Analysis on the Game of Co-opetition of ports in the China Yangtze Delta -Taking Shanghai port and Ningbo-Zhoushan port as an example

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Abstract : Due to rapid growth of economy in the world, which results into shipping goods flow one place to another in large volumes, the competition becoming more intense among ports. Shanghai port and Ningbo-Zhoushan port are the two most important ports in the Yangtze River Delta and have the same economic hinterland, inevitably there is a heated competition between the two ports. This paper using the approach of SWOT to analyze the issue of competition and cooperation between the two ports, and then makes an analysis of their Co-opetition strategies by employing the analyzing methods based on the Game theory. Finally, it puts forward some strategies to enhance the cooperation between the two ports.

Key words : Shanghai and Ningbo-Zhoushan ports, SWOT analysis, competition and cooperation, Game theory, integrated development

1. Introduction

Shanghai port and Ningbo-Zhoushan port, as the two world-class ports, are widely considered as two drive engines in the Yangtze Delta of China, which push forward the economic development of the region. However, through the analysis, it is obvious to find that, faced with limited supply of goods; fierce competitions are unavoidable between the two ports due to the fact that they are located in a same region. Meanwhile, the competition from Pearl River Delta and Bohai Sea, such as Guangzhou and Dalian, which is faced by the two ports, are also becoming increasingly intense. Therefore, Shanghai and Ningbo-Zhoushan have to implement Co-opetition strategy to consolidate their positions in regional economic and logistics. The implementation of the strategy also can add new content to the competition of the two ports.

At present, there are plenty of literatures about cooperation, but most of studies only focused on ports cooperation between different countries. In view of competition among adjacent ports in a region or in a country with small area like Yangtze Delta sometimes leads to a waste of resources and could be detrimental to the economy, it is very important to integrate adjacent ports through inter-port cooperation to enhance the overall competitiveness. For instance, port authorities in a region could get together or finance facilities in one port, and this port could then act as the nodal point of the transport

networks reaching the region, therefore could avoid unnecessary over-investments in each port (UNCTAD, 1996).

There are several objectives in conducting this research. Firstly, we use the SWOT analysis to identify the strengths, weaknesses, opportunities and threats between Shanghai and Ningbo-Zhoushan port, secondly, the study attempts to use of the game theory analysis to explore the path of relations between the two ports to achieve the Co-opetition, thirdly, it will present the recommendation that would assist in the solution of some problems encountered with future development of the two ports.

The paper is organized as follows. I first introduce the research background of the port system along the Yangtze River, then using the SWOT analysis to identify the strengths, weaknesses, opportunities and threats between Shanghai and Ningbo-Zhoushan port, subsequently, the use of game theory analysis to explore the path of relations between the two ports to achieve the Co-opetition, the section four we will supply some strategies for Co-opetition among the ports, the last section presents concluding remarks.

2. Shanghai, Ningbo-Zhoushan port situation based on SWOT analysis

SWOT analysis is a strategic planning method used to evaluate the strengths, weaknesses, opportunities, and

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threats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieve that objective. The technique is credited to Albert Humphrey, who led a convention at Stanford University in the 1960s and 1970s using data from fortune 500 companies. A SWOT analysis must first start with defining a desired end state or objective. A SWOT analysis may be incorporated into the strategic planning model. Strategic Planning has been the subject of much research (Michael, P., 1997). As below Figure 1:
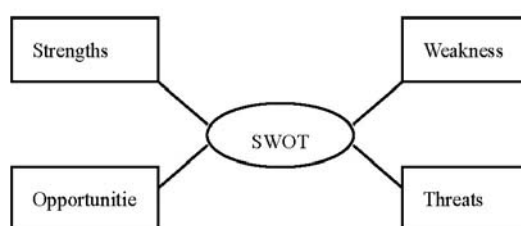

Fig. 1 SWOT analysis diagram

2.1 Strengths

2.1.1 Strengths of the Shanghai port

Shanghai port located on the Huangpu River at the mouth of the Yangtze Delta River, is the largest port in China. Being the center of China's coastwise traffic, Shanghai has a highly developed economy and it has established trade relationship with about 160 countries, and regions throughout the world and served 20 international shipping lines. It is not only a comprehensive and multi-propose commercial port and one of China's main foreign trade ports, but also is on the Yangtze Delta River traffic, and ocean shipping and being a water-rail intermodal transport juncture.

