeast of Quanzhou. The port resources are superior, the coastline is 541 km long and the natural coastline of the planned port is 113.7 kilometers, of which the deep-water line is 57.2 kilometers. Quanzhou port has 92 productive berths, of which there are 25 tens of above-ten-thousand-tons deep-water berths (including two 300-thousand-ton berths, four 100-thousand-ton berth, eight 50-thousand-ton berths and eleven 10-thousand-ton berths); the port capacity reaches 119 million 860 thousand tons, of which container loading capacity is 1 million 230 thousand TEU. Quanzhou port has more than 130 transport routes, 76 container routes, and shipping trade with 30 countries and regions in the world (Qzgw.com, 2018).

4.3.1.3 Xiamen port

Xiamen port, located in Xiamen and Zhangzhou, Southeast of Fujian Province, is located in the mouth of the Ninelongjiang River, facing the East China Sea, on the Taiwan Strait, and is the gateway of the southeast of China (Chinaports.com, 2018). The total length of the natural coastline of Xiamen port is about 899 km, and the total length of the terminal is about 94 km. The main port resources are located in Xiamen Ring Bay and Dongshan Ring Bay. Xiamen port consists of 10 ports: Dongdu, Haicang, Xiangan, Zhaoyin, Houshi, Shima, Gulei, Dongshan, Yunxiao and Zhaoan. In 2013, the integration of Xiamen and Zhangzhou ports was completed (Chinaports.com, 2018).

4.3.2 Guangdong Port Integration

Guangdong has 3368 kilometers of coastline, 998 navigable rivers and 14213 kilometers of navigable mileage. There are nine coastal ports in Guangdong, namely Guangzhou, Zhanjiang, Shenzhen, Humen, Zhuhai, Huizhou, Zhongshan, Shantou and Maoming.

In 2012, the Guangdong provincial government put forward the idea of integrating the resources of the Pearl River Delta port group and compiled the "Pearl River Delta port group integrated development planning research". In 2014, the "Pearl River Delta Port

Group Integrated Development Symposium" was held in Guangzhou, and Guangdong port integration plan was focused on. In July 19, 2018, the Guangdong Provincial Department of Transport issued a letter of reply to the 20180201st session of the twelve first session of the Guangdong Provincial Committee of the Chinese people's Political Consultative Conference. The document is proposed that Guangzhou port group and Shenzhen port group should be the two main bodies and integrate the state-owned port assets of 14 coastal cities and Foshan cities. The document is also proposed that a draft of Guangdong port resources integration plan has been formed (Ship.sh, 2018).

Guangdong has four major coastal ports, namely Guangzhou, Shenzhen, Zhuhai and Zhanjiang.

4.3.2.1 Guangzhou Port

Guangzhou port is the largest comprehensive hub port in Southern China. Guangzhou port is located in the Pearl River Estuary and the Pearl River Delta region, bordering on the South China Sea, adjacent to Hongkong and Macao. Guangzhou port area is divided into 4 port areas: Neigang, Huangpu, Xinsha and Nansha. Guangzhou port has advanced facilities for large container, coal, grain, oil and chemical engineering deep-water wharf, and the largest rolling ship terminal in Southern China (Gzport.gov.cn, 2018). The port of Guangzhou has 807 berths, 88 anchorages, 23 buoys, 76 berths above 10000 tons, with the maximum berthing capacity of 300 thousand tons. Guangzhou port has a vast economic hinterland, mainly in Guangdong and relying on Guangzhou, including Guangdong, Guangxi, Hunan, Hubei, Yunnan, Guizhou, Sichuan and Henan, Jiangxi, Fujian. The import and export cargo of Guangzhou port are: coal, oil, metal ore, steel, mineral materials, cement, wood, non-metallic ore, chemical fertilizer, pesticide, salt, grain and so on (Gzport.gov.cn, 2018).

4.3.2.2 Shenzhen Port

Shenzhen port is located in the southern part of the Pearl River Delta of Guangdong province. It has 8 port areas: Shekou, Chiwan, Mawan, Dongjiaotou, Yantian, Fuyong, Shayuyong and Neihe. Guangzhou port has 106 square kilometers of water and 16 square kilometers of land area, with 113 above-500-ton berths, of which 100 productive berths, 26 ten-thousand-ton deep-water berths, and 5 container berths. The port's annual comprehensive throughput capacity is 35 million tons, of which container throughput is 1 million 400 thousand TEU (Sztb.gov.cn, 2018). The total length of the terminal is 12965 meters, the maximum berthing capacity is 75 thousand tons, the area of the warehouse is 1 million 692 thousand and 100 square meters, and the number of loading and unloading machinery is about 800. The direct hinterland of the

Shenzhen port is part of Shenzhen, Huiyang, Dongguan and the Pearl River Delta. The indirect hinterland covers Hubei, Hunan, Jiangxi, northern Guangdong, East Guangdong, West Guangdong and Guangxi. The main traffic type is container. The transportation cargo include fertilizer, grain, feed, sugar, steel, cement, wood, gravel, petroleum, coal, ore and so on (Sztb.gov.cn, 2018).

4.3.2.3 Zhuhai Port

Zhuhai port is located in the south of Guangdong Province, the right bank of the Pearl River Estuary. The economic hinterland of Zhuhai port is Zhuhai City area and the western part of the Pearl River Delta. The total length of the Zhuhai port coastline is 17098m. There are 148 productive berths, of which 27 are deep water berths, with a comprehensive capacity of 135 million 150 thousand tons per year (containing 1 million 810 thousand TEU/year for container) (China Ports Journal Press, 2016).

4.3.2.4 Zhanjiang Port

Zhanjiang Port is located in Leizhou Peninsula, Guangdong Province, east of the South China Sea. Zhanjiang port is the shortest route to Southeast Asia, Africa, Europe and Oceania on the mainland of China. It is the main channel for goods in the southwest and Southern China regions of China (Zjport.com, 2018). The Zhanjiang port (Group) Limited by Share Ltd is the largest public port operator in Zhanjiang port, formerly known as the Zhanjiang port authority. Zhanjiang port group has three operating ports in Tiaoshun island, Xiahai and Xiashan, with 38 productive berths, of which 26 are over ten thousand tons, the largest 300 thousand tons land shore crude oil wharf in the country, the largest 250-thousand-ton Iron Ore Wharf in Southern China and the deepest 300-thousand-ton waterway in the region of Asia. The capacity of the port is 49 million 540 thousand tons per year. The storage area of the port area is 227 thousand square meters, the yard area is 1 million 334 thousand square meters, the oil tank volume is 542 thousand cubic meters, the loading and unloading machinery is more than 770 sets. The main types of discharge in Zhanjiang port include coal, oil, metal ore, non-metallic ore, chemical fertilizer, pesticide, grain, nonferrous metal, chemical raw materials, steel, pharmaceutical products and wood (Zjport.com, 2018).

4.3.3 Guangxi Port Integration

Guangxi is located in the Beibu Gulf of Southern China, facing Southeast Asia. Its mainland coastline is 1595 km. There are three seaports in Guangxi, namely Fangchenggang port, Qinzhou port and Beihai port. In December 2009, the Ministry of Transportation issued an announcement that Fangchenggang, Qinzhou port and

Beihai port in Guangxi were integrated, and the name "Guangxi Beibu Gulf Port" was used in a unified way. Beibu Gulf port pioneered the integration of port assets across the administration area (Chen,2018). In 2014, the "Beihai port share" of the listed company was renamed "the port of Beibu Gulf". The assets of the main wharfs and berths in the three port areas are listed as a whole, which realizes the unified planning, construction and operation of the Beibu Gulf Port in Guangxi. In October 2014, the Guangxi provincial government issued comments on deepening the reform to accelerate the development of the Beibu Gulf port, which clearly deepened the reform of the system and mechanism of the port management and operation. In March 2015, Beibu Gulf port of Guangxi was listed as one of the pilot reforms of regional port development in the Ministry of transport. In June 30, 2015, the Guangxi transportation department, the arrangement, the development and Reform Commission, the finance office, the Beibu Gulf office and the SASAC issued the pilot program for the pilot implementation of the integrated reform of the coastal port development of the Beibu Gulf of Guangxi. The implementation plan clarifies the goal of integrated development of Guangxi's Beibu Gulf coastal port (Chen,2018). In October 2015, Guangxi Beibu Gulf Port Authority was established, and the administrative responsibilities of the former Beihai, Qinzhou and Fangchenggang municipalities were fully integrated. In January 2016, the Qinzhou branch of the Beibu Gulf port administration and the Fangchenggang branch were set up, marking the unification of the three ports in the Beibu Gulf port of Guangxi and the realization of the unification in the real sense.

4.3.3.1 Fangchenggang Port

Fangchenggang is the largest port in Western China, along with the southern part of Guangxi and the North Bank of Beibu Gulf. Fangchenggang's direct economic hinterland is Guangxi Fangchenggang City, Qinzhou, Guangxi Baise and Nanning. The indirect economic hinterland is in the other regions in Guangxi, and in the western regions of Yunnan, Guizhou, Sichuan, Chongqing, Hunan, Hubei, Henan and other provinces in Central China. In the Fangchenggang economic hinterland, there are south subtropical climate resources, agroforestry, marine resources and rich mineral resources. In the indirect economic hinterland, there are rich mineral resources. Fangchenggang now has 35 berths, of which 31 are productive berths, and 21 are deep-water berths of 10000 tons or more.

4.3.3.2 Qinzhou Port

The port of Qinzhou is located in the Qinzhou Bay, the top of the Beibu Gulf Bay. It is an important port in China. Qinzhou port is located in the center of Guangxi coastal area. It is the link between Southern China economic circle and southwest economic circle. The economic hinterland of Qinzhou port is Guangxi, Yunnan, Guizhou and

Sichuan southwest. There are 39 industrial berths, including 2 70-thousand-ton berths, 5 50-thousand-ton berths, 1 30-thousand-ton berths, 3 10-thousand-ton berths, 16 1000~5000-ton berths and 12 1000-tons berths. The port annual design capacity is 22 million 960 thousand tons.

4.3.3.3 Beihai Port

Beihai port is located in the south of Guangxi, the bay of Beibu Gulf of South China Sea. It is an important port for Guangxi to open to the outside world. The land area of the port area of the Beihai port is 15.71 square kilometers, and there are 11 berths, the quay is 1218.5 meters long, of which there are 6 berths above ten thousand tons, the maximum berthing capacity is 35 thousand tons, the storage area is 82 thousand square meters, and the number of loading and unloading machinery is 52. Beihai port governs the old original Beihai port area, the Shibuling port area, the Tieshangang port area and the Dafengjiang port area.

4.3.4 Hainan Port Integration

Hainan is located at the southernmost end of China. There are 68 natural harbors in Hainan Province, of which 24 have been opened. The four largest harbors are Haikou Harbor, Basuo Harbor, Yangpu Harbor and Sanya Harbor. Other major ports include: Qing Lan port, Puqian port, Xincun port, Tanmen port, Baimajing port, Boao port and Xinying port.

At the end of 2016, the Hainan provincial government issued the Hainan port resources integration plan (Hainan.gov.cn, 2018). Hainan province will adopt the model of "government promotion and market decision" to carry out the integration of port resources. That is, relying mainly on the market means, the government promotes the reorganization of the port enterprise assets in the region to form a unified port enterprise group, and relies on the enterprise group to integrate the self-natural resources and the operating resources of the port in the province (Chinaports.com, 2018).

The ports with high transport capacity in Hainan are Haikou port and Yangpu Port.

4.3.4.1 Haikou Port

Haikou Port, located in Haikou City, is a comprehensive economic entity engaged in port handling, warehousing, water passenger and freight transport and container transport. Haikou port is the transportation hub and passenger and freight distribution

center of Hainan province. In the development strategy of China's coastal ports, Haikou Port has been listed as a major coastal port by the Ministry of Communications and an international container trunk port in Hainan Province. There are 3 port areas in Haikou port: Xiuying port area, Xingang port area and Macun port area (Hngh.com.cn, 2018).

4.3.4.2 Yangpu Port

Yangpu Port is located in Yangpu Economic Development Zone, Hainan. Yangpu Port has 9 berths, of which 3 are 50-thousand-ton class general bulk berths, and the design capacity is about 7.6 million tons. Yangpu Port has 5 warehouses, with a total area of 27 thousand square meters, with a storage area of 120 thousand square meters and a container yard of 20 thousand square meters (Ypport.com, 2018).

Chapter 5 Analysis of Port integration in Bohai Sea Cluster

5.1 PPA of Bohai Sea Cluster

In this part of the analysis, we mainly analyze the two situations, which are before and after integration. Before the integration, we studied the nine most important ports in the region, namely, Dalian (DL), Yingkou (YK), Qinhuangdao (QH), Tangshan (TS), Huanghua (HH), Tianjin (TJ), Qingdao (QD), Yantai (YT) and Rizhao (RZ). After integration, we studied four ports, namely, Liaoning (LN), Hebei (HB), Shandong (SD) and Tianjin (TJ). It should be noted that the abbreviation of these ports is based on its spelling, rather than its real port code.

5.1.1 PPA for Total Traffic of Bohai Sea Cluster

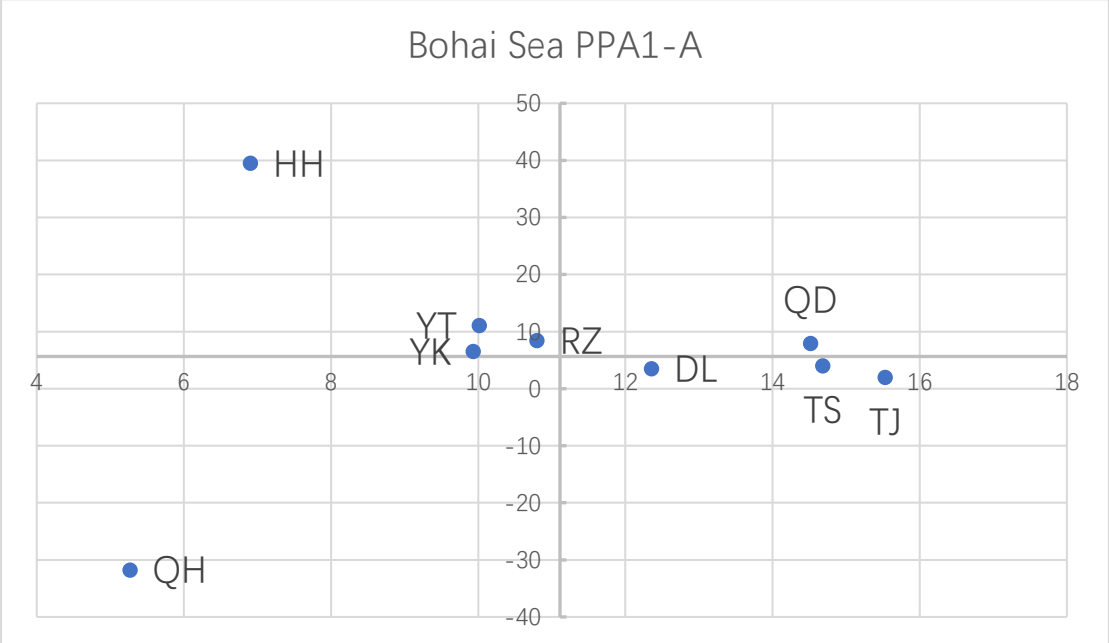

Figure 6 Level 1 of PPA of Bohai Sea cluster (Before Integration)

Source: Own elaboration based on China Ports Year Book

Fig 6 shows the total traffic situation before the integration of the Bohai port area. The nine ports are divided into four different quadrants, showing a variety of situations. The average market share of the region is 9.79%, with an average growth of 5.64%. Among them, Qingdao is the only Star Performer, and Qinhuangdao is the only Minor Performer. But the difference is that Qinhuangdao is the only negative growth port, while Qingdao's growth rate is not outstanding. There are three ports in the Mature Leader area, namely Dalian, Tangshan and Tianjin. The market share of Tianjin is the highest in the region, reaching 15.53%. The four ports of Huanghua, Yingkou, Yantai

and Rizhao are in the High Potential region, and the Huanghua port has grown by 39.45% to become the fastest growing port in the region, while the other three ports are on average. Apart from Qinhuangdao and Huanghua, which are the two ports in Hebei, the growth rate of the other seven ports is at an average level. In the analysis of this part, the general market share of Hebei's ports is low, the ports in Liaoning and Shandong are basically mediocre, and Tianjin shows strong market possessions.

