Research on the Coordinated Development of Ports around Pearl River-West River Economic Belt

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Abstract-Nowadays the fierce competition of port groups has become one of Guangdong and Guangxi's development hurdles, alongside the rapid construction of the Pearl River-West River Economic Belt. As a result, it becomes even more necessary and important to investigate coordinated port development in the region. This article investigates the 2008-2019 relevant statistics of the Shenzhen Port, Guangzhou Port, Shantou Port, Zhanjiang Port, and Fangcheng Port around the Pearl River-West River Economic Belt. The study discovered that: first and foremost, the port group's Matthew effect is more visible, and the law of the strong and the strong can be implemented in the coordinated development and construction of the port group. Second, the coordinated growth of port clusters is hampered by inconsistencies in policy, infrastructure, and the level of openness of the regional economy. Finally, while the development of a single port in the Pearl River Group is well-organized, the development of the entire port group is not. The cause could be that port products are becoming increasingly homogeneous as a result of blindly following the trend. Relatively speaking, the building of West River Port is supported by the government. However, due to its limited strength, the order of a single port is not large. As a result, the Pearl River Port, which is very competitive, should take the lead and pursue distinctive development. West River Ports should engage more closely with Pearl River Basin ports to build a network of replenishing ports.

Keywords-component; Pearl River-West River Ports; coordination degree; Coordination model

1 INTRODUCTION

Since China's reform and opening up, the lack of coordination of spatial strategic development has produced a chasm between regions, urban and rural areas, and groups, as well as different social conflicts. For example, there have been phenomena such as resource competition and resource waste in the Pearl River Delta port clusters in the rapid expansion of the port clusters. The Pearl River-West River Economic Belt is bolstered by the trade channel of the Guangdong-Hong Kong-Macao Greater Bay Area, as well as the world's largest and most sustainable industrial and supply chains. As a result, it has become increasingly critical to address the coordinated development of ports in this region. However, with the rapid development of port clusters, it is frequently hard to avoid concerns such as homogenous competition. The extensive port growth paradigm, for example, has issues such as terminal overcapacity, unequal resource allocation, and violent competition [1]. The primary cause of the aforementioned issues is that the current development model of my country's port clusters has not kept up with the demands of the new normal. From the standpoint of coordinated growth of port clusters, this study

ICEMME 2022, November 18-20, Nanjing, People's Republic of China

DOI 10.4108/eai.18-11-2022.2326865

investigates the mechanism of port cluster coordination and identifies the main hinterland elements that affect the comprehensive development of ports and their impact mechanisms.

2 RESEARCH STATUS

Domestic academics studying the development of port clusters are currently focusing on the building of connectivity among port clusters. According to Knat (2017), market functioning and regulation are hampered by ferocious competition in the port economy [2]. According to Masato (2018), port building wastes more resources because investors participate in unethical business competition [3]. Gan Aiping (2021) investigated the phenomena of self-controlled systems, repetitious building, anarchy, and extreme competitiveness among ports in the Yangtze River Delta port group [4]. Many researchers are working on relevant research to ease the condition of hostile competition for port groups. Wang Bailing (2018) has achieved remarkable results in reshaping the port industrial organization, improving the port group's overall strength [5]. Guo Liquan (2019) analyzes port group resource integration from the standpoint of transportation system social welfare maximization [6]. Ji Lei (2020) used the VAR model and discovered that the cargo throughput of the port grows in lockstep with the hinterland's economic development pace [7].

However, previous port group study has been limited to explaining the port competition situation or the port resource game. Previous port group study lacked time comparisons and a standardized research model, and the samples had a significant impact on the evaluation index results. Furthermore, while the Pearl River and the West River of the port area construction is significantly different, making sample selection more thorough and objective.

3 EVALUATION OF COORDINATION DEGREE OF PORT GROUP

This article evaluates the development status of ports in southern my country as opposed to previous studies on single ports and single port clusters.