Fuelled on by China's powerful economic growth that is forecast to expand a further 7% to 8% in next few years, the Shanghai port is likely to benefit form a larger regional role, especially with the completion of the offshore center. The strong growth rate of China's containerized exports is the main engine of growth for Shanghai port traffic and Shanghai port's container throughput is growing at such a phenomenal rate. In terms of monetary cost comparisons, Shanghai has lower operation charges than neighboring ports such as the Hong Kong and Kaohsiung.

2.1.2 Strengths of the Ningbo-Zhoushan port

Ningbo-Zhoushan port area lies in the coast of southeast China, on the mouth of Hangzhou bay, and the position where the Yangtze River, Qiantang River and the Yong River run to sea. This area is back onto the Yangtze River delta, the T-type conjunction of the Yangtze River economic belt and the eastern coastal economic belt. Its direct hinterland is one of the areas with the greatest economic vigor and potential for development, where the economic development level is the highest in China. Ningbo port and Zhoushan port adjoin, whose waterway distance is less than 3n miles.

Ningbo-Zhoushan port area locates on the conjunction of the main coastal channels and the "golden waterway" of the Yangtze River. It is 130n miles north away from wusongkou of Shanghai, 433n miles away from Tsingtao, 688n miles away from Qinhuangdao, 824n miles south away from Guangzhou, 476n miles away from Xiamen. Its distance of the international air routes from Hong Kong, Keelung , Busan, Osaka and Kobe are less than 1000n miles, while its distance from the port of America , Oceania, Persian Gulf, Eastern Africa , etc. And other strengths as follows:

A. Hinterland of the economically developed, important location and location advantages.

B. Ningbo-Zhoushan port has deep water, rich channels and near the shore. Also have vast waters to anchorage. Ningbo-Zhoushan port has rich channel resource.

C. They have good collection and distribution system. Cargo in Ningbo-Zhoushan port can be distributed quickly via truck, train, air and vessel.

2.2 Weaknesses

2.2.1 Weaknesses of the Shanghai port

Shanghai port cargo throughput is expanding constantly, but shipping service sector is relatively small. The soft environment construction also needs to strengthen. At present the establishment of the Shanghai yangshan free trade port zone, although there is no substantial difference between bonded port and freeport, but freeport is more effective. Shanghai port in the shipping finance lease, and marine insurance, shipping economic and other fields, have weak shipping services. The current global shipping loan and financing business are almost the globally recognized three big shipping financing center control-London, Hamburg, New York, By contrast, Shanghai in the related field, in global market share of less than 1%, its cargo throughput hard to match the "world first".

2.2.2 Weaknesses of the Ningbo-Zhoushan port

Because of natural conditions, Ningbo-Zhoushan port construction and channel maintenance costs are relatively low, the cost of port operations has certain advantages compared with Shanghai, but compare to other ports, and have the following disadvantages:

First, lacking of integrated service system, they lack finance insurance and other relevant service.

Second, not take full advantage of the coastline. Sometimes they will mix the function of coastline.

Third, the level of development of port can not make the balance of resource in the shore. Ningbo port developed rapidly but lack of land resources. Zhoushan port is restricted owing to the islands.

2.3 Opportunities

To the Shanghai port, in the next few years, the strong growth rate of China's containerized exports will be still the main engine of growth for Shanghai port traffic. And Shanghai will become a major hub port and international container shipping center. To cope with the increasing volume of imports and exports, Shanghai port has actively constructed port facilities. Shanghai port also has actively constructed deepwater ports to accept large container vessels.

About Ningbo-Zhoushan Port, compared with land transportation, water transportation is cheaper. Ningbo-Zhoushan port can take use of the rivers to develop inland water transportation to explore new hinterland. The government pays attention to the development of Ningbo-Zhoushan port. It's a good chance to develop the build of Hangzhou Bay Bridge. Further expand the Ningbo port hinterland.

2.4 Potential threat

Shanghai port facing increased competition in domestic and foreign ports. Based on large-scale container ships trends, hardware and software environment for the construction of Shanghai is more demanding. At the same time, About Potential threat of Ningbo-Zhoushan port, Shanghai port is stronger than Ningbo-Zhoushan port. They are not far from each other. When yangshan port builds it will threat Ningbo-Zhoushan port. And there are too many ports in the Asian and Pacific regions. Every port wants to canvas cargos; the competition is increasing (Wang, L.H., 2009).