The integrated situation is displayed in Fig 7. The four ports appeared in two different quadrants: Shandong and Liaoning become Star Performer, while Tianjin and Hebei become Minor Performer, with an average growth of 4.62%. Due to the fact that Tianjin has not been complemented in the process of integration, its outstanding market share in the previous analysis has instead become the last one. After integration, Hebei still failed to change its low growth rate, and its market share was not outstanding. Shandong and Liaoning had little difference in individual performance before integration, but after integration, Shandong became the best port in the region. The reason is that Shandong had an advantage in the number of large ports, and its main port, Qingdao, is obviously ahead of Liaoning's main Dalian Port. After the integration, Tianjin has been obviously impacted, while Shandong has achieved outstanding

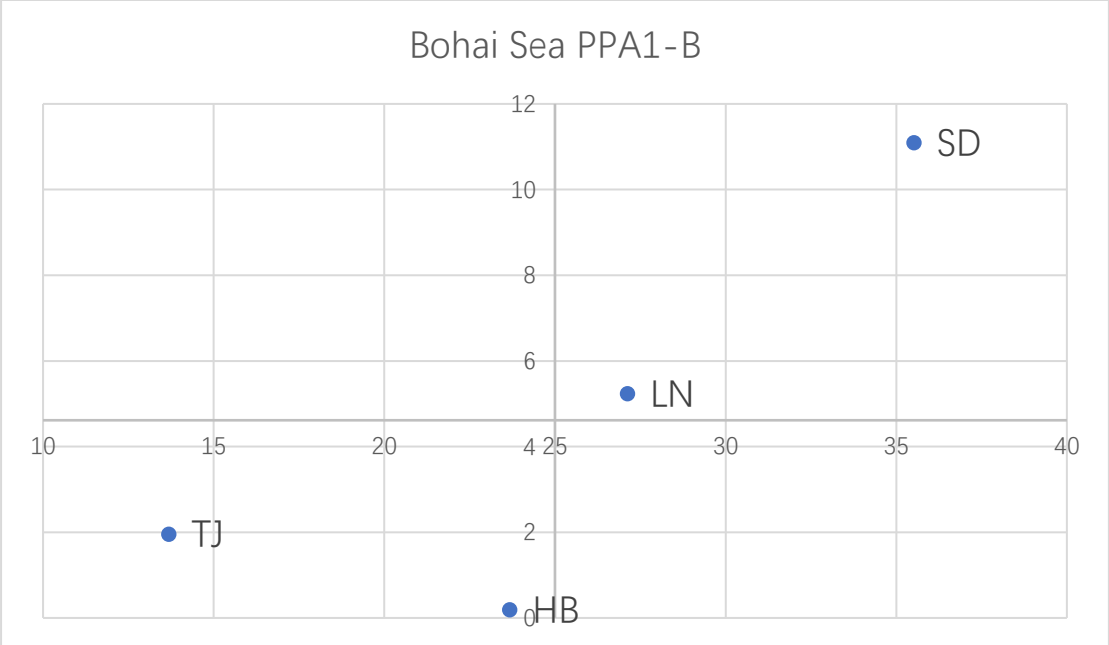

Figure 7 Level 1 of PPA of Bohai Sea cluster (After Integration)

advantages.

Source: Own elaboration based on China Ports Year Book

5.1.2 PPA of Traffic Categories for Individual Ports in Bohai Sea Cluster

In this phase, we will study the integrated four ports, namely, Liaoning, Hebei, Shandong and Tianjin, their respective four types of traffic share and growth.

5.1.2.1 PPA of Traffic Categories for Liaoning

In Fig 8, we can see that the average traffic growth in Liaoning is 13.77%. Container is Mature Leader and it is the major category in Liaoning (its share is 41.88%), but the growth rate is the least. The share of liquid bulk is below average, while its growth is obviously higher than the other two categories, so it is High Potential. Liaoning did not vigorously carry out the business of dry bulk. The development of dry bulk goods is not outstanding, and it does not belong to the dominant cargo type in Liaoning, after all, its share is obviously lower than the other three types. Therefore, dry bulk is Minor Performer in Liaoning.

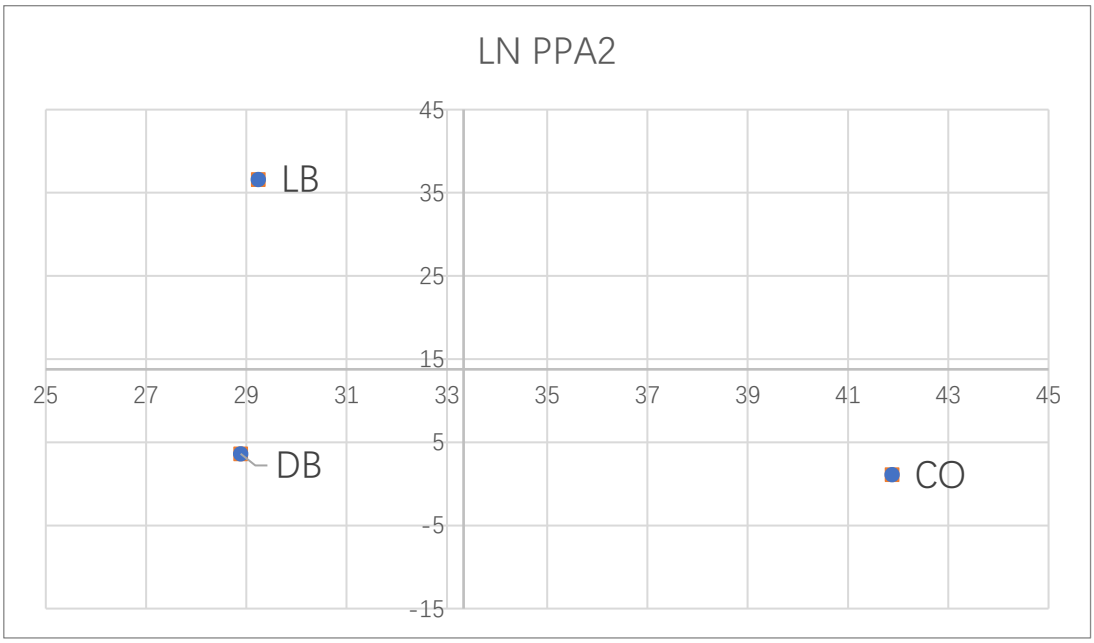

Figure 8 Level 2 of PPA of Liaoning

Source: Own elaboration based on China Ports Year Book

5.1.2.2 PPA of Traffic Categories for Hebei

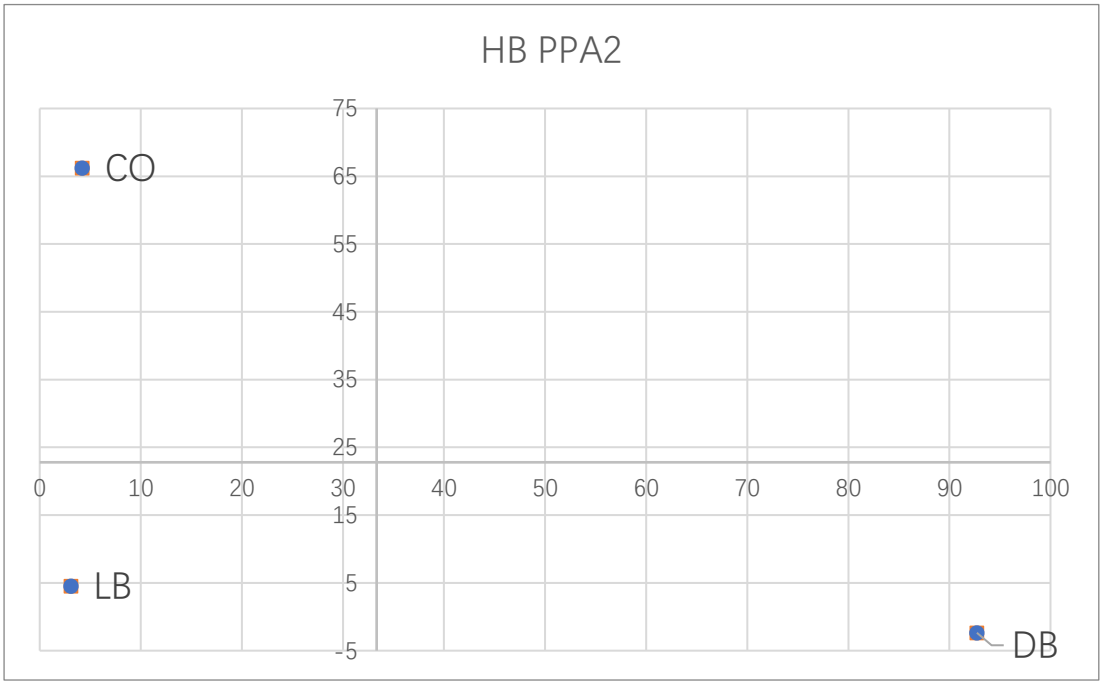

Figure 9 Level 2 of PPA of Hebei

Source: Own elaboration based on China Ports Year Book

In Fig 9, three traffic categories in Hebei appear in three different quadrants, but unfortunately, there is a vacancy in the Star Performer area. Dry bulk is the Mature Leader and accounts for 92.72% of Hebei's port business, becoming the absolute mainstay of Hebei, but negative growth has greatly reduced its strength. Although container business occupies a small proportion of Hebei, the growth rate of 66.19% is indeed outstanding. So, it is High Potential. The proportion of liquid bulk cargo in Hebei port business is almost the same as that of container, but the growth is obviously insufficient, which makes it as Minor Performer. The average of growth of three categories is 22.79%.

5.1.2.3 PPA of Traffic Categories for Shandong

In Fig 10, there is a first quadrant vacancy in the performance of various types in Shandong. Liquid bulk cargo becomes the High Potential in Shandong, while its growth of 61.60% is the fasted among three types and the share is less than other types. Despite the low growth rate of dry bulk, the share of 47.16% still makes it a Mature Leader. Containers is Minor Performer of Shandong, because the two indicators are less than average. The average of growth is 26.28%.

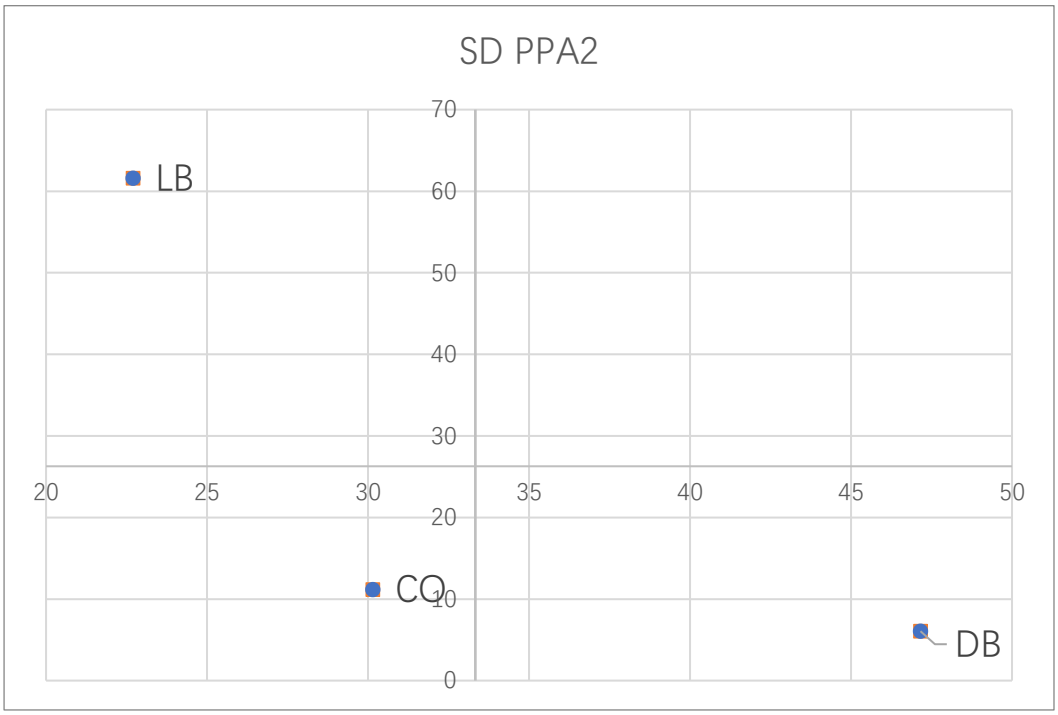

Figure 10 Level 2 of PPA of Shandong

Source: Own elaboration based on China Ports Year Book

5.1.2.4 PPA of Traffic Categories for Tianjin

Fig 11 shows the results of various cargo types analysis in Tianjin. Containers and dry bulk become Star Performer. The share of dry bulk was 52.00%, and the growth rate is 6.04%. These two indexes both are the highest in Tianjin. The growth of the container is 3.27%, slightly higher than the average (2.39%). Liquid bulk cargo has become the only Minor Performer in four categories due to its small share and growth.

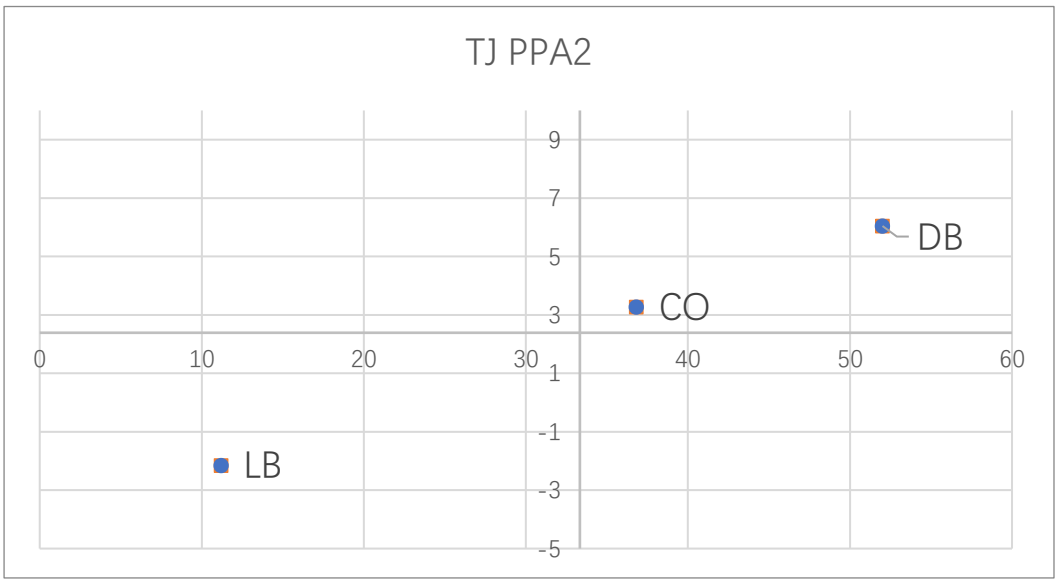

Figure 11 Level 2 of PPA of Tianjin

Source: Own elaboration based on China Ports Year Book

5.1.2.5 Conclusion of PPA of Traffic Categories in Bohai Sea Cluster

In this stage of analysis, after integration, Tianjin is the only port which has its own Star Performer, but unfortunately, the other three ports do not. Except for Liaoning, Dry bulk is the largest share traffic type among the other three ports. Moreover, the growth of dry bulk is usually very low. The share of liquid bulk in four ports is smaller than the average value. Container is irregular, and its performance in four ports appears in four different quadrants.

5.1.3 PPA for individual Traffic Categories in Bohai Sea Cluster

On the research object, this stage is the same as the previous stage. We continue to study the four ports after the integration of the region, and the cargo types are the same as the previous stage. We analyze the performance of four ports on four different traffic categories.

5.1.3.1 PPA for Container in Bohai Sea Cluster

The container condition of Bohai Sea Area is displayed in Fig 12. The four integrated ports do not appear in the Star Performer region, which means that in the container operations of the Bohai Sea region, none of the four ports was higher than the average of the both indicators of share and growth (20.43%). Hebei has become High Potential. Its growth rate of 66.19% is obviously higher than that of other ports, but its share is only 4.97%, which is also lower than the average level. Tianjin is Minor Performer in analysis of container market. Its share and growth are third in four ports, and both two parameters are below average. Liaoning and Shandong became Mature Leader in this analysis, but they are slightly different. Liaoning and Shandong became Mature Leader in this analysis, but they are slightly different. Shandong has a market share of 40.81%, the highest in cluster. Liaoning's growth is only 1.09%, the lowest in the analysis.