3.1 Establishment of indicator system

First, we construct a China port synergy model based on Meng Qingsong's (1999) composite synergy model [8]. Second, we select indicators following according to Huang Changsheng (2020) [9] and Liu Lin (2020) [10]. From perspective of the capacity of a port's throughput, it is an important indicator that reflects the current state of port production and operation. These two indicators' global rankings also reflect the state of comprehensive port operations and coordinated development. The port's economic hinterland subsystem serves as a source of financial support for the port's long-term development. Secondly, port logistics belongs to the tertiary industry category itself. Port logistics can increase the service industry's output value. Furthermore, both foreign commerce and fixed asset investment at the port are critical indicators of the port's healthy development. Therefore, we use the indicator system in Table 1 to evaluate the development of port clusters in southern China.

Table 1 Evaluation indicators for coordinated development of port clusters

Criterion level	Index level
Port infrastructure	Length of wharf
	Number of berths
	Number of berths over 10,000 tons
Port throughput capacity	Cargo throughput
	Port container throughput
Port hinterland support	Gross Regional Product (GDP)
	Proportion of tertiary industry
Port trade and investment	Social investment in fixed assets
	Total trade import and export
	Total trade imports
	Total trade exports

3.2 Models and methods

1) Entropy method

The entropy method which assigns values to various indicators based on the original data and highlights the local differences, is an objective weighting method based on the difference-driven principle.

2) The order degree model of the composite system

a) System order

The subsystem $S_{i,j} \in [1, k]$ is assumed in this study, and the sequence parameter variable in its development process is $u_{jn} = (e_{j1}, e_{j2}, ..., e_{jn})$. According to formula (1), the degree of order $S_j(u_{ji})$ has a value range of $0\text{-}1$.

$$S_j(u_{ji}) = \begin{Bmatrix} \dfrac{u_{ji} - \min u_{ji}}{\max u_{ji} - \min u_{ji}}, i \in [1, l_1] \\ \dfrac{\max u_{ji} - u_{ji}}{\max u_{ji} - \min u_{ji}}, i \in [l_1 + 1, n] \end{Bmatrix} \quad (1)$$

To compute the order degree of the system S, the linear weighted summation approach is employed, and the calculation formula is as follows formulas (2):

$$S_j(u_{ji}) = \sum_{j=1}^{n} w_j u_{ji} \quad (2)$$

b) Coordination degree model of composite system

MC is defined as the composite system's coordination degree.

$$MC = \sqrt[N^k]{\left|\prod_{f=1}^{n}\left[s_j^1(u_j) - s_j^0(u_j)\right]\right|} \tag{3}$$

$$N = \frac{\min_j\left[s_j^1(u_j) - s_j^0(u_j)\right]}{\left|\min_j\left[s_j^1(u_j) - s_j^0(u_j)\right]\right|}, j = 1,2... \tag{4}$$

It is the order degree value of the composite system in formulas (3) and (4). MC reflects the overall system's coordinated development status. MC typically has a value range of $[-1,1]$. The bigger the value, the better the composite system's order throughout this time period.

4 PANEL DATA ANALYSIS OF THE COOPERATIVE DEVELOPMENT OF PORT GROUPS

This paper selects the coastal ports around Pearl River-West River Economic Belt as the research object to test whether the coordinated development of port clusters has the influence of the Matthew effect.

4.1 Source of data

The data for this article were compiled from the “China Statistical Yearbook” and the “China Port Yearbook”.

4.2 Results of composite synergy model

1) The The entropy of Ports around Pearl River-West River

Some traits are discovered by computing the weights of numerous indicators, as the Figure 1 shown. First and foremost, the right to foreign trade and investment in the Pearl River basin is significantly more vital than that of West River Port. As a result, foreign trade investment has a significant impact on the port. Secondly, the neighboring Pearl River port has a significant spillover influence in the West River subsystem. Transportation assistance is mostly derived from strong local government backing and the protection of local policies. Therefore, the weight of relevant indicators of this component accounts for a very large proportion. Finally, in terms of basic port construction, the Pearl River basin ports group has relatively significant economic hinterland support. Therefore, it is critical that the modern port construction can match the massive industrial chain and supply chain in the economic hinterland.