From the above information, the complementary relationship between Shanghai and Ningbo-Zhoushan Port as below.

Port	Channel depth	Port level of Information	Port rates	Collection and distribution network
Shanghai N-Z	Inferior Superiority	Superiority Inferior	Superiority Inferior	Superiority Inferior

Fig. 2 Compare the advantages and disadvantages between Shanghai and Ningbo‑Zhoushan (N-Z) Port

If strengthening of regional cooperation in the pursuit of local interests, while seeking mutual benefit and getting win-win situation, not only can effectively avoid destructive competitions, but also strengthening the overall competitiveness of the Yangtze Delta ports and becoming a model for regional cooperation in China, from the SWOT analysis, based on the further use of game theory and methods, competing game and overall performance analysis between the Shanghai and Ningbo‑Zhoushan port like this.

3. Analysis of the competing game between Shanghai and Ningbo-Zhoushan Port

Game theory, also known as game playing, decision-making body is to study the direct interaction of behavior when making decisions, and the balance of this theory (Xie, S.Y., 2002). Basic concepts of game theory including: participants, actions, results, information, strategies, payment function, and balance. Among them, the participants, strategies, game payment function are referred to as the standard type of presentation, participants, actions and collectively referred to as game rules, game analysis is determined using the rules of the game balance (all participants in the optimal combination of strategies or action) (Lee, S.X., 2008).

On Shanghai, Ningbo-Zhoushan port is concerned, Shanghai and Ningbo-Zhoushan port as a player, developing various strategies to achieve the largest interest in the same region. Shanghai and Ningbo- Zhoushan port are the two most important ports in the Yangtze River Delta, because the two ports located in close proximity, and there is some overlap in the development strategies, so there will be some competition, the port duplication is an important issue. From the perspective of game theory to study how the two ports from competition to cooperation, pros and cons of both sides, to illustrate the advantages of cooperation. First, let me from the perspective of non-cooperative game to analyze the construction between the two ports.

3.1 The overlap constructions of No-Cooperative game among ports

Assuming that participation in the game's strategic choice, Shanghai and Ningbo-Zhoushan port's strategic choice are "new berth" and "no new berth" in each other's decision-making when information is incomplete. From this we can get the game matrix (As below Table1)

Table 1 Duplication between ports of building No-Cooperative game matrix

Shanghai port	Ningbo-Zhoushan port		
	Strategy choices	New building	No building
	New building	(-c -d)	(A - B)
	No building	(-A B)	(a b)

Among，A>a>c>0, B>b>d>o

According to the above matrix can be analyzed, when the Shanghai select "new berths", if the Ningbo-Zhoushan select "no building", then the result is for(A -B), Shanghai port will get highest benefit, but the Ningbo-Zhoushan port will get maximum loss, so Ningbo-Zhoushan port will select "new berth". In this case, even for a great of capital appear loss -d, but relative not to build garages loss for -B, it is a small loss, conversely, if the Ningbo-Zhoushan Port select "new berth", and Shanghai port will take the same action, the result of games will fall into a "prisoner's dilemma", the both sides will suffered losses.

Table 2: Hangzhou, Jiaxing, Huzhou, the three regions, by Shanghai port, Ningbo-Zhoushan(NZ) port exit the quantity. UNIT:TEU

area	ports	2007		2008	
		Container volume	Percent %	Container volume	Percent %
Jia Xing	shanghai	33490	100	39821	78.10
	N-z	0	0	11185	21.90
Hu Zhou	shanghai	20798	99.30	34558	98.10
	N-z	147	0.70	680	1.90
Hang Zhou	shanghai	34937	18.40	39261	21.20
	N-z	154510	81.60	146273	78.80
area	ports	2009		2010	
		Container volume	Percent %	Container volume	Percent %
Jia Xing	shanghai	46521.6	64.40	54100	52.90
	N-z	25747.2	35.60	48210	47.1
Hu Zhou	shanghai	29508	98.30	36120	97.90
	N-z	516	1.70	760	2.10
Hang zhou	shanghai	33964.8	18.30	45800	22.10
	N-z	145581.6	81.70	161000	77.90