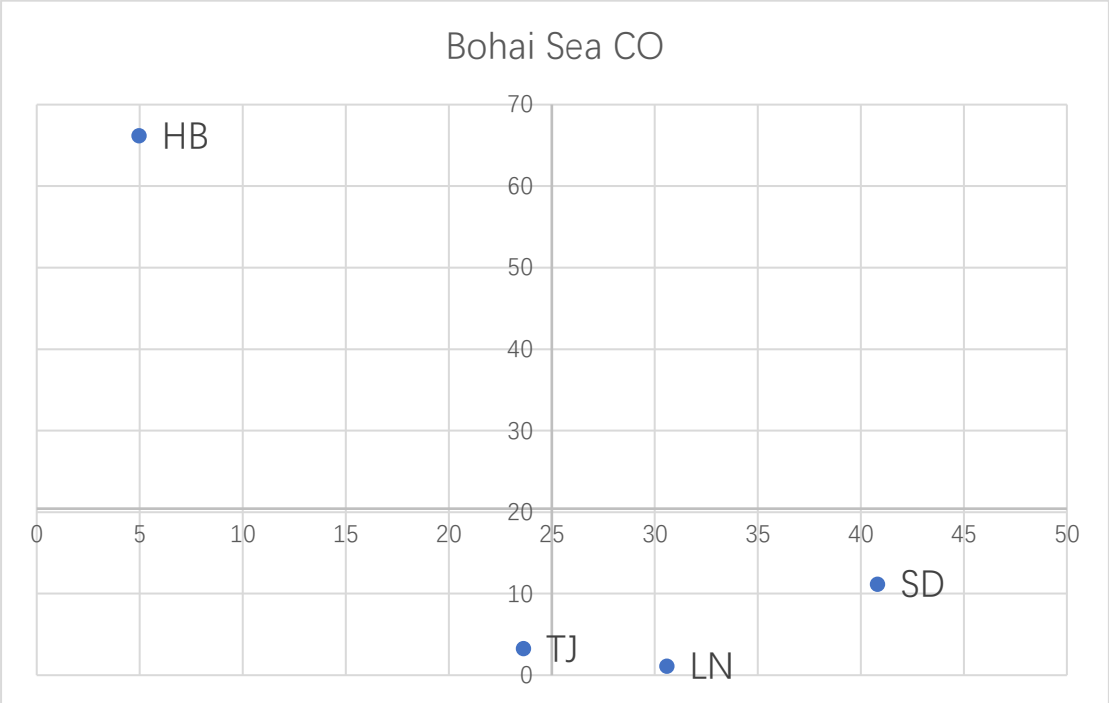

Figure 12 Level 3 of PPA of Container in Bohai Sea Cluster
Source: Own elaboration based on China Ports Year Book

5.1.3.2 PPA for Dry Bulk in Bohai Sea Cluster

In Fig 13, no port appears in the third quadrant, so the four ports in the region have at least one index higher than the average value. Liaoning and Tianjin are High Potential on dry bulk, but Liaoning has the lowest market share of 9.26%, with an increase of 3.62%, almost equal to 3.34 of average value. Tianjin is superior to Liaoning in these two indicators. Shandong's growth is similar to that of Tianjin and has only reached the highest level with very little advantage. But it has 28.03% market share, so it becomes the only Star Performer of this analysis. Although Shandong's growth is negative, Shandong's market share is as high as 48.05%, leading to other competitors. That also makes it to be the Mature Leader of the dry bulk market in the region.

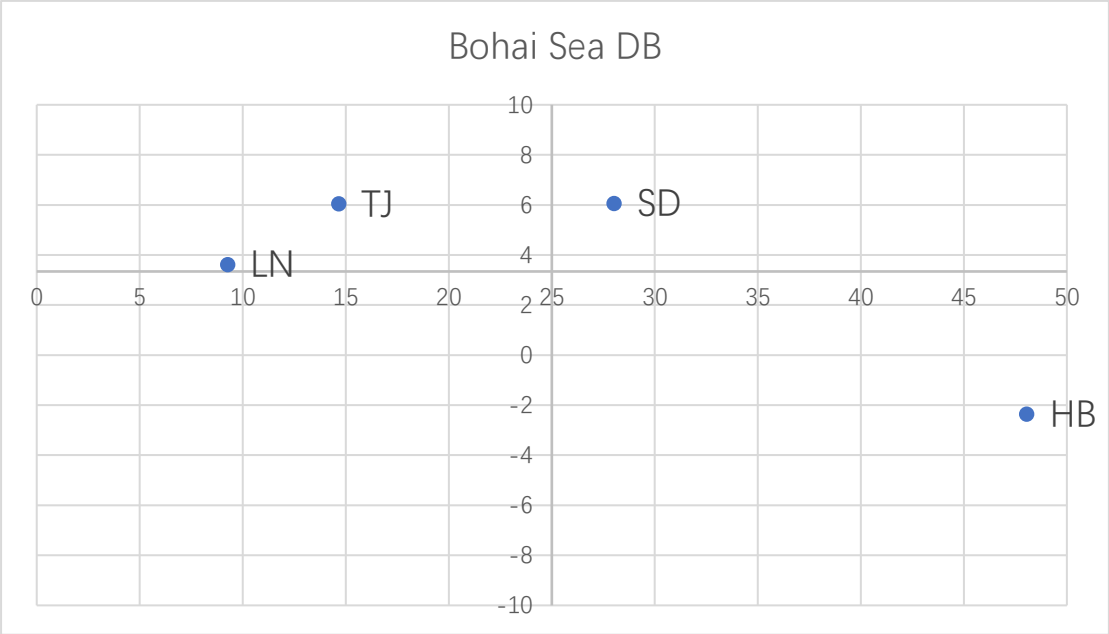

Figure 13 Level 3 of PPA of Dry Bulk in Bohai Sea Cluster
Source: Own elaboration based on China Ports Year Book

5.1.3.3 PPA for Liquid Bulk in Bohai Sea Cluster

Fig 14 shows the situation of Bohai's liquid bulk market after port integration. In the analysis of the market, there is dramatic polarization between the subjects, that is, Shandong and Liaoning become Star Performer and Hebei and Tianjin become Minor Performer. Shandong's performance in this market is excellent, no matter market share or growth rate is significantly higher than its competitors. In particular, the market share is as high as 48.86%, almost the sum of the other three ports. Although Liaoning and Shandong are in the same area, there is a clear gap between Shandong and China. By contrast, the performance of Tianjin and Hebei are much weaker. Hebei's share is only 5.77%, and Tianjin's growth is negative. The average growth of the four ports is 25.15%.

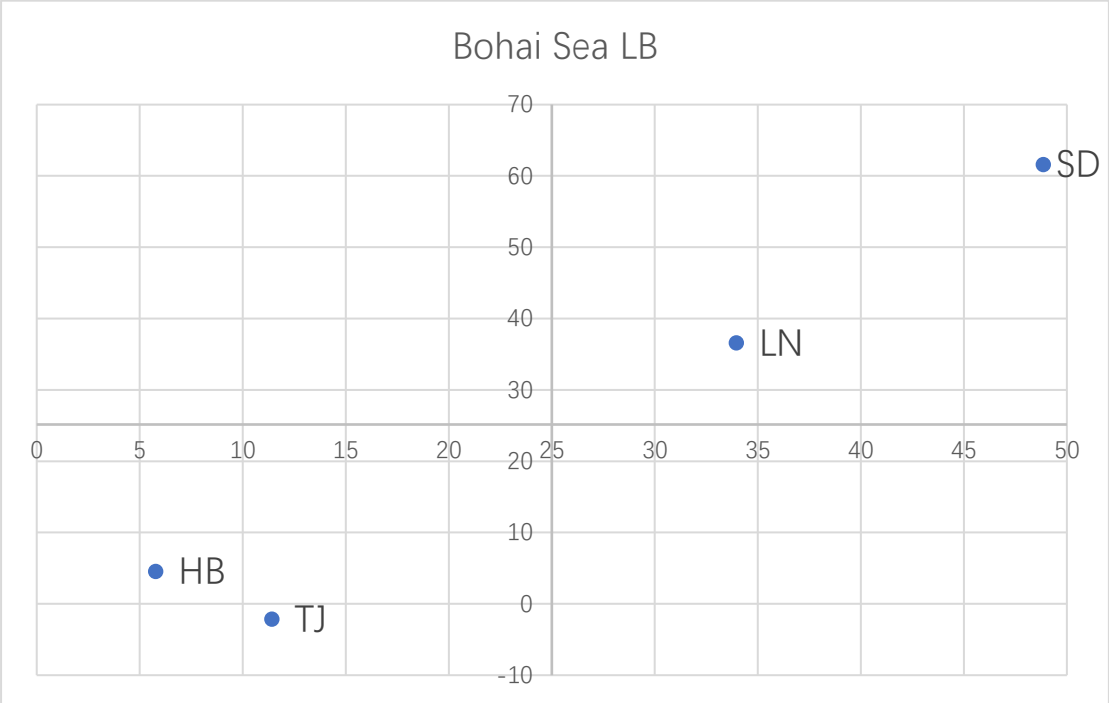

Figure 14 Level 3 of PPA of Liquid Bulk in Bohai Sea Cluster
Source: Own elaboration based on China Ports Year Book

5.1.3.4 Conclusion for PPA for Individual Traffic Categories in Bohai Sea Cluster

In the analysis of three traffic categories, no port is always in the same quadrant, that is, no port has absolute advantages or disadvantages. However, Shandong appears in Star Performer area two times and never appears in Minor Performer area. On the contrary, Tianjin never becomes Star Performer, but has become Minor Performer for the two times. Besides Shandong's outstanding performance in the liquid bulk market, no port is significantly higher than other competitors in the two indicators. In other words, in the analysis of traffic types, the results tend to be diversified. But generally, Shandong has relative advantages and Tianjin is relatively inferior after integration.

5.1.4 PPA for Individual Traffic Categories Related to Share in Bohai Sea Cluster.

In this analysis, the object of our study is the four integrated ports, and the content of the study is their performance in different traffic markets. The abscissa is the weight of the cargo in the region, and the graphic radius is the inter share in each port.

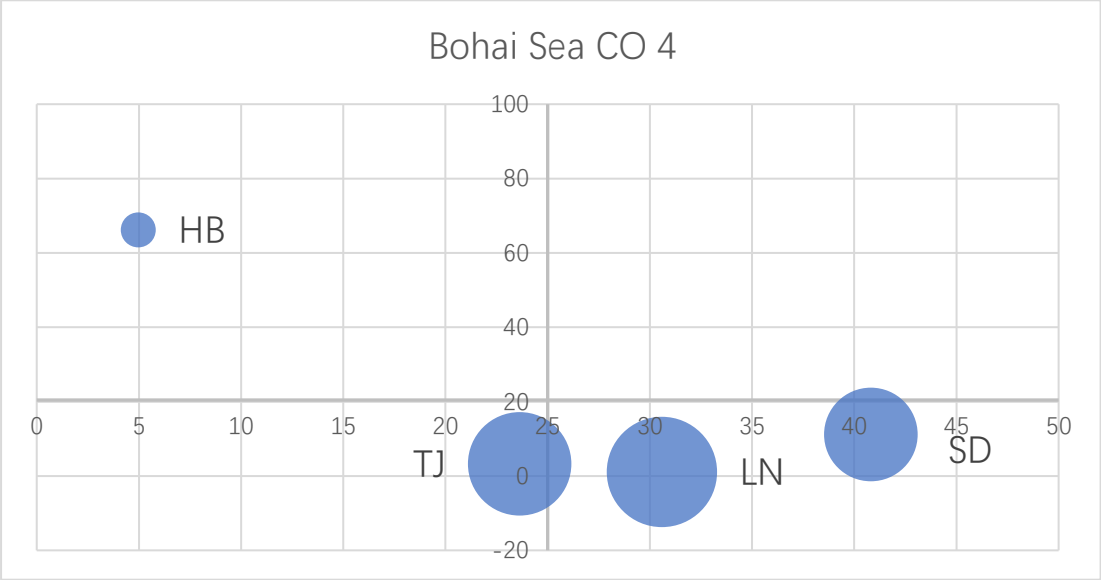

Figure 15 Level 4 of PPA of Container in Bohai Sea Cluster

Source: Own elaboration based on China Ports Year Book

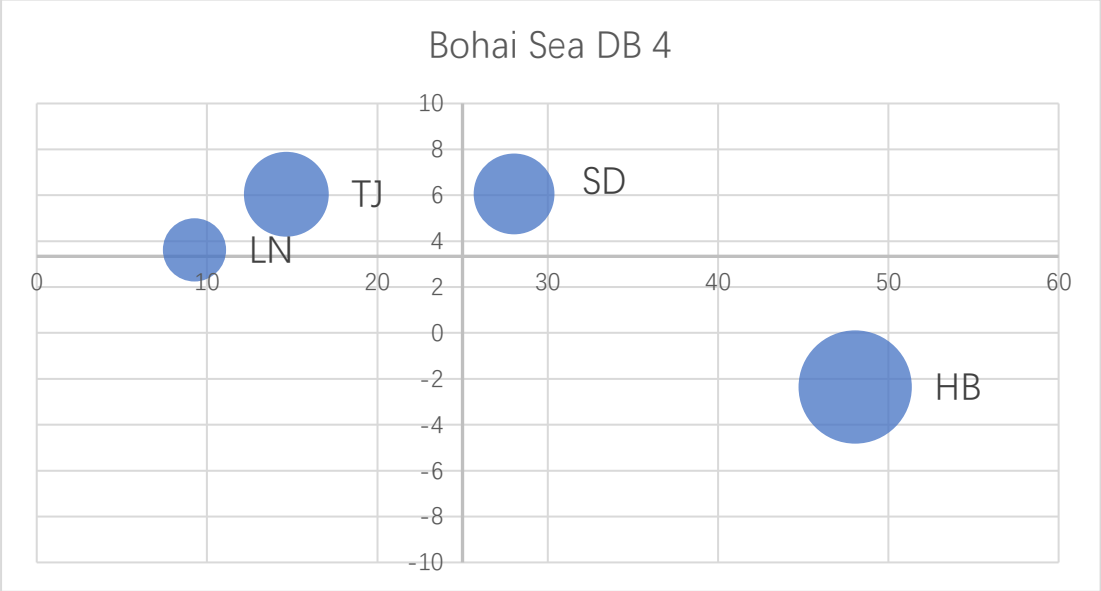

Figure 16 Level 4 of PPA of Dry Bulk in Bohai Sea Cluster

Source: Own elaboration based on China Ports Year Book

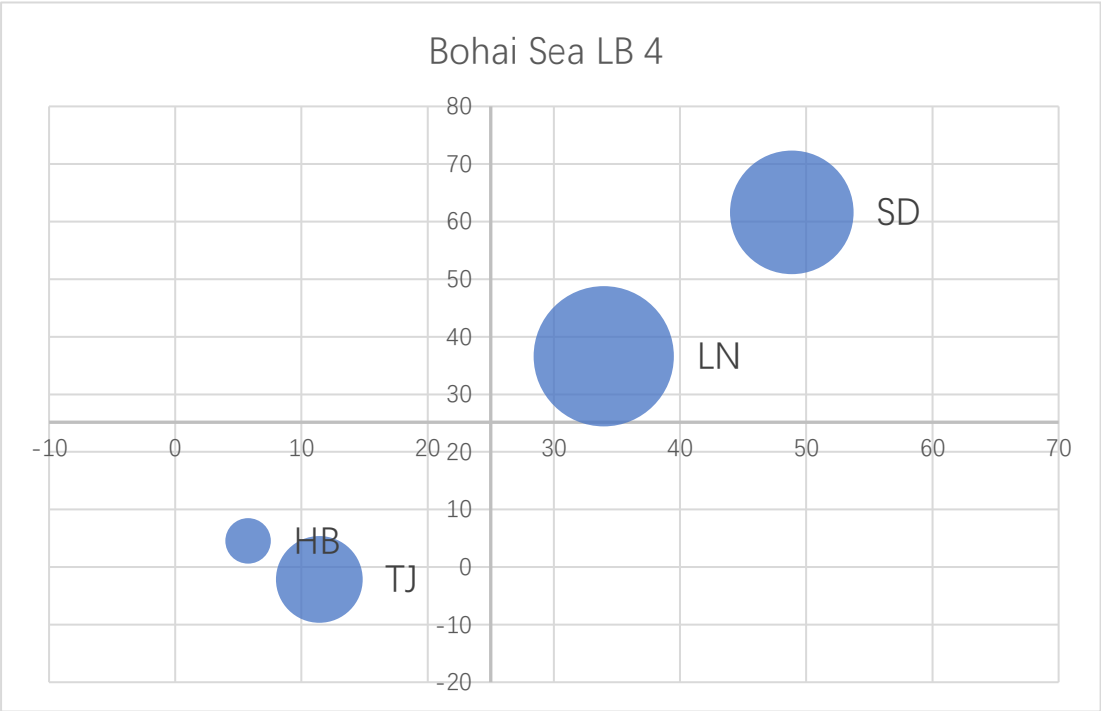

Figure 17 Level 4 of PPA of Liquid Bulk in Bohai Sea Cluster
Source: Own elaboration based on China Ports Year Book

Fig 15, Fig 16 and Fig 17 show that, in the analysis of level, the ports showed diversity in different traffic types. The regional share of the ports with the smallest internal share is smaller than the average, indicating that there is no extreme difference in the overall size of the four ports. In other respects, there is no obvious link between the performance of these ports and their internal share.

5.2 PDA of Bohai Sea cluster

In this part, we will analyze the change of diversity of Bohai Sea port cluster before and after integration. Before integration, we still chose nine ports such as Dalian. After the integration, we selected four ports, such as Liaoning. This is in line with the analysis of the previous section.