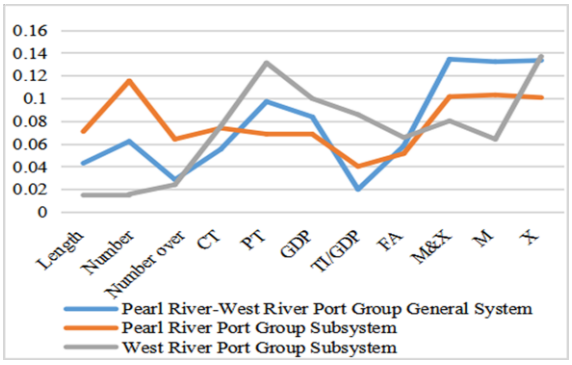

Figure 1 *The weight of each indicator in different systems*

2) The order degree of Ports around Pearl River-West River Economic Belt

a) Shenzhen Subsystem

The order of Shenzhen Port is the overall rise, but during the rise it has also declined. First and foremost, because Shenzhen Port's cargo throughput is primarily made up of foreign trade containers, it was severely impacted by the global financial crisis in 2008. Shenzhen port's port order degree fell in 2008-2009 due to a decrease in cargo flow. From 2010 to 2013, the infrastructure and economic hinterland of Shenzhen Port have been rapidly improved. According to related research, Shenzhen Port's asynchrony became more serious between 2014 and 2016, resulting in a significant drop in the port's orderliness. The port area in front of Shenzhen is incompatible with the city's spatial layout, while supporting facilities in the rear port area are incompatible with the layout of urban industrial land. Finally, as a result of the city's repositioning, Shenzhen Port's narrow urban land and production coastline are unable to accommodate the expansion, causing further tensions between Hong Kong and Shenzhen.

b) Guangzhou Port Subsystem

The port of Guangzhou has become a major economic and trading center in southern China with its main commercial backland, which leads to a good order degree from 2008 to 2019. The results of the model show two evidently increasing times in the orderliness of Guangzhou Port. First of all, in 2015, the Guangzhou Three-Year Action Plan for Shipping Center Construction 2015-2017 launched the planning and construction of shipping logistics cluster area and construction of port. In 2017, Guangzhou Port Group firmly grasped the strategic national orientation of “Belt and Road” and the international maritime transport hub of Guangzhou.

c) Shantou Port Subsystem

The port order for Shantou in the Pearl River-West River Economic Belt has been quite low. Shantou Port has long been a Pearl River Delta feeder port. There is a significant contrast between Shantou's economic hinterland and its own infrastructure when compared to the other two ports. As a result, Shantou Port's orderliness is among the slowest in the Pearl River Delta port group. Shantou Port's orderly degree dropped from 2013 to 2016, mostly due to the influence of the Pearl River port's homogenized competition, as well as the inconsistency of its own port area building and the pace of modernization work.

d) Zhanjiang Port Subsystem

The orderliness of Zhanjiang Port is higher than that of Haikou Port according to Table 2. After the foundation of New China, Zhanjiang Port was the first deep-water seaport developed and built entirely by itself. Despite the fact that it has been continuously increasing, there is still a gap between Zhanjiang Port and other ports around Pearl River-West River Economic Belt. Among them, it is worth noting that the orderliness of Zhanjiang Port in 2015 decreased, mainly due to a variety of factors such as insufficient power for global economic recovery, slowing domestic economic growth, increased competition in developing countries, and continued sluggish international commodity prices. Later, the growth of Zhanjiang Port had a consistent rising tendency because of the continuous deepening of the "Belt and Road" construction.

e) Fangchenggang Port

Fangchenggang port is a deep-water port on the mainland's southwest coast with obvious geographical advantages. It is the most convenient entry point for inland China into the Central and South Peninsulas, facing Southeast Asian countries. It is situated in the heart of the Guangxi Beibu Gulf Economic Zone, at the crossroads of the South China, Southwest, and ASEAN economic circles. The order of Fangchenggang ports in the Pearl River-West River Economic Belt port group is relatively low. The lack of breakthrough is primarily due to its reliance on the economic hinterland and the traditional port business.