Source: Shanghai logistics statistical data compilation

It is also the reality of the situation. For example, Jiaxing-Huzhou area in the southern wing of Yangtze River Delta, the local private economy develops very fast, and the palace have a number of manufacturing enterprises. Every year a large number of products and raw materials require for transport by sea. Shanghai port was once the region's traditional economic hinterland, especially in Jiaxing, Huzhou two places, the vast majority of cargo through Shanghai port. To reverse the negative situation, to expand its share of supply in the region, Ningbo-Zhoushan port has taken a number of measures, for example, actively contributed to the construction of Hangzhou bay bridge, injecting Jiaxing zhapu port, these measures have get positive result.
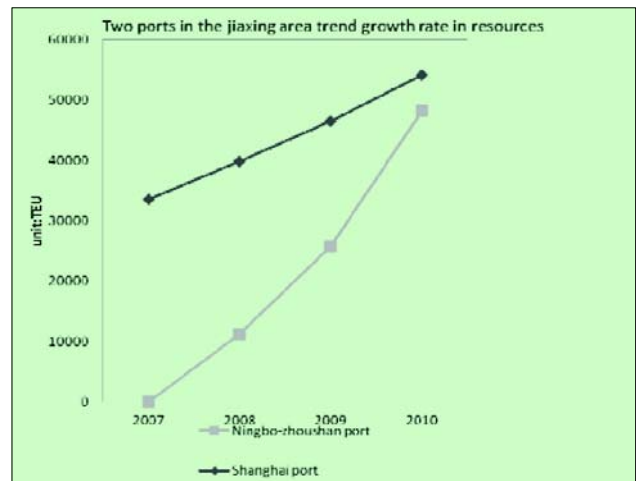

Fig. 3 Two ports in the Jiaxing area trend growth rate in resources

As shown in the chart, as Ningbo-Zhoushan port taken some active measures, caused the hang-jia-hu area source of goods obviously from Shanghai port to the Ningbo-Zhoushan port, especially control the stock of zhapu port, strengthened the Ningbo-Zhoushan port superiority in the region. In order to strive for the source of goods, Shanghai port has constructed the dushan port, in order to strengthen its influence in northern of Zhejiang province (Shen, J.M., 2008).

Undeniable, in order to expansion the business in the same region, the two ports all embark from own benefit maximization, carrying on the decision-making and the construction. But, we must clearly understand that, if two ports do not consider the local market scale, they will increase the risk of port operation. Ports of blind expansion of investment results, will be the port surplus of production capacity, and ultimately damage the long-term development

of the ports. Therefore, win-win cooperation is the right way; it is the inevitable choice between the two ports.

3.2 The "price war" of No-Cooperative game among ports

If overcapacity of the production, the harbor enterprise in order to survive, seize more market share, is bound to be fierce "price war", by reducing port customs taxes and handling charges to attract more number of sources, the result is that both sides fall into the price war mire, and lead unnecessary losses.

Taking the Shanghai and the Ningbo-Zhoushan as an example, the two ports only 180km, they all locate in the China Yangtze Delta, two ports' economic hinterland of the high degree of overlap, the development history is not long, therefore, two ports in a price war is inevitable.

Assuming the parties involved in the game, and Ningbo-Zhoushan port and Shanghai port strategic choice are "bargains" and "down", each other's decision-making when information is incomplete, both sides do not know each other the concrete choice, only can act according to the situation which faces respectively to guess opposite party strategy choice to be possible to result in the gambling matrix from this. (As below Table 3)

Table 3 The game matrix in the "price war" between ports

Shang hai port	Ningbo-Zhoushan port		
	Strategy choices	Price reduction	No price reduction
	Price reduction	(-100 -150)	(300 - 200)
	No price reduction	(-200 300)	(200 150)

Based on the above matrix that can be analyzed, when the Shanghai port carries on the strategic choice, no matter the choose reduces price or not to reduce price, to the Ningbo-Zhoushan port, the most superior strategy is to reduce price. Because, if Shanghai port chooses reduce price, but the Ningbo-Zhoushan does not reduce price, will suffer loss for -200, namely (300 -200), so it must choose to reduce price, that is (-100 -150), if the Shanghai port does not to reduce price, and the Ningbo-Zhoushan port will take the same action, then only get the benefits for 150, but if reducing price, the income reaches as high as 300, so that it will continue to choose to cut price. Similarly, it can be concluded that, for the two ports, the most superior choice is to reduce price for the (- 100 -150), the two ports suffer the loss. If this situation continues, the ports will cause many adverse effects for the long-term development.