Integrated Port	Individual Port	HHI Before Integration	HHI Assumption	HHI After Integration	Rate of Change (%)
LN	DL	4175.636	3816.65	3442.86	-9.79
	YK	3457.662			
HB	QH	8937.722	8755.42	8623.70	-1.50
	TS	8247.237			
	HH	9081.306			

TJ	TJ	4184.634	4184.63	4184.63	0.00
SD	QD	3632.438	4045.54	3647.72	-9.83
	YD	3588.709			
	RZ	4915.486			

Table 1 PDA analysis of Bohai Sea cluster

Source: Own elaboration based on China Ports Year Book

According to Table 1, before integration, Yingkou is the lowest port of HHI index, only 3457.662, while Huanghua is the highest, reaching 9081.306. The HHI index of ports of Hebei are all exceed 8000, while the data of the other three regions are all below 5000.

After integration, Liaoning becomes the most diverse port with HHI index of 3442.86. Compared with Liaoning, Shandong and Tianjin are higher successively and slightly about HHI index. The diversity of Hebei is significantly lower than the other three ports. Compared with the data before integration, Shandong dropped by 9.83%, while Hebei dropped by only 1.50%.

From the data point of view, in the process of integration in Shandong and Liaoning, various traffic types have complemented each other, thus increasing the diversity. The transport structure of Hebei's ports is relatively simple before integration. After integration, there is still not much change, indicating that the port integration in Hebei is mostly the integration of ports of the same traffic type. Diversity of Tianjin is not affected by the integration.

Chapter 6 Analysis of Port Integration in Yangtze River Delta Cluster

6.1 PPA of Yangtze River Delta Cluster

At this stage, we will analyze the two cases, the situation before port integration and the situation after port integration. Before the integration of the port, the object of our study is the independent port in the region, namely, Lianyungang port (LY), Nantong port (NT), Shanghai port (SH), Ningbo port (NB), Zhoushan port (ZS) and Wenzhou port (WZ). In our research, the integrated ports are Jiangsu (JS), Zhejiang (ZJ) and Shanghai (SH). Although Ningbo port and Zhoushan port have been integrated, but because of the analysis of the inter provincial port integration, and the two ports in the data on the independent accounting, so the two ports in the research as two independent ports.

6.1.1 PPA for Total Traffic in Yangtze River Delta Cluster

In this level of analysis, we study the changes in the total traffic of port cluster in the Yangtze River Delta before and after integration.

Although there are six ports before integration, there are still no ports appearing in the Minor Performer area in Fig 18. The average market share of these ports is 16.67%, with an average growth rate of 4.39%. Zhoushan port became the only Star Performer with its extraordinary growth (22.74%). Wenzhou, Lianyungang and Nantong are High Potential, and Wenzhou's market share is the lowest in the region, reaching only 3.90%. The situation in Lianyungang and Nantong is very close. Ningbo and Shanghai became Mature Leader, the growth of Shanghai (32.56%) was similar to that of Ningbo, but the market share of Shanghai was significantly higher than that of Ningbo, and it was in the head of each port in the region. On the whole, Shanghai's market share is relatively advanced. Jiangsu's ports are similar: the market share is low, and the growth rate is mediocre. The port of Zhejiang is diversified, and the three ports are in different quadrants.

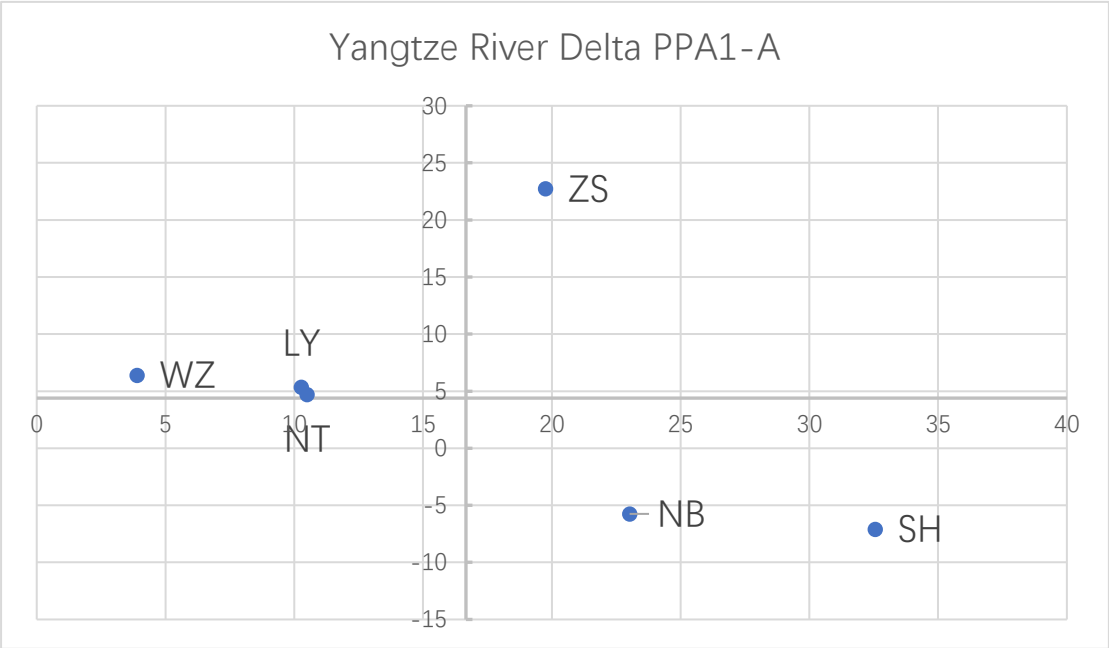

Figure 18 Level 1 of PPA of Yangtze River Delta cluster (Before Integration)
Source: Own elaboration based on China Ports Year Book

After integration, as Fig 19 shows, the average growth is 1.19%. Zhejiang became Star Performer, especially its market share reached 46.68%. Jiangsu's growth is slightly lower than that of Zhenjiang, but because of its low market share, Zhejiang is High Potential. Shanghai has become Minor Performer due to its too low growth rate and relatively low market share. Jiangsu is least affected by integration, and its overall performance is in line with the second quadrant of its port. Shanghai becomes Minor Performer from Mature Leader because it has not been added to the new members, and the market share has been severely impacted by the integration and its own low growth rate. Although Zhejiang's ports are different before integration, Zhejiang becomes a port with high growth and market share in region.

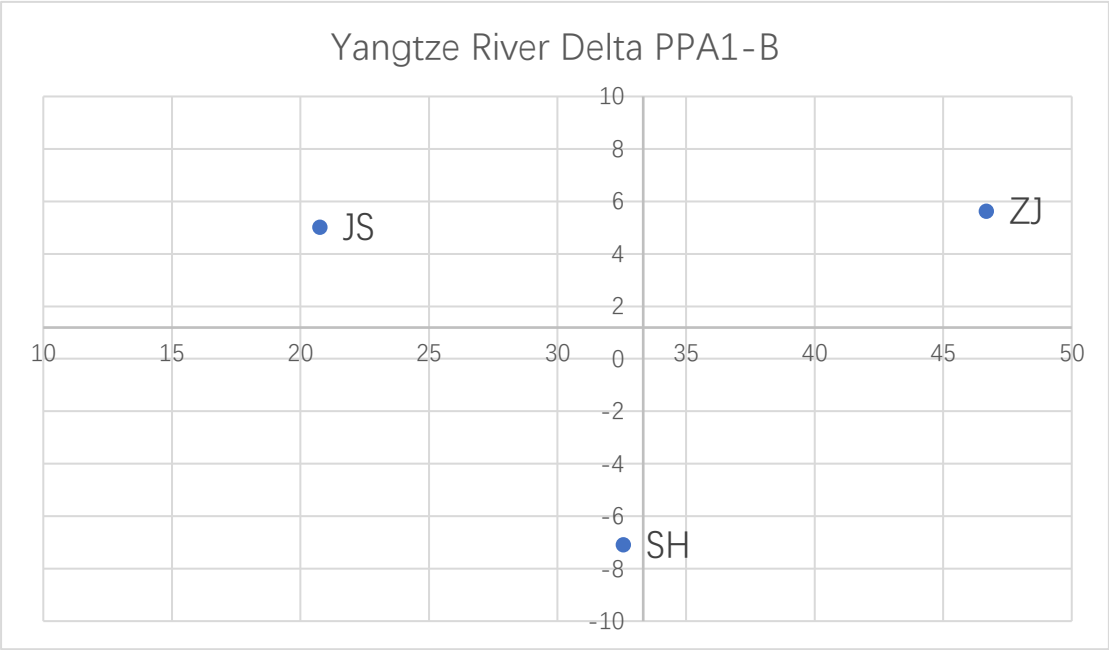

Figure 19 Level 1 of PPA of Yangtze River Delta cluster (After Integration)
Source: Own elaboration based on China Ports Year Book

6.1.2 PPA of Traffic Categories for Individual Ports in Yangtze River Delta Cluster

At this stage, we analyze the traffic type structure of Jiangsu, Zhejiang and Shanghai.

6.1.2.1 PPA of Traffic Categories for Jiangsu

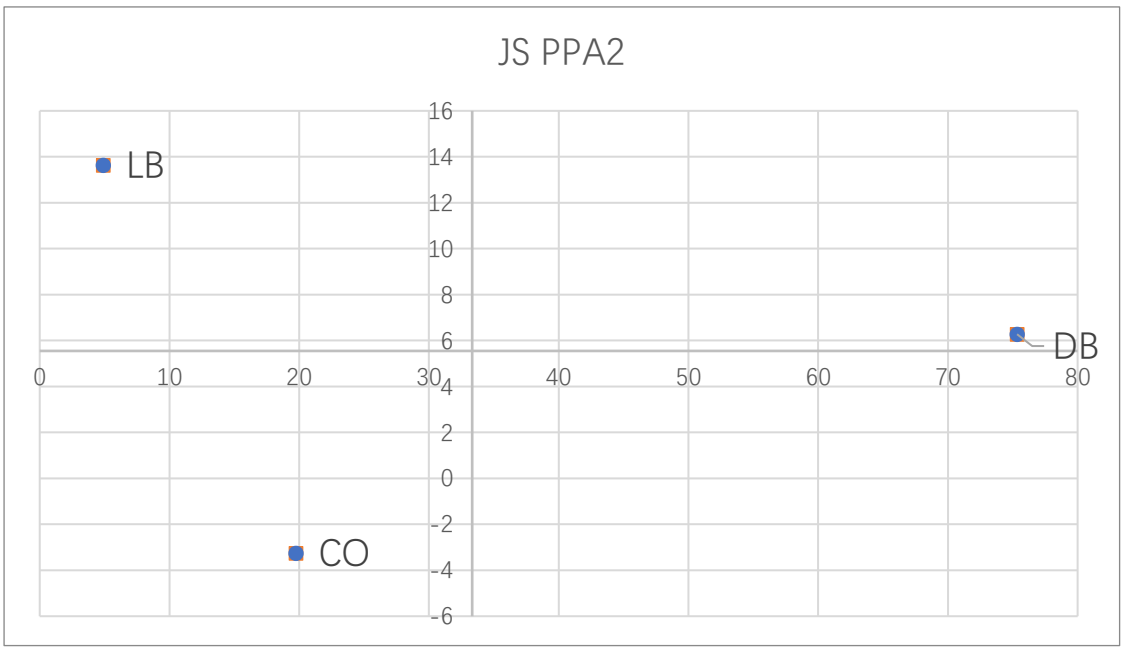

Figure 20 Level 2 of PPA of Jiangsu

Source: Own elaboration based on China Ports Year Book

Fig 20 shows the traffic structure in Jiangsu. Dry Bulk is Star Performer of Jiangsu port. In particular, the share of Dry Bulk in Jiangsu reached 75.33%, which surpassed the sum of the other three types. Its growth rate is 6.28%, exceeding the average value of -5.55%. The liquid bulk cargo is High Potential of Jiangsu port. Liquid bulk is Jiangsu's HP. Although its share (4.90%) is lowest, its growth of 13.63% is obviously higher than that of other categories. Container business is undoubtedly the Minor Performer of Jiangsu port. Because its growth is -3.26%, much lower than other kinds, and its share is also lower than the average value.

6.1.2.2 PPA of Traffic Categories for Zhejiang

In Fig 21, the three types of traffic in Zhejiang are belonged to three different quadrants. Liquid bulk is Zhejiang's Star Performer. Its share and growth are the highest in the province. Its share and growth are not the highest among the three types, but they are both above average. Liquid bulk's growth (13.36%) is the highest and its share (20.77%) is the lowest, so it is High Potential. On the contrary, dry bulk has the highest share of 44.15% and the lowest growth rate of -12.98%. The average growth of three types is 3.56%

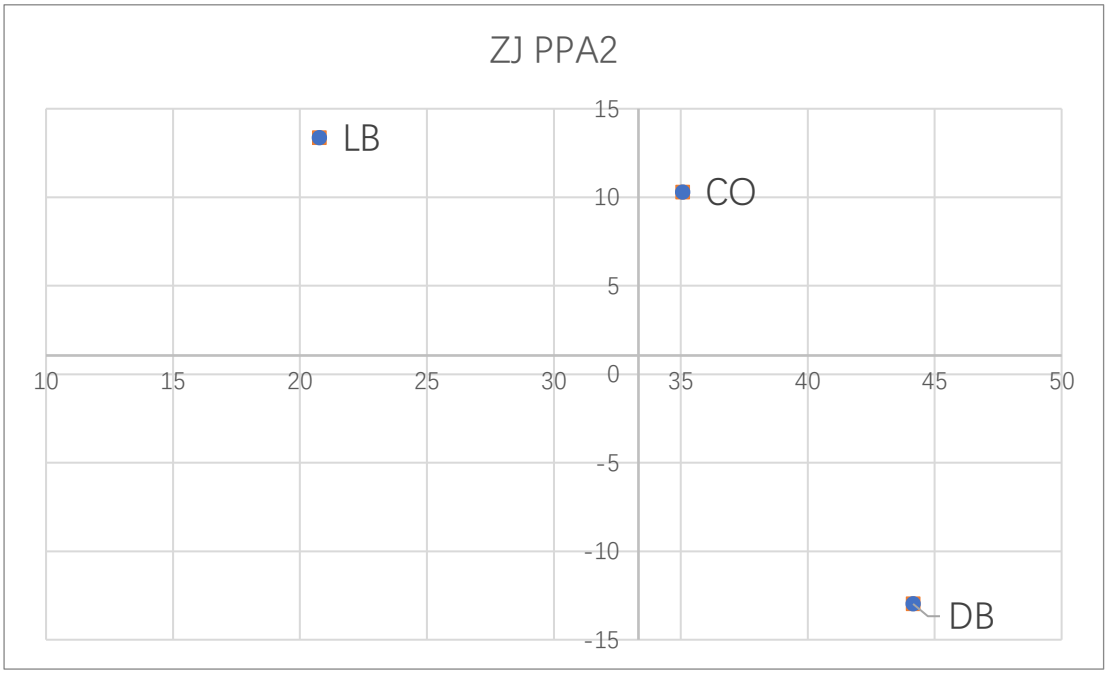

Figure 21 Level 2 of PPA of Zhejiang

Source: Own elaboration based on China Ports Year Book

6.1.2.3 PPA of Traffic Categories for Shanghai

There is a vacancy in the fourth quadrant of Fig 22. The growth of containers (5.24%) is slightly higher than average (4.15%), but its share of 68.36% of the port makes it Star Performer. Dry bulk is Minor Performer of Shanghai port, and it is at the bottom of growth rate by -16.56%. The average growth rate of the four types of traffic in Shanghai port is 37.65%. The internal share of liquid bulk is only 4.69%, but it still relies on the highest growth rate of 23.77% to become High Potential.

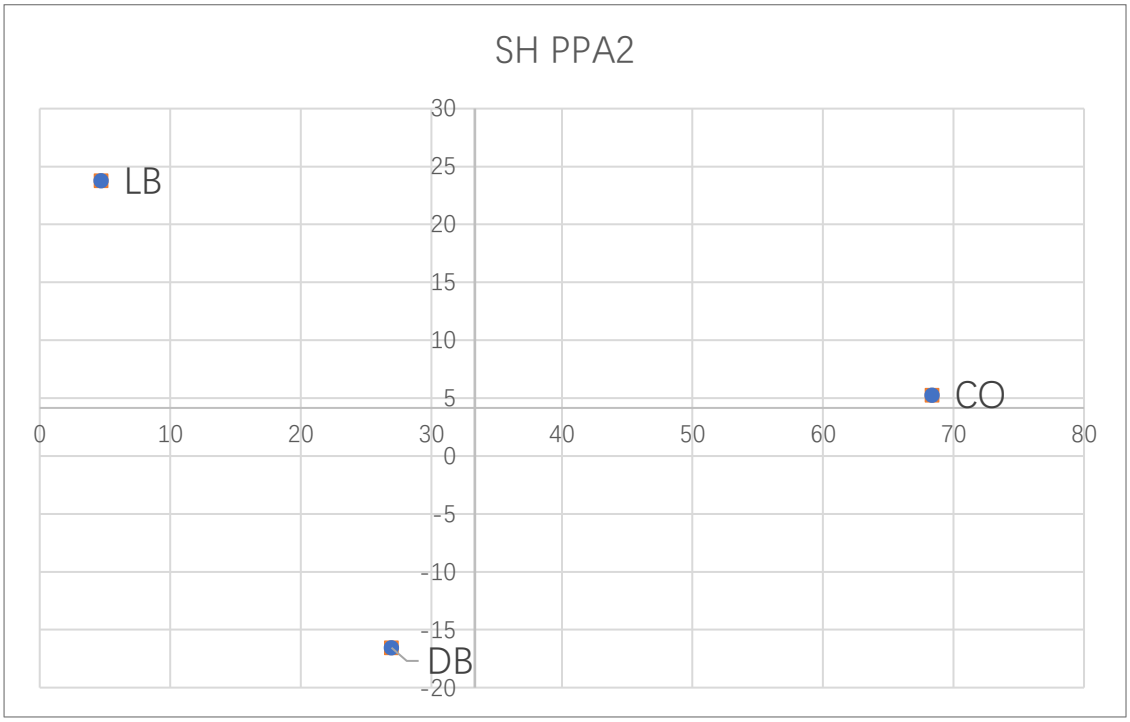

Figure 22 Level 2 of PPA of Shanghai
Source: Own elaboration based on China Ports Year Book

6.1.2.4 Conclusion of PPA of Traffic Categories in Yangtze River Delta Cluster

The presence of liquid bulk cargo in the second quadrant in the analysis of the three ports indicates that the share of liquid bulk cargo in the ports of the Yangtze River Delta is small but growing rapidly. In this port cluster, the growth of dry bulk goods is generally low, and the share is relatively large. Containers are more unstable because it is Star Performer in two ports and Minor Performer in another one.