Table 2 The order degree of Ports around Pearl River-West River from 2008 to 2019

Year	Guangzhou Port	Shenzhen Port	Shantou Port	Zhanjiang Port	Fangchenggang Port
2008	0.276221	0.421818	0.026831	0.029125	0.008026
2009	0.286419	0.393880	0.027187	0.046665	0.021921
2010	0.336673	0.479052	0.030332	0.051486	0.027043
2011	0.358800	0.535097	0.037492	0.055187	0.032697
2012	0.372141	0.585107	0.039898	0.061387	0.037272
2013	0.392635	0.644954	0.043197	0.063985	0.037473
2014	0.418260	0.616318	0.045787	0.071385	0.040151
2015	0.437910	0.594157	0.049053	0.077305	0.044665
2016	0.450936	0.578802	0.052761	0.083218	0.044788
2017	0.488965	0.618852	0.058913	0.090046	0.049961
2018	0.515170	0.671062	0.058761	0.092393	0.055393

3) The coordinated development of the Ports cluster around Pearl River-West River from 2008 to 2019

a) The Pearl River Delta Port Group Compound synergy

The coordination of port groups in the Pearl River Economic Belt subsystem is relatively poor, due to vicious competition and resource competition. Division, fierce rivalry, and repeated construction all contribute to a pearl river delta port port's overall competitiveness. After 2013, the Pearl River Delta port group's development became increasingly disconnected. To

accelerate the pace of adjustment and improve the port's capacity to respond to risks, detailed analysis and clear positioning of the port growth in Guangzhou and Shenzhen are required.

b) The West River Port Group Compound synergy

The growth speed of the West River port group has been favorable from 2008 to 2019, according to the coordination degree of the complex system of the West River port group. The major explanation is because the port group around West River typically weak and has minimal regional variation. Despite the fact that the southwest coastal port group's overall development began late, it is progressing at a quick pace. The primary cause for the decrease in the degree of coordination of the port group's composite system during 2014-2015 was the adjustment of foreign trade policy.

c) The Pearl River-West River Compound synergy

It is discovered that the Pearl River and West River subsystems mutually influence the overall system of the Pearl River-West River Economic Belt. Because the Pearl River basin's port strength is relatively strong, the Pearl River has a significant impact on the coordinated development of the entire economic belt. Despite the fact that the Pearl River Delta port faces fierce competition, the composite system's coordination degree is relatively improved after the addition of ports in the West River Basin. It demonstrates that the ports in the West River basin provide back-up feeding for the Pearl River port throughout the system.

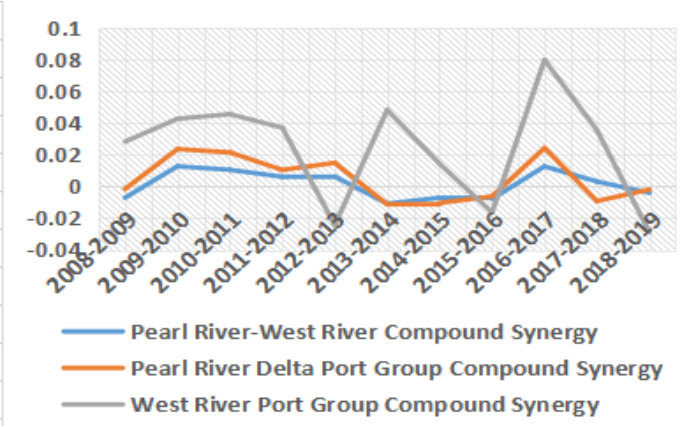

Figure 2 *The coordinated development of the three port synergys*

5 CONCLUSION

This article's empirical model discovered that: First, port orderliness improves with economic expansion and ongoing infrastructure investment. Second, there is a “Matthew effect” among major ports in China. The greater the port's economic hinterland, the more orderly the port in general. Third, the greater the port group's proximity to a prosperous economic region, the greater the rivalry and the homogeneity. Fourth, the right to foreign trade and investment in the Pearl River basin is significantly more vital than that of West River Port. As a result, foreign trade investment has a significant impact on the port. Fifth, the study discovered a number of

phenomena in which individual port orderliness is typically good. But the synergy of the port cluster complex system is low or numerous, which may be due to the “herd effect” of a few dominant port clusters. It causes other ports in the port group to chase homogeneous items blindly.

Based on the evaluative analysis of the port coordination degree and the empirical model, this study believes that the overall coordination degree among Chinese ports is consistent with economic growth, and the orderliness of each port is also consistent and increasing. As a result, in accordance with the current circumstances, relevant actions for the growth of the port group should be taken. First of all, we must strengthen the connection between ports by establishing a port group meeting mechanism. Secondly, we must rectify and reform against homogeneous competition. Finally, the port cluster should be modernized.

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