Let me to use a simple example to express the situation of price war. Suppose that within a region there are m (1,2, ···i···, m) ports with the similar size, within the region total supply for Q, the total receipts for R, a single port earnings for R_i, the cost of the new berths is C_i, but within the region when the number of ports increase to n(n >m >0), the initial cost of the port of loading and unloading unit is P_i^1, later after reduce price unit expense is p_i^2, can arrive at new berths in the port group and reduce costs after the return function.

Total revenue $R=\sum_{i=1}^{n} R_i = \sum_{i=1}^{n} \left(\frac{1}{n}Q* p_i^2 - C_i\right)$

If the port does not repeat the construction of berths, loading and unloading costs without "price war" can be drawn from the new port group revenue function.

Total revenue $R* = \sum_{i=1}^{m} R_i = \sum_{i=1}^{m} \left(\frac{1}{m}Q* P_i^1\right)$

By contrast, we can see:

$\sum_{i=1}^{n} \left(\frac{1}{n}Q* p_i^2 - C_i\right) = R < R_1 = \sum_{i=1}^{n} \left(\frac{1}{n}Q* p_i^2\right)$

$\sum_{i=1}^{n} \left(\frac{1}{n}Q* p_i^2\right) = R_1 < R_2 = \sum_{i=1}^{n} \left(\frac{1}{n}Q* P_i^1\right)$

$\sum_{i=1}^{n} \left(\frac{1}{n}Q* P_i^1\right) = R_2 < R* = \sum_{i=1}^{m} \left(\frac{1}{m}Q* P_i^1\right)$ So,

$\sum_{i=1}^{n} \left(\frac{1}{n}Q* p_i^2 - C_i\right) = R < R* = \sum_{i=1}^{m} \left(\frac{1}{m}Q* P_i^1\right)$

Through above derivation, we know, for a port group, if possible, to reduce duplication among the ports, and reasonable adjustment to handling cost, will be able to better avoid vicious competition, so that maximize the benefits of the entire port group, in the long run, each port is also good.

3.3 The game of cooperation among ports

Judging by previous No-Cooperative game competition, for every port within the port group is concerned, when making the develop plan, must taking into account the reaction of the neighboring ports, especially about the newly-built berths, expanding production capacity and adjusting the loading and unloading rates. For this sensitive issues, if handle improperly, will result in vicious competition with neighboring ports, harming the neighbor port benefit while harming the own interests (Mi, J.H., 2007).

Carrying on the analysis from the game theory angle, when a single port in the choice of cooperation or no-cooperation is based on self-interest maximization, but many times their optimal solution may not be achieved,

because other participant's benefit has received the loss. Thus in order to realize a superior choice, the port needs to develop the related communication consultation with other participants in order to realize minimal lose, as far as possible maximized benefit, let me explain with an example.

Assuming Shanghai and Ningbo-Zhoushan port have two strategic choices: cooperation and non-cooperation. The game matrix as follows:

Table 4 Cooperation and Non-Cooperation game matrix among ports

Shanghai port	Ningbo-Zhoushan port		
	Strategy choices	Cooperation	Non-cooperation
	Cooperation	(200　200)	(- 200　400)
	Non-cooperation	(500　-300)	(-100　- 100)

According to the above matrix, if both sides fully maximize their own interests, not to consider the other side, as a result they will get into the "prisoner's dilemma", the final option is not to cooperate, namely (-100　-100). However, if both sides can take into account each other's interests, and adjust the loading and unloading berths in the new rate and other sensitive issues, making certain promises and concessions, selecting the program of cooperation will benefit both sides, namely (200 200).

In summary, although game theory of cooperative solving the problem of maximize benefits, making both sides to minimize losses, there are some loopholes in this theory, is likely to be used by one of the participant parties, and appear the "broke a promise" situation. Take the above model as the example, when Shanghai port commitment to cooperative game, if Ningbo- Zhoushan port "breaks a promise" and chooses not to cooperate, then the Ningbo -Zhoushan port will be able to obtain incomes for 400, but Shanghai will suffer heavy losses for -200. Thus, the both sides have the risk of breaking an agreement (Dong, G.,

2006). Especially in the area of port construction, because requiring huge funds, long construction period, but the investment recovery period is very slow, once the newly built port forming the scale, the other near ports wants to catch up by building new quay harbor, have to pay an even heavier price inevitably, even gain does not equal the loss (Peng, J., (2008). From long-term development into consideration, regardless of which regional group ports, each port needs to seek common ground while maintaining difference in the competition to achieve complementary advantages, thus promoting the communal development. This will not only reduce unnecessary duplication and unhealthy competition, but also indirectly reduce the operating costs, benefits of its own development.