6.1.3 PPA for Individual Traffic Categories in Yangtze River Delta Cluster

At this stage, we analyze the pattern of port integration in Yangtze River Delta under

different traffic types. The subjects of study are still Jiangsu, Zhejiang and Shanghai.

6.1.3.1 PPA for container in Yangtze River Delta Cluster

In Fig 23, the three ports are clearly divided into two categories. Shanghai and Zhejiang are Star Performer while Jiangsu becomes Minor Performer alone. Shanghai's share reached 57.32%, which surpassed that of the other two ports, with an increase of 5.24%, slightly higher than the average of 4.09%. Of the three ports, Zhejiang has the highest growth rate of 10.29%, and its share is 34.14%. Jiangsu is far inferior to Shanghai and Zhejiang in terms of share or growth, and its growth is negative.

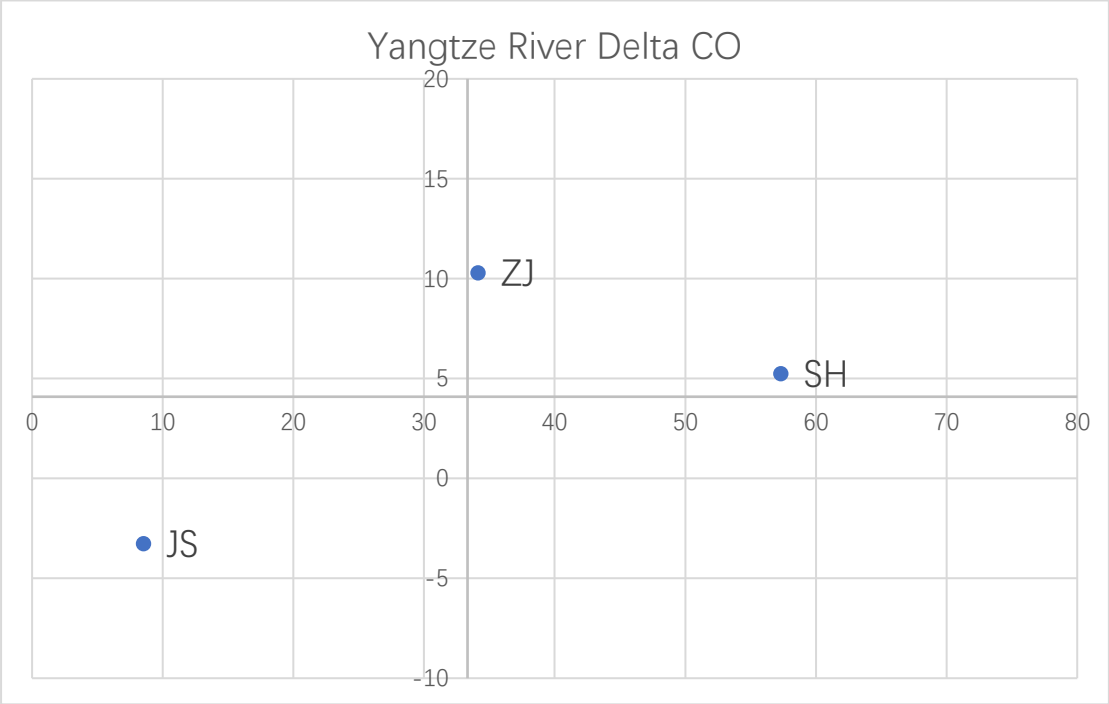

Figure 23 Level 3 of PPA of Container in Yangtze River Delta
Source: Own elaboration based on China Ports Year Book

6.1.3.2 PPA for Dry Bulk in Yangtze River Delta Cluster

The average growth of three ports in dry bulk is -7.75% in Fig 24. Zhejiang has the highest share of 43.80%, with a growth rate of -12.98 and below average, so Zhejiang is Mature Leader. Jiangsu has the highest growth rate of 6.28%, the only positive growth port, and its share is slightly below average, becoming High Potential. Shanghai is Minor Performer, because its two indicators are the lowest. There is no Star Performer in dry bulk market in Yangtze River Delta cluster.

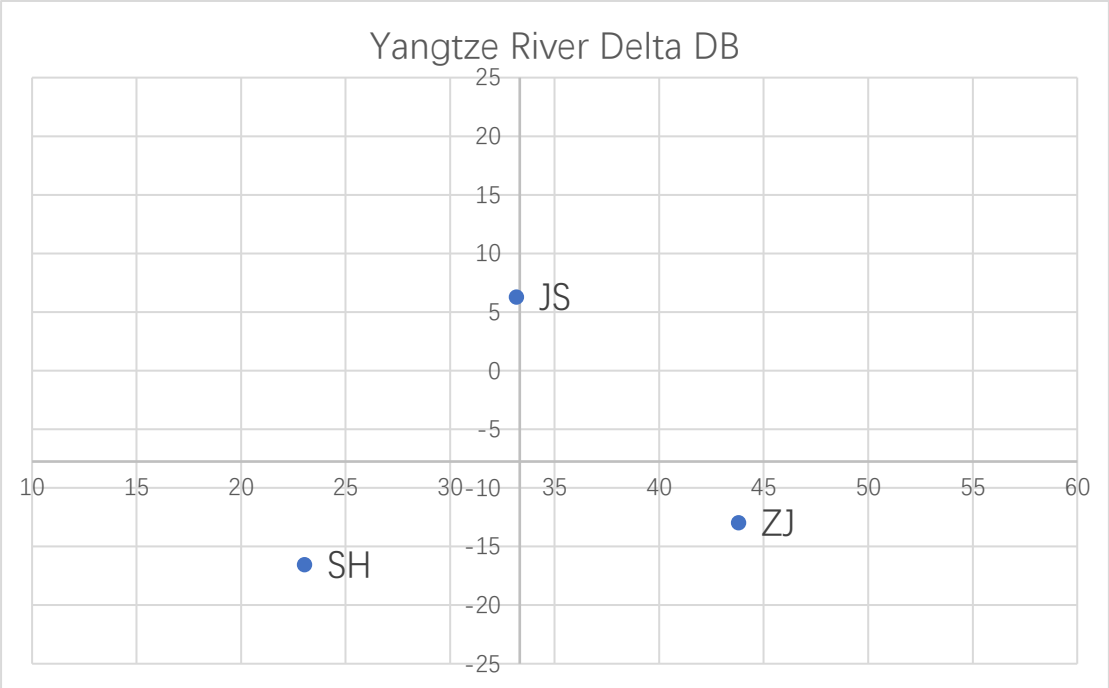

Figure 24 Level 3 of PPA of Dry Bulk in Yangtze River Delta

Source: Own elaboration based on China Ports Year Book

6.1.3.3 PPA for Liquid Bulk in Yangtze River Delta Cluster

Fig 25 shows the pattern of the Yangtze River Delta port in liquid bulk cargo. Like dry bulk, no port in this area is Star Performer. Zhejiang, with its share of 76.95%, is the absolute hegemony of the region, but its growth is 13.34%, lower than the average value of 16.92%. Therefore, Zhejiang is Mature Leader. Although Jiangsu is very similar to Zhejiang in its growth (13.63%), its low market share (8.06%) makes it as a Minor Performer for liquid bulk in the Yangtze River Delta region. Compared with Zhejiang, Shanghai's market share is only slightly higher than Jiangsu, but its growth is the highest of three ports, up to 23.77%, so Shanghai is High Potential.

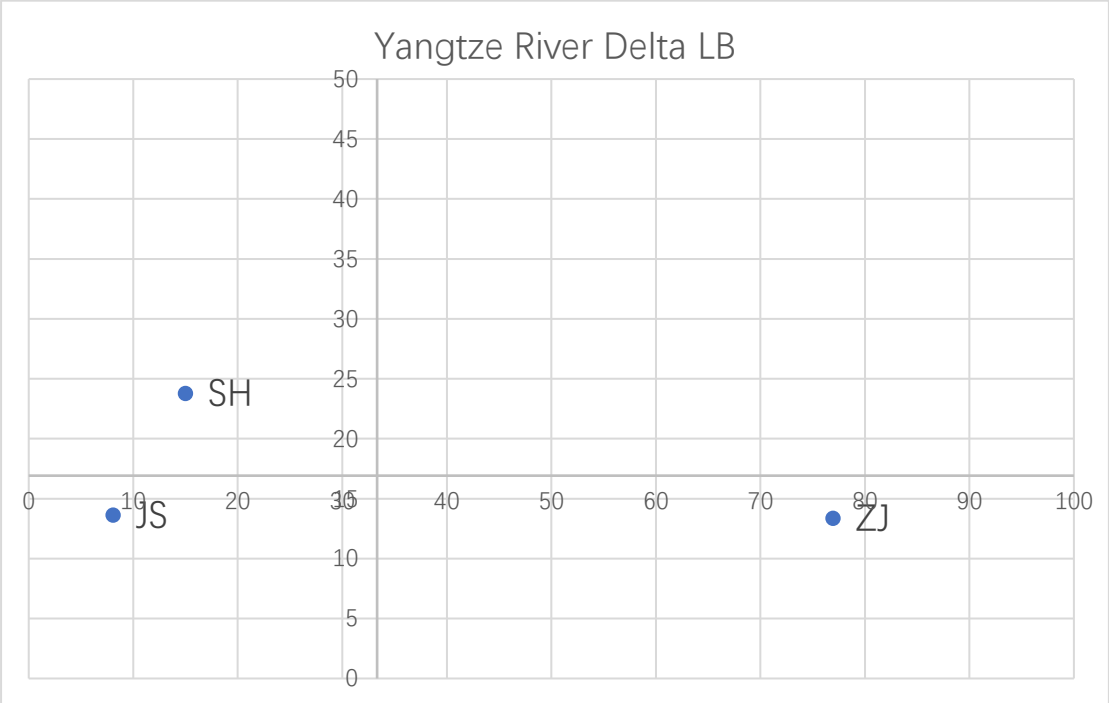

Figure 25 Level 3 of PPA of Liquid Bulk in Yangtze River Delta
Source: Own elaboration based on China Ports Year Book

6.1.3.4 Conclusion for PPA for Individual Traffic Categories in Yangtze River Delta Cluster

Under three different traffic types, no port is always in the same quadrant. Therefore, on the whole, there are no absolute strong or weak in the three ports of Jiangsu, Zhejiang and Shanghai. Competitiveness is still relatively high in this region. After all, there is no sign of monopoly. But it is worth noting that Jiangsu has become Minor Performer two times, but it has never been Star Performer. In this region, Jiangsu is in a relatively vulnerable position clearly. Zhejiang has the largest share of the two categories, of which exceeded 50% once. Shanghai behaves very differently in different traffic types.

6.1.4 PPA for Individual Traffic Categories Related to Share in Yangtze River Delta Cluster

In this level, we analyze the performance of the regional share and growth of the integrated Yangtze River Delta ports under different traffic types, and their internal share in the region.

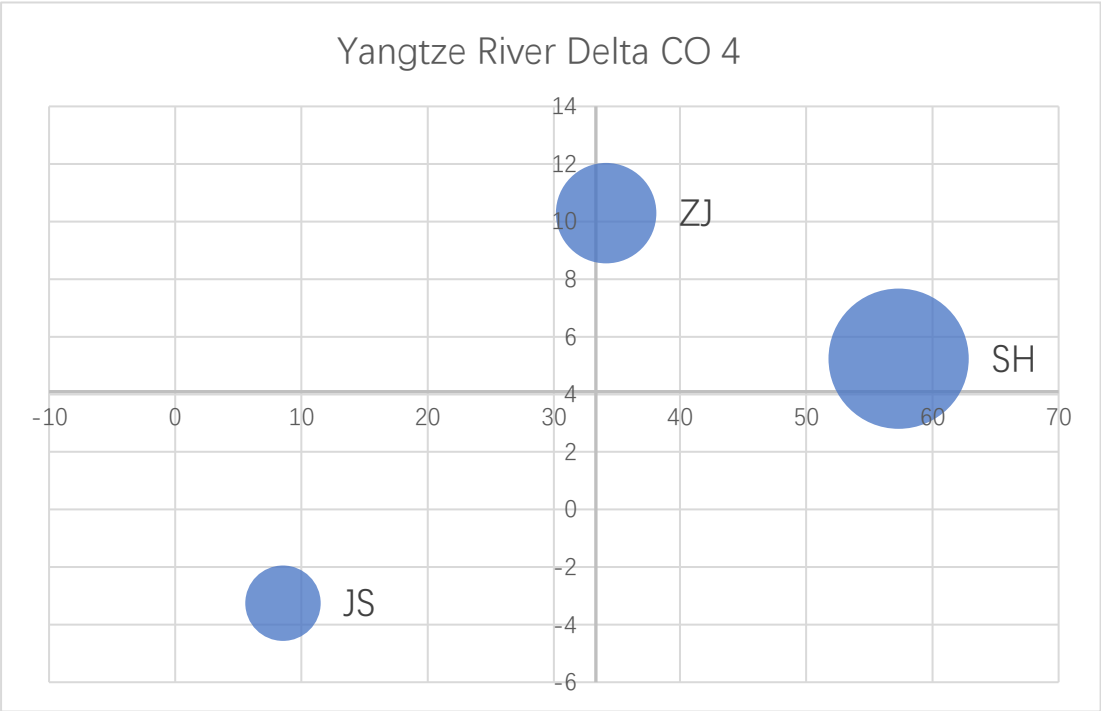

Figure 26 Level 4 of PPA of Container in Yangtze River Delta
Source: Own elaboration based on China Ports Year Book

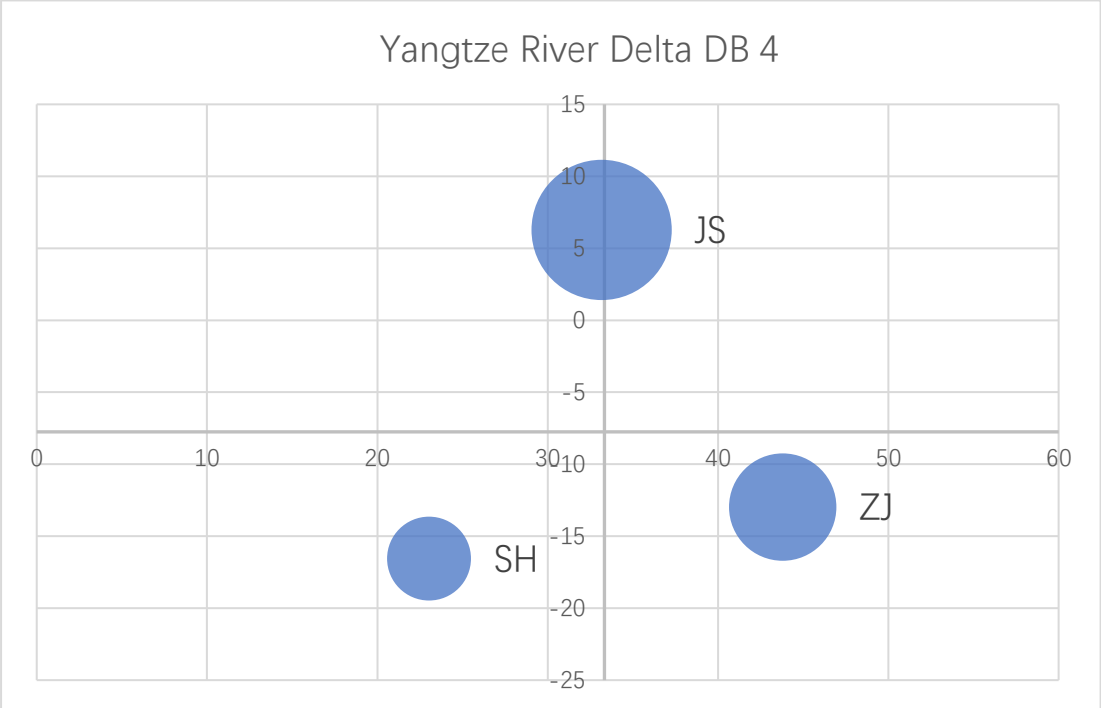

Figure 27 Level 4 of PPA of Dry Bulk in Yangtze River Delta
Source: Own elaboration based on China Ports Year Book

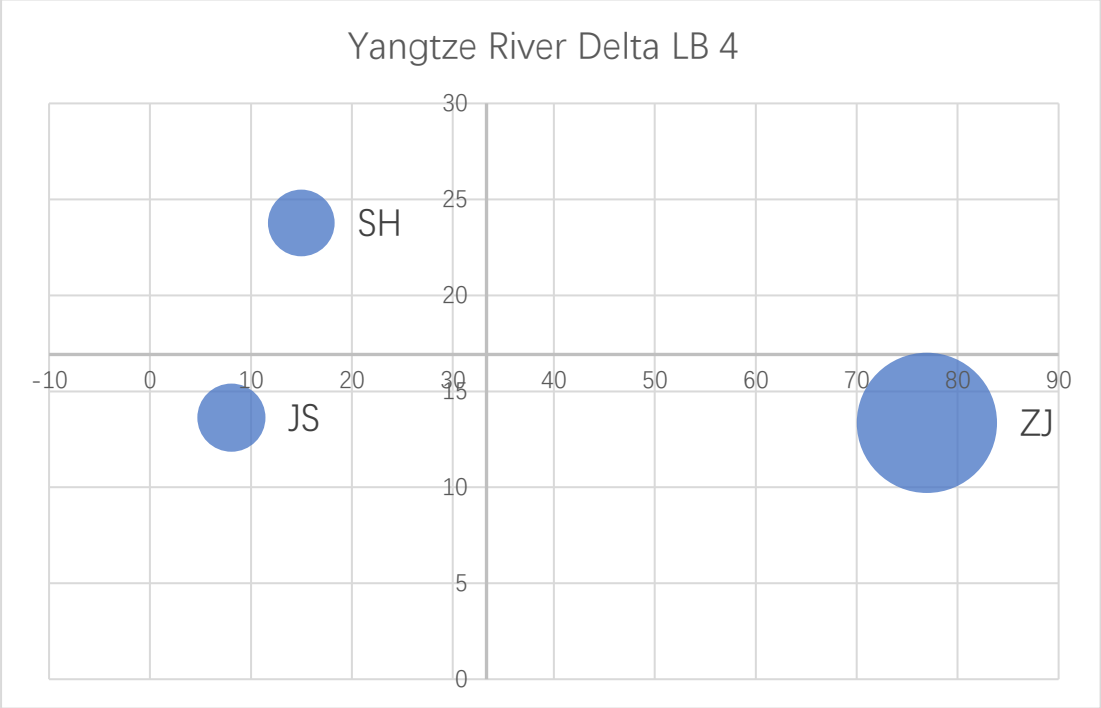

Figure 28 Level 4 of PPA of Liquid Bulk in Yangtze River Delta
Source: Own elaboration based on China Ports Year Book

In the container market, from Fig 26, 27 and 28, the port with a larger share has a larger internal share, and vice versa. has a large internal share, and vice versa. For dry bulk, the internal share of the port is directly proportional to its growth. For the prospect of liquid bulk, the internal share of the port is directly proportional to the regional share and inversely proportional to the growth.

6.2 PDA of Yangtze River Delta cluster

We analyze the change of diversity of ports in the Yangtze River Delta before and after integration through the HHI index.

According to Table 6.2, before integration, Ningbo's HHI index is 3958.144, the lowest among six ports, and Nantong's index is 6852.005, the highest. The index of other ports is between 5000 and 6000. Jiangsu's two ports are the highest and second highest in this indicator.

After integration, the index of Zhejiang is 4922.56, the lowest among three ports. Shanghai is higher than Zhejiang in this data, reaching 5420.92. the HHI index of Jiangsu is the highest, which is 6089.82.

After integration, Zhejiang's index dropped significantly, reaching 26.64%. This shows that in the process of integration, Zhejiang has coordinated the proportion of traffic

types between different ports, making the diversity improved after integration, thus increasing the stability of the port. Considering the obvious diversity of the ports before Zhejiang's integration, the integration of Zhejiang has largely eliminated this point. The diversity of the two ports in Jiangsu was very low before integration and the situation was almost unchanged. This proves that before the integration, the bias traffic types of Lianyungang and Nantong are the same and the integration doesn't change that. The diversity of Shanghai is not affected by the integration.

Integrated Port	Individual Port	HHI Before Integration	HHI Assumption	HHI After Integration	Rate of Change (%)
JS	LY	5839.259	6345.63	6089.82	-4.03
	NT	6852.005			
ZJ	NB	3958.144	4922.56	3611.19	-26.64
	ZS	5550.328			
	WZ	5259.197			
SH	SH	5420.920	5420.92	5420.92	0.00

Table 2 PDA analysis of Yangtze River Delta cluster

Source: Own elaboration based on China Ports Year Book

Chapter 7 Analysis of Port Integration in South China Sea Cluster

7.1 PPA of South China Sea Cluster

We analyze the performance of the ports in South China Sea port cluster before and after integration. With regard to the pre-integration port, we analyze ten of them, namely, Fuzhou (FZ), Quanzhou (QZ), Xiamen (XM), Guangzhou (GZ), Shenzhen (SZ), Zhuhai (ZH), Zhanjiang (ZA), Beibu Gulf (BG), Haikou (HK) and Yangpu (YP). The integrated ports int this cluster are Fujian (FJ), Guangdong (GD), Guangxi (GX) and Hainan (HN). These four ports are all our research objects.

7.1.1 PPA for Total Traffic in South China Sea Cluster

In this level, we analyze the pattern of the pre-integrated port and the integrated port on the Total Traffic to analyze the impact of integration on the overall throughput of the port cluster.

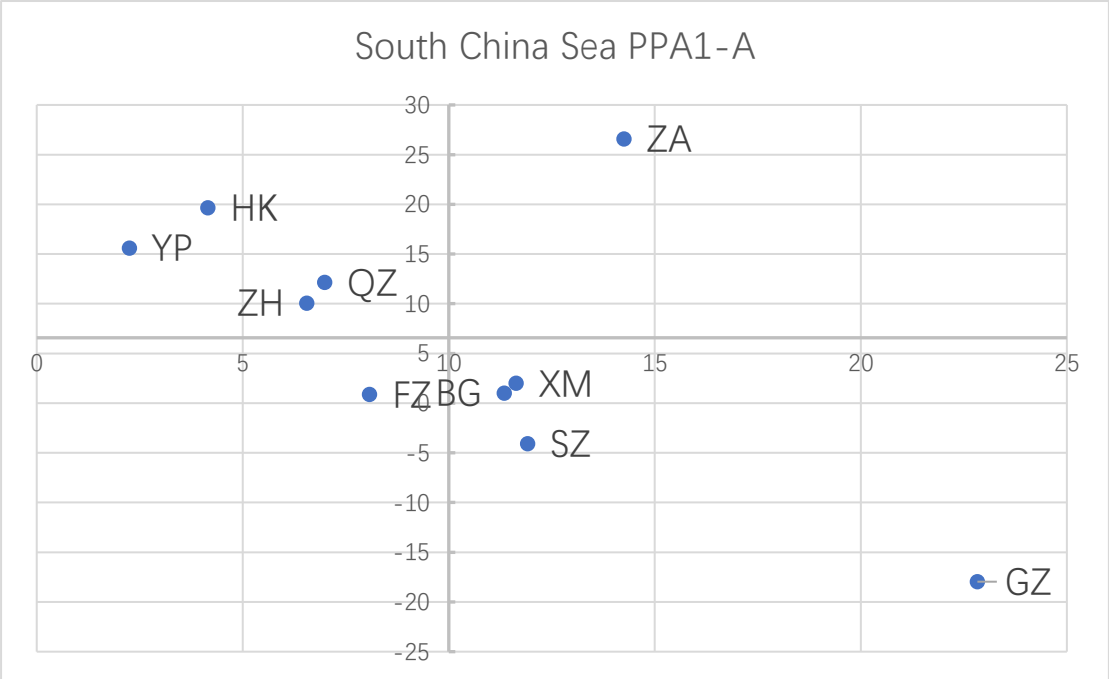

Figure 29 Level 1 of PPA of South China Sea cluster (Before Integration)
Source: Own elaboration based on China Ports Year Book

For the South China Sea port cluster, the total throughput of the ten ports before integration is shown in Fig 29. The average growth of the ten ports is 6.58%. These ports appear in four quadrants, but there are each only one port in the first quadrant

and the fourth quadrant. Zhanjiang's growth is 26.55%, surpassing that of other competitors. In addition, Zhanjiang's share is 14.25%, more than the average. With these two points, Zhanjiang becomes the only Star Performer. Fuzhou is the opposite. Although Fuzhou's share and growth were not too low, both were below average, making it the only Minor Performer. The four ports of Yangpu, Haikou, Zhuhai and Quanzhou are High Potential. Among them, the share of Yangpu is 2.25%, which is the lowest share of all ports. Guangzhou, Shenzhen, Xiamen and Beibu Gulf become Mature Leader. In this port cluster, Guangzhou has the largest share (22.83%) and the lowest growth (-17.96%). On the whole, Guangdong has a large port share and small port share is in Hainan. Ports in Fujian and Guangxi are generally on average.

The pattern of integrated ports about Total Traffic in this region is shown in Fig 30. None of the four ports after integration is Star Performer. Hainan has the lowest share of 6.40%, but with the highest growth of 18.19%, it has become the only High Potential. Guangxi's two indicators are below average, making it the only Minor Performer. Guangdong has the largest share of 55.55%, while its growth is the lowest, -3.34%, so it is Mature Leader. Fujian is in the same quadrant as Guangdong. Its growth rate is 4.10%, very close to the average 4.99%, and its share is 26.70%, slightly higher than the average.

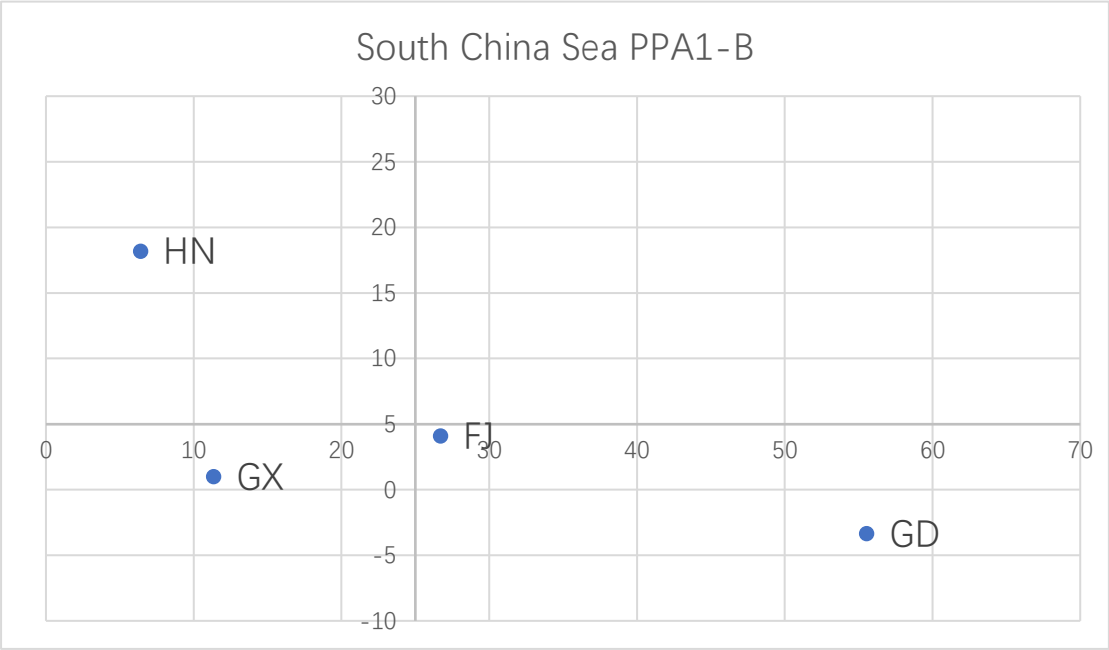

Figure 30 Level 1 of PPA of South China Sea cluster (After Integration)
Source: Own elaboration based on China Ports Year Book

After integration, Guangdong's share is still eye-catching, but its growth is low. On the contrary, although Hainan's market share is still low, it grows rapidly. Fujian is relatively mediocre in terms of overall throughput in this region. Guangxi's Beibu Gulf port has been integrated many years ago, but it does not get new members in this turn of integration, so the performance is not good enough.

7.1.2 PPA of Traffic Categories for Individual Ports in South China Sea Cluster

At this stage, we analyze four integrated ports of Fujian, Guangdong, Guangxi and Hainan about the traffic structure.

7.1.2.1 PPA of Traffic Categories for Fujian

In Fig 31, Container is the Star Performer in the traffic structure of Fujian port. Its share and growth are the highest in port, 54.18% and 13.31% respectively. Dry bulk, which is Minor Performer, grows by 14.77%, less than the other two types of transportation, and its share is 32.90%, slightly below the average. The share of liquid bulk is the lowest of three, at 12.92%, but it grows by 9.74%, above the average (2.76%), so it was High Potential.

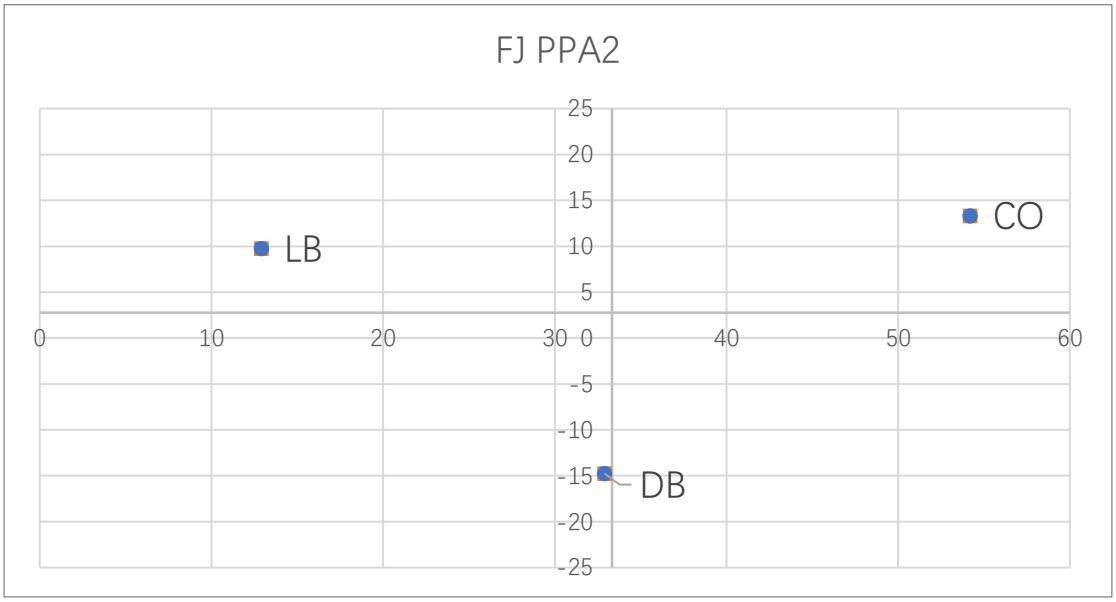

Figure 31 Level 2 of PPA of Fujian
Source: Own elaboration based on China Ports Year Book

7.1.2.2 PPA of Traffic Categories for Guangdong

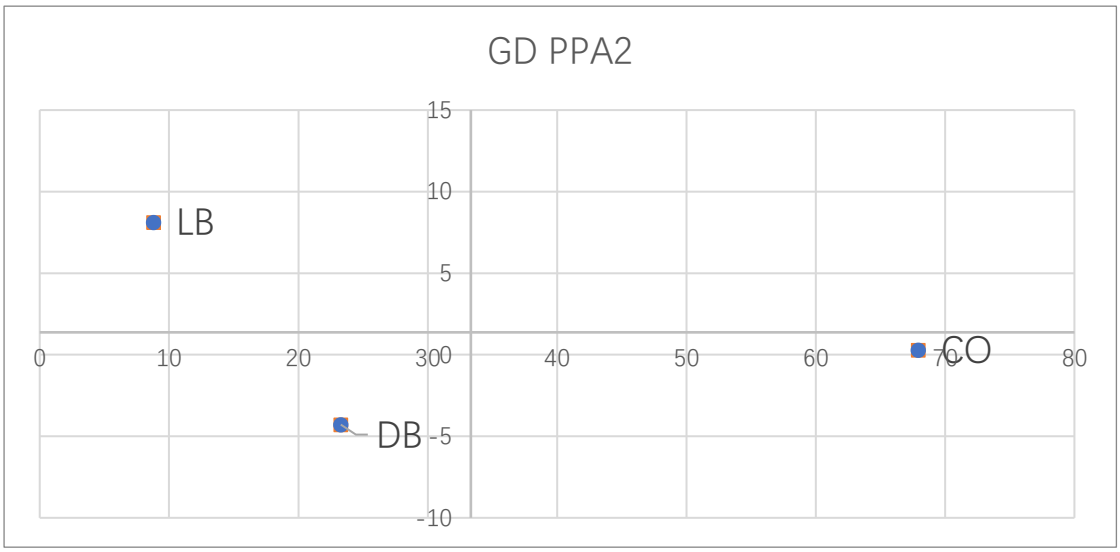

Figure 32 Level 2 of PPA of Guangdong

Source: Own elaboration based on China Ports Year Book

Fig 32 shows the traffic structure of Guangdong. The share of container is 67.93%, which exceeds the sum of the other two. Its growth rate is 0.28%, slightly below the average (1.37%). So, it becomes Mature Leader. Liquid bulk has the lowest share of 8.79%, but at the same time, it has the highest growth rate of 8.12%. This is the reason why it becomes High Potential. Dry bulk is Minor Performer, which has the lowest growth rate (-4.28%) and its share is lower than the average value. In the traffic structure of Guangdong, there is a vacancy in the first quadrant.