4. Strategies for Co-opetition among the ports

From the above ports Co-opetition gambling to analysis, on track to achieve cooperation, requiring both sides to engage in rational analysis, and take the appropriate strategy. The fact proved that appropriate competition among ports will help improve productivity and optimize resource allocation, can effectively alleviate the port container handling capacity, and promote the port technical level and the service level fast enhancement. Ningbo-Zhoushan port and Shanghai port should give full play their respective advantages, strengthen joint development, enhance the Yangtze River Delta port cluster in Northeast Asia, the overall competitiveness of the shipping market, and increase China's port influence in the world.

Ningbo – Zhoushan port and Shanghai port are all located in the Yangtze River Delta region, but due to administrative region segmentation, coupled with different systems and mechanisms, two ports interaction development advancement come under certain influence (Wang, Y.E.,

Table 5 Gambling behavior among the Yangtze River Delta ports

Analysis	Game structure	The best interests of participation port	The understanding about interests of other involved ports	The behavior and the distribution of benefits of involved in ports		
				Interests of the port of first action	Interests of other involved ports	Response of other involved ports
Competition	Zero-sum game	completely inconsistent	Without consideration	Have obtained	Be lost	Fight
Cooperation	Positive-sum game	completely consistent	Fully consideration	Based on a long term mutual trust to allocate additional value		cooperate
Co-opetition	Positive but variable game	No completely consistent	The two sides recognize and the interaction	Have obtained	Spillover effect is greater than the direct loss	Tendency to cooperate
					Spillover effect is less than the direct loss	Tendency to compete

2008).Thus, the central and local governments in two ports must be the scale of investment planning and layout, to be co-ordination arrangement, from the perspective of regional economic integration, integration of two ports resources and create better conditions for industrial development, expand the industrial development, to promote two coordinated development and achieve win-win situation. Through the establishment of a scientific and rational way for approval of port construction, cut off local government unnecessary investment, causes various ports at under the market economy operation mechanism, arranges own investment scale reasonably. At the same time, taking the following measures:

The establishment of motivation mechanism can make the opportunism benefit as little as possible. Increasing the financial, taxation, credit and other support effort. Financial and tax policy as a powerful tool for government regulation, the Shanghai and Ningbo – Zhoushan port development cooperation can play an effective incentive. Financial support must be clear that Shanghai and Ningbo – Zhoushan port have been encouraged cooperative behavior.

The establishment of binding mechanism. Binding agreement must be severely punished for opportunistic behavior, party to an agreement on compliance with reward, making cooperation in selfish behavior can not receive additional benefits. This will reduce the opportunistic behavior, increasing the possibility of cooperation.

The establishment of monitoring mechanism. Shanghai, Ningbo – Zhoushan port cooperation is a long-term repetition gambling in the process, the game side was informed through various channels and means of making information on other side of the game, more accurately and make their own decisions based on the other side of the most excellent judge. That is, to establish monitoring mechanisms, both act to increase transparency and enhance long-term interests of the game to try to give up the possibility of seeking short-term profit motive, which is the final game of the important conditions to achieve win-win situation.

5. Concluding remarks

Cooperation and competition represent the direction of development for the world's ports. There is no exception for the Yangtze Delta ports of China. Presently the Shanghai and Ningbo-Zhoushan port are in a period of high-speed growth and stiff competition, and no port operates in isolation.

This paper endeavors to show that Co-opetition between the Shanghai and Ningbo-Zhoushan port and helps them to take advantage of one another's strengths and utilize resources rationally. Through our effort, we can adopt a scientific Co-opetition strategy to integrate the Yangtze Delta ports of China, achieve a more rational distribution of ports, and realize more effective port functions. Turning competition among ports into cooperation along with competition, we can achieve "win-win" or even "multiple-win" results, thus raising China's Yangtze Delta port's international competitiveness.

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