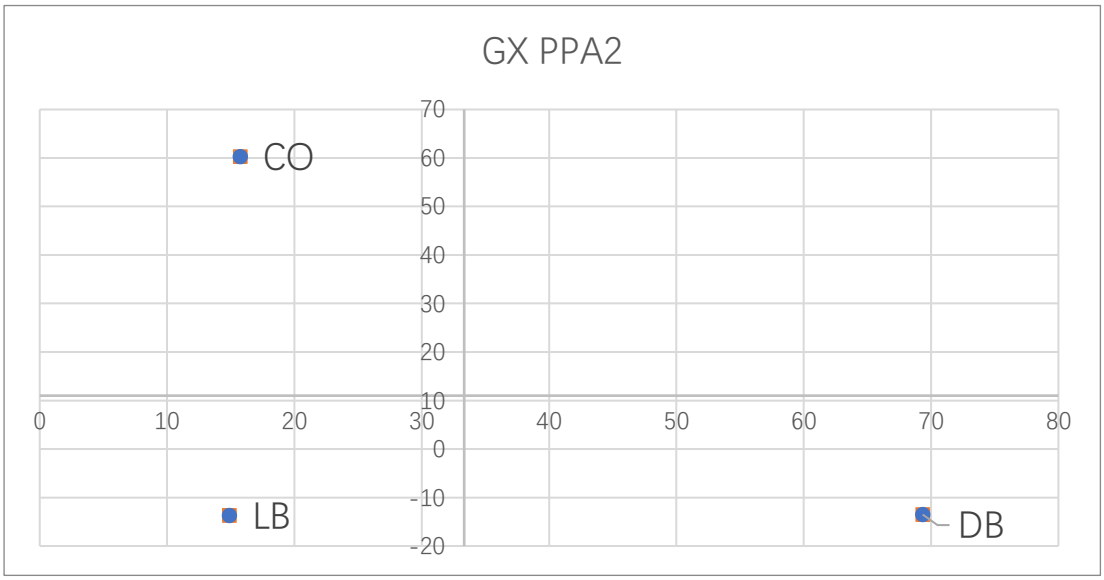

Figure 33 Level 2 of PPA of Guangxi

Source: Own elaboration based on China Ports Year Book

7.1.2.3 PPA of Traffic Categories for Guangxi

In Fig 33 of traffic structure of Guangxi, the three traffic types do not appear in the first quadrant, which is the same as in Guangdong. Dry bulk grows below average (11.00%), but its share exceeds half, to 69.34%, so dry bulk is Mature Leader. The container has the fastest growth rate (60.26%), and its share is below average, so the container is High Potential. Liquid bulk cargo is Minor Performer in the traffic structure of Guangxi, because it is at the bottom of the two indicators of share and growth, 14.90% and -13.75% respectively.

7.1.2.4 PPA of Traffic Categories for Hainan

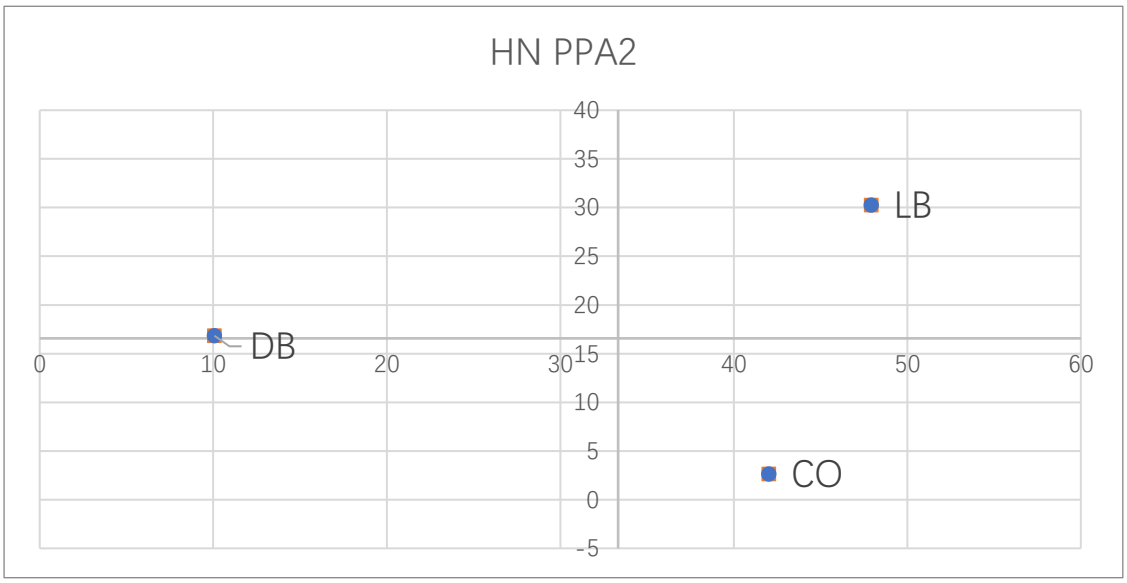

Figure 34 Level 2 of PPA of Hainan
Source: Own elaboration based on China Ports Year Book

The performance of three traffic categories in Hainan is shown in Fig 34. Liquid bulk is Star Performer, its share and growth are the highest, 47.91% and 30.24% respectively. The share of container is slightly lower than that of liquid bulk but higher than average, its growth is 2.62%, the lowest. So, the container is Mature Leader. Dry bulk is High Potential, its share is the lowest, 10.07%, and its growth is 16.84%, extremely slightly above average of 16.58%.

7.1.2.5 Conclusion of PPA of Traffic Categories in South China Sea Cluster

From the traffic structure of different ports, no traffic type is always in the same

quadrant. Therefore, the type of traffic of the South China Sea Port Group has a certain variety. The share of containers exceeded the average in three ports, of which two exceeded 50%. So, containers should be the main traffic type of this port cluster. On the contrary, the share of liquid bulk is three times below average, of which two are bottom. This proves that the share of liquid bulk in the region is generally low. The growth of dry bulk cargo is not good in this port group, three times below the average and the other extremely slightly above the average.

7.1.3 PPA for Individual Traffic Categories in South China Sea Cluster

At this level, we analyze the pattern of port integration in South China Sea for different traffic types. The ports studied are integrated ports, namely Fujian, Guangdong, Guangxi and Hainan.

7.1.3.1 PPA for Container in South China Sea Cluster

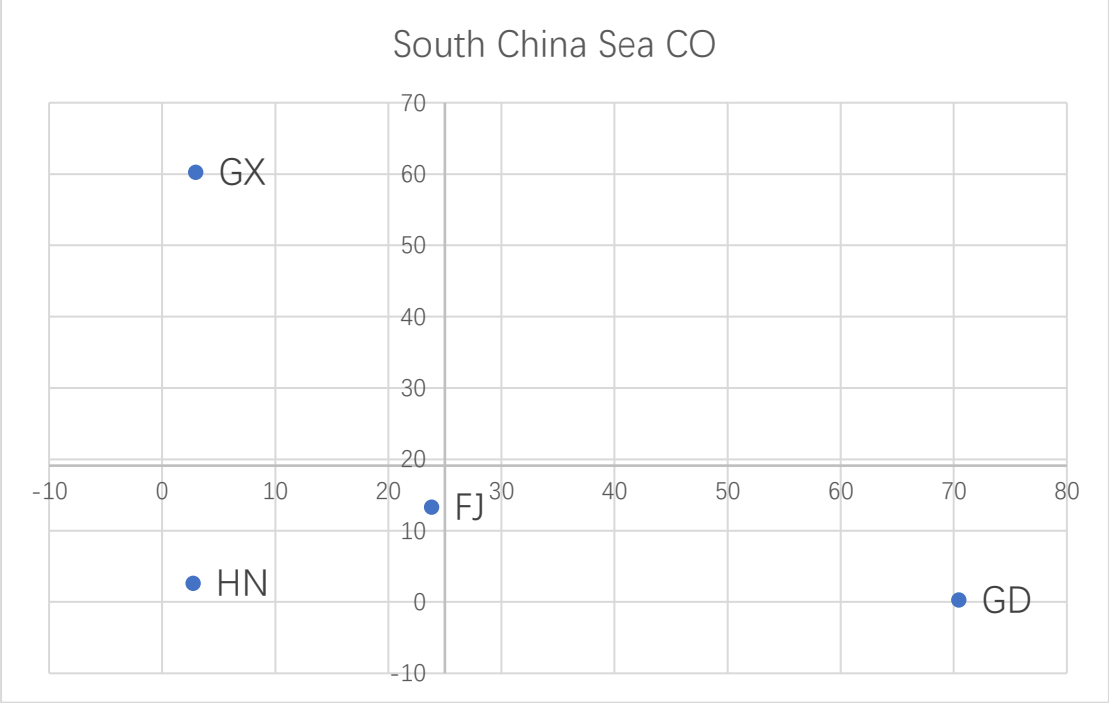

Figure 35 Level 3 of PPA of Container in South China Sea Cluster
Source: Own elaboration based on China Ports Year Book

In Fig 35, The four ports in the South China Sea are divided into three quadrants, and the first quadrant is vacancy. Guangdong's share reaches 70.45%, much higher than that of the other three ports, but its growth is the lowest, only 0.28%, which makes Guangdong as Mature Leader. Guangxi's growth is significantly higher than that of other ports, reaching 60.26%, and its share is below average, making it High Potential.

Hainan and Fujian are Minor Performer. Hainan's two indicators are lower than Fujian, with the lowest share of 2.75%. The overall performance of Fujian is very close to the average. The average growth of four ports is 19.12%

7.1.3.2 PPA for Dry Bulk in South China Sea Cluster

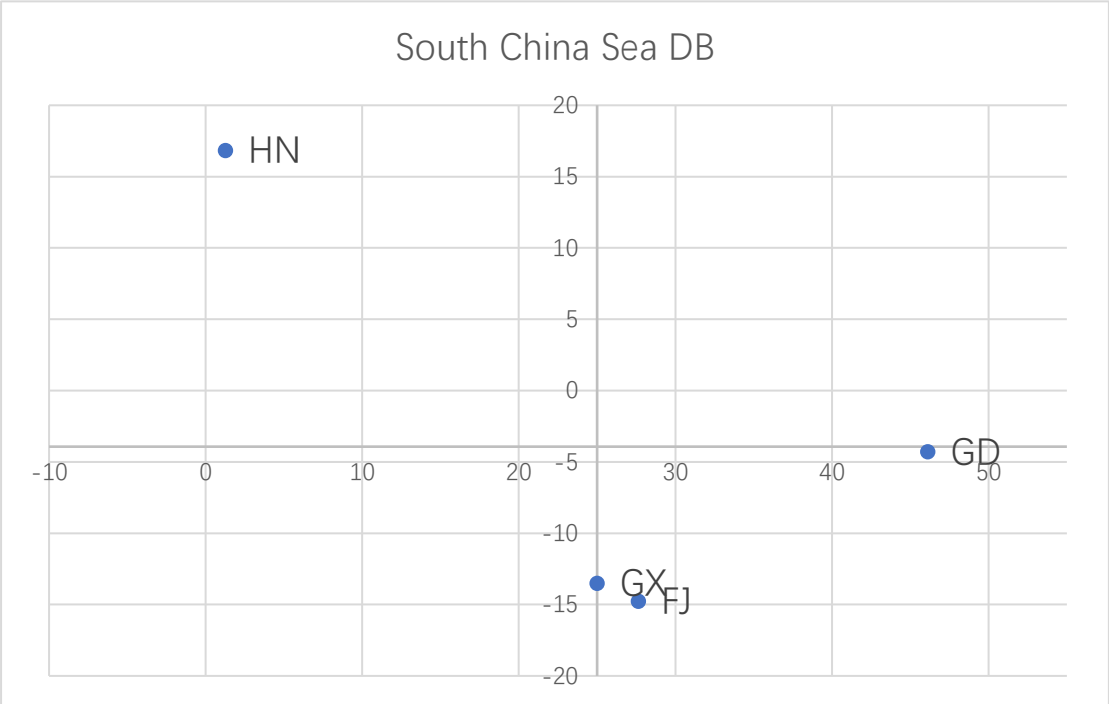

Figure 36 Level 3 of PPA of Dry Bulk in South China Sea Cluster
Source: Own elaboration based on China Ports Year Book

Fig 36 shows the performance of four integrated ports in dry bulk. Guangdong has the largest share of 46.11%, close to 50%, and its growth rate is - 4.28%, very close to the average of -3.93%, so Guangdong is Mature Leader. Fujian is in the same quadrant as Guangdong, but its growth is -14.77%, lower than that of other ports, and the share is smaller than that of Guangdong. Hainan has a tiny market share of 1.26%, but it grows by 16.84%, much higher than the other three ports, making it a High Potential. Guangxi is the only Minor Performer. Its growth is -13.51%, and its share is slightly below average. Among them, no port becomes Star Performer in this category.

7.1.3.3 PPA for Liquid Bulk in South China Sea Cluster

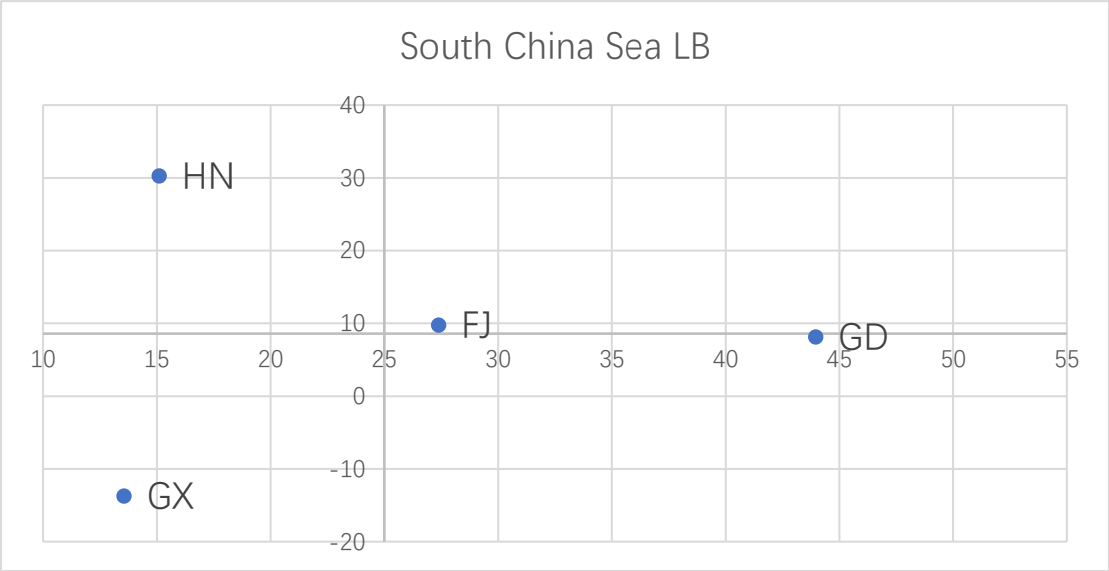

Figure 37 Level 3 of PPA of Liquid Bulk in South China Sea Cluster
Source: Own elaboration based on China Ports Year Book

The pattern of integrated ports of South China Sea cluster in liquid bulk is shown in Fig 37. Four ports appear in four different quadrants. Fujian's two indicators are not outstanding, but they are all above average and this is why Fujian becomes Star Performer. Guangdong, Mature Leader, has a significantly higher market share than other ports, growing by 8.12%, slightly below the average of 8.59%. Hainan's growth is 30.24%, the highest, and its share is below average, so Hainan is High Potential. Guangxi's share and growth are the lowest. It has no doubt to become Minor Performer.

7.1.3.4 Conclusion for PPA for Individual Traffic Categories in South China Sea Cluster

In three different traffic categories, no one of the four ports always appears on the same quadrant. Therefore, none of the four ports has always been in the leading and inferior position in the both two indicators. However, Guangdong has the largest share of the three transportation types. And Hainan's share is always lower than the average while Fujian's share is on the average more or less. So, for share, Guangdong has obvious advantages, while Hainan is the opposite. Fujian is mediocrity, and Guangxi is unstable.

7.1.4 PPA for Individual Traffic Categories Related to Share in South China Sea Cluster

In this level, we study the regional share, internal share and growth of the integrated

ports of the South China Sea port group in different traffic types.

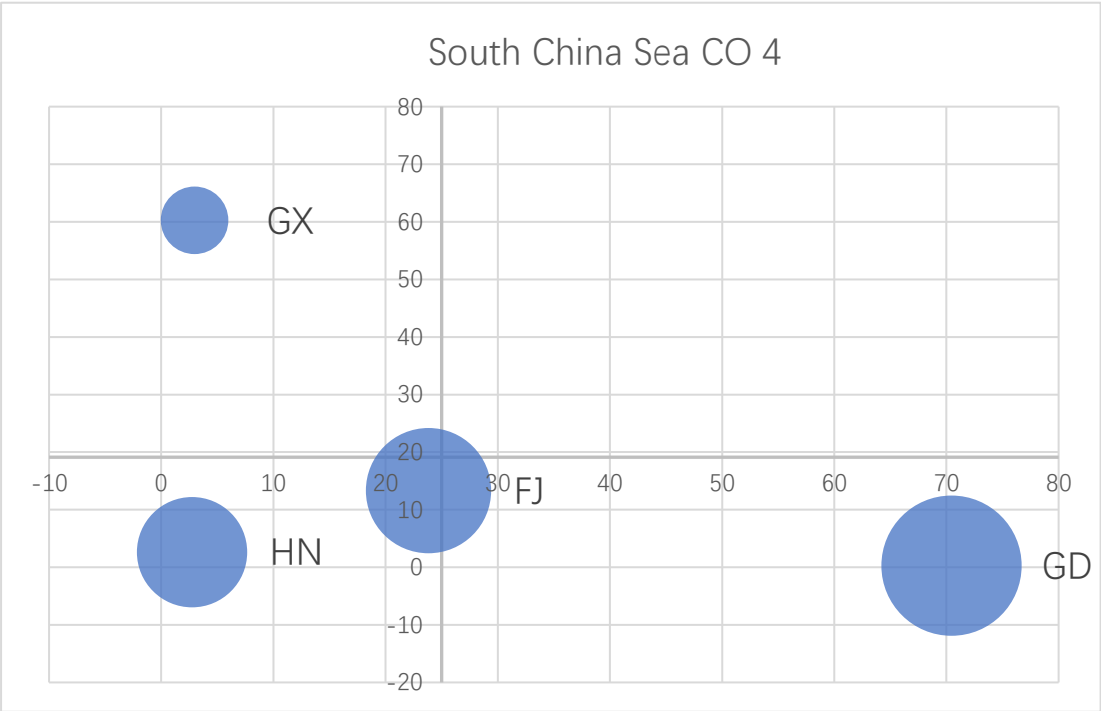

Figure 38 Level 4 of PPA of Container in South China Sea Cluster
Source: Own elaboration based on China Ports Year Book

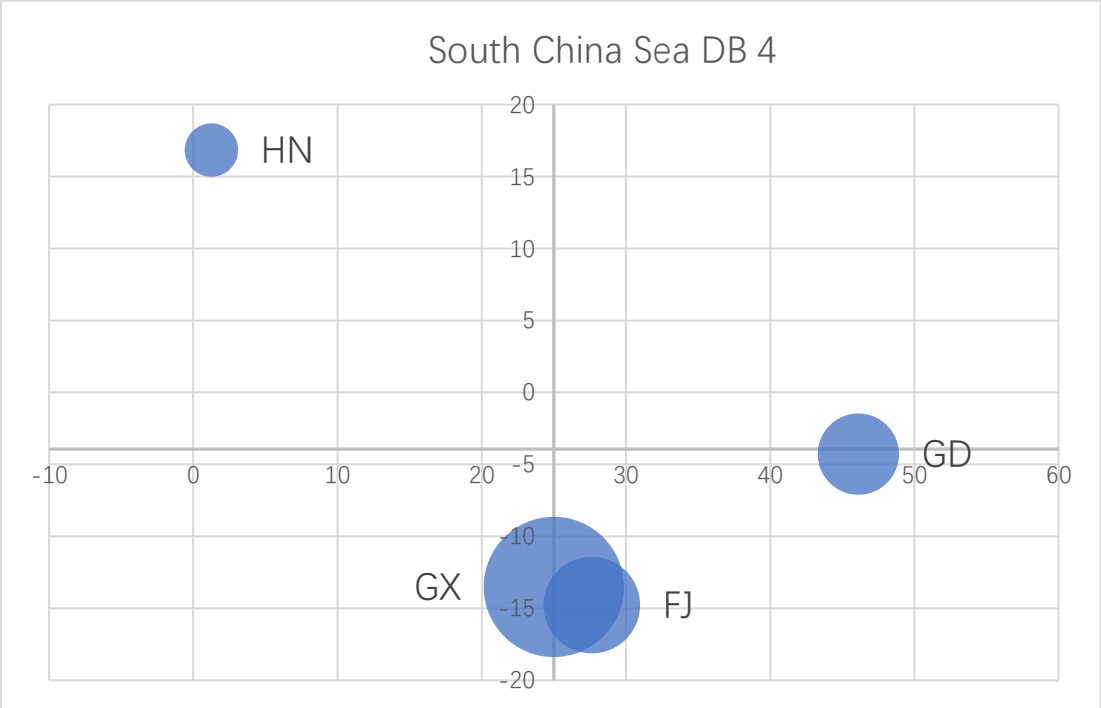

Figure 39 Level 4 of PPA of Dry Bulk in South China Sea Cluster
Source: Own elaboration based on China Ports Year Book

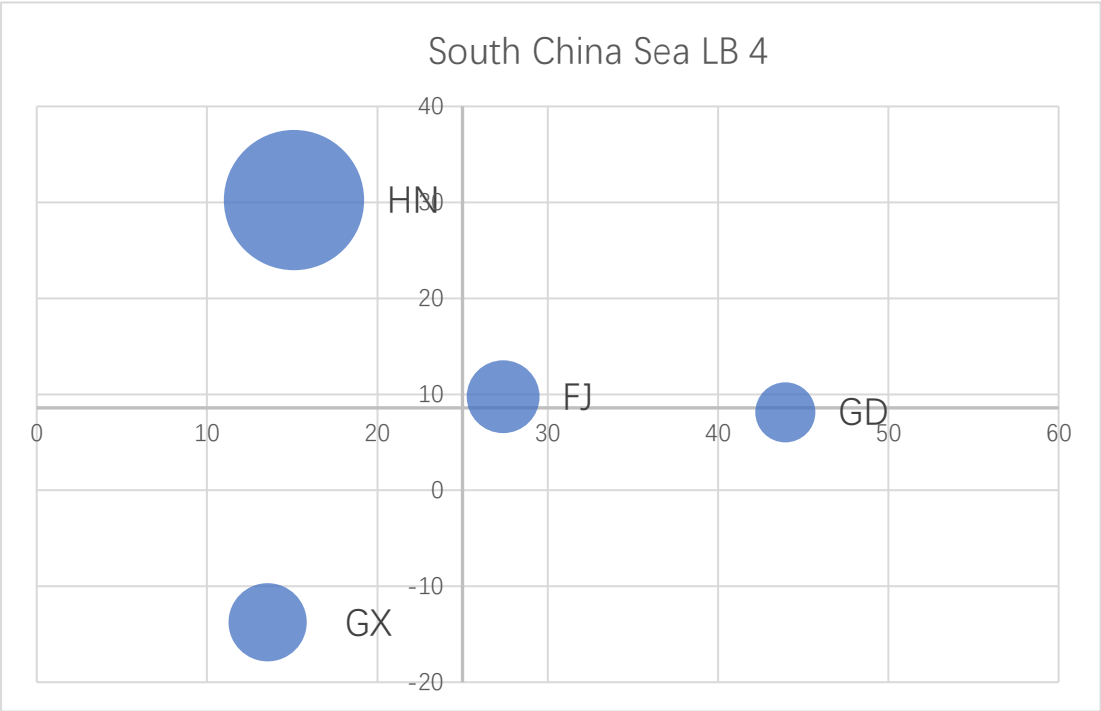

Figure 40 Level 4 of PPA of Liquid Bulk in South China Sea Cluster
Source: Own elaboration based on China Ports Year Book

Showed in Fig 38, 39 and 40, for container, the internal share of the port is directly proportional to the regional share in the rough. In dry bulk market, the larger the internal share, the lower the port growth. But in liquid bulk, the law of dry bulk has the opposite performance.

7.2 PDA of South China Sea Cluster

Table 7.2 shows the change of diversity of ports before and after integration.

Integrated Port	Individual Port	HHI Before Integration	HHI Assumption	HHI After Integration	Rate of Change (%)
FJ	FZ	5195.781	5111.63	4184.93	-18.13
	QZ	3676.573			
	XM	6462.539			
GD	GZ	5780.122	6010.64	5233.67	-12.93
	SZ	8922.702			
	ZH	4734.807			
	ZA	4604.937			
GX	BG	5278.729	5278.73	5278.73	0.00
HN	HK	8096.125	7316.94	4162.50	-43.11

	YP	6537.752			

Table 3 PDA analysis of South China Sea

Source: Own elaboration based on China Ports Year Book

In the ports before integration, Quanzhou's HHI index is the lowest, 3676.573, while Haikou's is highest, 8096.125. Except for these two, most other ports are in the interval of 4000-6500. In the prediction of HHI index, Hainan is significantly higher than other ports.

After integration, Hainan's HHI index is the lowest, and Fujian is close to it. Guangxi has the highest index, while Guangdong is almost the same as it.

The diversity of port traffic in Hainan is changed the most by integration, and the HHI index decreased by 43.11%. Both Guangdong and Fujian have reduced 10%-20% on the index. From the point of view of traffic type, before the integration, most of the ports in Guangdong were mainly supplied by containers, and the structure has not changed much after the integration. Then, before the integration, although Hainan has a port with a high HHI index, they are complementary to each other after the integration, thus enhancing the diversity.

Chapter 8 Conclusion

8.1 Conclusion of Bohai Sea Cluster

The result of PPA for Bohai Sea cluster is showed in Table 4. In Bohai Sea cluster, the integrated Shandong port becomes the best performer, because the ports that make up it are generally dynamic. Liaoning is slightly inferior to it. Tianjin has the smallest share and Hebei has the lowest growth. In particular, the relative performance of Tianjin is obviously affected by port integration. The share of dry bulk is very large but the growth of it is low. The share of liquid bulk is smaller than average in all port in this cluster and container is irregular. In comparison of different traffic types, Shandong has overall advantages and Tianjin is at a disadvantage.

	Scenario	Star Performer	High Potential	Minor Performer	Mature Leader
Level 1	**Before Integration**	Qingdao	Huanghua Yantai Yingkou	Qinhuangdao	Dalian Tianjin Tangshan
	After Integration	Shandong Liaoning		Tianjin Hebei	
Level 2	**Liaoning**		LB	DB	CO
	Hebei		CO	LB	DB
	Shandong		LB	CO	DB
	Tianjin	DB, CO		LB	
Level 3	**CO**		Hebei	Tianjin	Liaoning Shandong
	DB	Shandong	Tianjin Liaoning		Hebei
	LB	Shandong Liaoning		Hebei Tianjin	

Table 4 Summary of PPA for Bohai Sea Cluster

Source: Own elaboration based on China Ports Year Book

For PDA of Bohai Sea cluster, the diversity of Shandong and Liaoning are improved by integration. And the integration of Hebei is mostly the integration of ports of the same traffic category. Because Hebei's HHI indexes are both high before and after integration. Diversity of Tianjin is not changed by the integration.

8.2 Conclusion of Yangtze River Delta Cluster

The result of PPA for Yangtze River Delta cluster is showed in Table 5. In Yangtze River Delta cluster, after integration, Zhejiang has the best performance, Jiangsu's share is the lowest and Shanghai's growth is the worst. Integration has little impact on Jiangsu and has a significant negative impact on Shanghai. Liquid bulk often has low share and high growth, while dry bulk is opposite. Shanghai, Zhejiang and Jiangsu have different performances under different traffic types, and there are no ports with obvious absolute advantages, which is different from the other two port clusters. Jiangsu's overall performance is slightly worse.

	Scenario	Star Performer	High Potential	Minor Performer	Mature Leader
Level 1	**Before Integration**	Zhoushan	Lianyungang Wenzhou Nantong		Ningbo Shanghai
	After Integration	Zhejiang	Jiangsu	Shanghai	
Level 2	**Jiangsu**	DB	LB	CO	
	Zhejiang	CO	LB		DB
	Shanghai	CO	LB	DB	
Level 3	**CO**	Shanghai Zhejiang		Jiangsu	
	DB		Jiangsu	Shanghai	Zhejiang
	LB		Shanghai	Jiangsu	Zhejiang

Table 5 Summary of PPA for Yangtze River Delta Cluster

Source: Own elaboration based on China Ports Year Book

In PDA of Yangtze River Delta cluster, before and after the integration, the diversity of Zhejiang is always the highest and is changed significantly. On the contrary, Jiangsu's HHI index is always the highest in two scenarios, and the rate of decline is small. Diversity of Shanghai is not changed.

8.3 Conclusion of South China Sea Cluster

Table 6 shows the result of PPA for South China Sea cluster. In South China Sea cluster, there is no obvious advantage port in the Guangdong, Guangxi, Fujian and Hainan, which is different from the other two port clusters. But the share of Guangdong and the growth of Hainan are both higher than others obviously. The share of container in this area is large, and the share of liquid bulk is small. In different traffic types, Guangdong

always has a large share and Hainan's is small. In this respect, Fujian is ordinary, and Guangxi is instable.

	Scenario	Star Performer	High Potential	Minor Performer	Mature Leader
Level 1	**Before Integration**	Zhanjiang	Haikou Yangpu Zhuhai Quanzhou	Fuzhou	Beibu Gulf Xiamen Shenzhen Guangzhou
	After Integration		Hainan	Guangxi	Fujian Guangdong
Level 2	**Fujian**	CO	LB	DB	
	Guangdong		LB	DB	CO
	Guangxi		CO	LB	DB
	Hainan	LB	DB		CO
Level 3	**CO**		Guangxi	Hainan Fujian	Guangdong
	DB		Hainan	Guangxi	Fujian Guangdong
	LB	Fujian	Hainan	Guangxi	Guangdong

Table 6 Summary of PPA for South China Sea Cluster

Source: Own elaboration based on China Ports Year Book

In PDA of South China Sea cluster, Hainan's HHI index is highest before integration and lowest after integration. The changes of HHI index of Guangdong and Fujian are 10%-20%. Before and after integration, containers are both the dominant traffic types in Guangdong. Diversity of Guangxi is not changed by integration.

8.4 Conclusion Commonalities of Three Port Clusters

In the three port clusters, there is each a port is not merged in the integration. They are Tianjin, Shanghai and Guangxi. In total traffic scenario, they all become Minor Performer after integration. Although we do not directly prove that integration has a positive impact on port performance, the perform of unintegrated ports are significantly worse than that of integrated ports.

In three different port clusters, the market share of liquid bulk is usually small, and the development of dry bulk is always low. Other aspects of the three types of traffic are not regular.

For the relationship between the internal share of traffic types and other factors, there

are obvious rules in the Yangtze River Delta port cluster and the South China Sea port cluster. The internal share of containers is directly proportional to the regional share. The internal share of dry bulk is inversely proportional to growth, while liquid bulk is the opposite. The difference of the traffic types of Bohai port cluster is relatively small, but it also shows the trend of this law. In addition, the ports with the largest variety of diversity have the highest growth rate in total traffic scenario in three port clusters.

8.5 Limitation and Recommendation

Since most ports are still in the process of integration and have not been completed, the performance of the integrated ports is predicted. The forecast result is the accumulation of the data of unintegrated ports which make up the it in that year. In the process of integration, the efficiency of the subordinate ports will be changed because of the integration plan. For example, the competitiveness of the subordinate ports will be enhanced after the optimization of logistics routes. At the same time, in order to avoid internal competition between the same cargo market, the business of some sub-ports will be redesigned or even weakened. In this way, the data of the integrated port will be different from those predicted by us. But generally speaking, the change trend of port integration will not be too deviation, because the above factors have a greater impact on the internal and less impact on the overall.

According to the conclusion, Tianjin, Shanghai, and Guangxi, which have no teammates in their respective port clusters, have been significantly impacted in the integration process. The operators of these ports can take the alliance strategy to integrate into other ports to reduce losses. In addition, considering the link between diversity and port performance, port operators can improve regional competitiveness by balancing the share of the port's internal traffic types.

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