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Research on inter action between the international competitiveness of ports and hinterland economy—a case study on Beibu Gulf Port Group

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Research on Interaction Between the International Competitiveness of Ports and Hinterland Economy—A Case Study on Beibu Gulf Port Group (2006-2018)

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DECLARATION

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

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

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ABSTRACT

With the continuous development of China's economic construction, ports, as the gateway to the outside world and the interface of maritime trade, play an irreplaceable role in the situation of rapid increase in global trade. The maritime shipping industry grasps the economic lifeline of information transmission, commodity trading, and industrial communication, and has become an important channel for economic exchanges and common development between China and neighboring countries. The openness of ports is the huge driving force to the surrounding economy. The improvement of port strength will promote the development of hinterland economy. Meanwhile, the good situation of hinterland will provide solid support for the improvement of port strength.

Beibu Gulf Port is an important transportation hub for "Three Nan" (Longnan, Dingnan, Quannan) and radiated ASEAN (Association of South East Asian Nations). This area has better deep-water conditions, rich port resources, and huge development potential and plays an important role in the construction and operation of the economic and social development as well as the comprehensive transportation system in the hinterland. By studying the relationship between international competitiveness of ports and the hinterland economic is of great significance to the improvement of port comprehensive strength and hinterland economic development in the Beibu Gulf region.

The dissertation starts from the literature review of the existing research and practical experience of ports and hinterland and put the study focus on the interactive relationship between the international competitiveness of port and hinterland economy. The paper takes the Beibu Gulf Port Group as an example, analyzing the current problems and situation of the Beibu Gulf Port Group and hinterland economy to verify the relationship between ports and hinterland economy and determine the factors affect the ports and hinterland economy. The study conducts a combination of

both qualitative and quantitative methods. Qualitative analysis provides the development of various stages of the port and hinterland economy, which provides a basis for further quantitative research. The idea of the study is to introduce the international competitiveness to describe the comprehensive strength level of the ports by selecting suitable indicators to construct an evaluation system and using the Entropy TOPSIS method for operation to evaluate indicators in four aspects closely related to port development of Beibu Gulf Port Group: operational capacity, infrastructure level, development potential and international participation.

Based on the evaluation result, panel data model will be used to study the respective relationship between indicators of port's international competitiveness and the hinterland economy. Finally, the study will put forward the suggestions that can improve the comprehensive strength of the Beibu Gulf Port Group in the future and promote the development of economy in Guangxi.

Key words: International Competitiveness of Ports, Hinterland economy, Beibu Gulf Port, Interaction relationship.

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LIST OF ABBREVIATIONS

AHP: Analytic Hierarchy Process

ASEAN: Association of Southeast Asian Nations

EWM: Entropy Weight Method

GDP: Gross Domestic Product

TOPSIS: The Technique for Order of Preference by Similarity to Ideal Solution

VAR: Vector Auto Regression

1 Introduction

1.1 Preface

For a long time, the trade activities between countries are mainly dependent on sea transportation. As the gate of communication between home and abroad, ports are highly valued by coastal countries. The development of export-oriented economy is inseparable from the port. As a transfer station for exchange, the role of ports has been gradually change from traditional single role of loading, unloading, transshipment, and storage of goods to a diversified and comprehensive system integrating logistics, information, commercial and industrial services. Ports and hinterland connections has been recognized as one of the most critical issues in port competitiveness and development in most ports around the world. The complete supporting facilities and advanced transportation as well as the information and talents gathered therefrom, make ports the driving force of economic development for regions and even the countries.

At present, China has formed five major port areas: First, the port groups around the tidal sea area consists of Dalian Port, Qingdao Port etc., serving the economic and social development in the north and Northeast Asia. The second is the group of ports in the Yangtze River Delta, mainly consists of Shanghai, Ningbo, Lianyungang port

etc., which serve the economic and social development along the Yangtze River. Third, the ports in the southeast coastal areas, mainly Xiamen and Fuzhou, serve the development needs of Fujian, Jiangxi and the "links" between the two sides. Fourthly, the ports in the Pearl River Delta region, mainly Guangzhou, Shenzhen, Zhuhai and Shantou ports in the eastern part of Guangdong, serve the social and economic development in South China. Fifth, the port group in the southwest coastal areas, mainly composed of Zhanjiang Port in the west of Guangdong, Beibu Gulf Port in Guangxi and the ports in Hainan Province, serves the development of the western region.

1.2 Research Background

1.2.1 The Existing Problems of China Ports in International Competition

As early as 1934, the German scholar Kautz's (1934) Port Location Theory believed that the position of the port location was determined by the development of its hinterland. Hinterland economic scale and economic development vitality is an effective support for port development. As the portal and economic promotion window of hinterland region, port is an important support for the economic structure of hinterland region. Modern port, as an international logistics center integrating technology, capital, logistics and information, plays an important role in radiating

and driving its hinterland. Port development not only affects the industrial structure and economic structure of hinterland, but also has important strategic significance for hinterland regional economic development and expanding opening to the outside world. The coordinated development of port hinterland has become one of the important problems in port management.

The ports of China are characterized by large quantity and large throughput of goods and the total throughput has ranked the first in the world. Since the economic development of China entered the new normal, the economic structure has become increasingly reasonable, the quality of economic growth has gradually improved, and the progress of scientific and technological development has accelerated. However, at the same time, there are still many problems at the major ports of China, such as weak infrastructure, unreasonable port logistics pattern, low level of informatization and backward management philosophy.

The existence of these problems has made significant short boards in other aspects of China Port logistics in international competition, which is not conducive to the promotion of port international competitiveness. At present, the supply and demand of port shipping is mainly supported by regional manufacturing, production and consumption in the region of the port. In addition to the development of ports themselves, there is still a problem of misplaced problem in the support of ports in

the hinterland in China, which leads to many ports unable to make full use of the characteristics and advantages of economic development in the hinterland, and unable to improve their competitiveness through specialized and characteristic development.

This kind of misplaced problem not only reduces the port's comprehensive competitiveness, delays the timing of port logistics development, but also has a negative effect on local economic development and local industrial structure upgrades. As China's economy enters a new period of low speed and steady growth and increasingly intensified international competition, it is urgent to solve these problems existing in China's port logistics.

The main reason for the above problems is that the development concept of China's port logistics has not caught up with the requirements of the new normal of economy. After entering the new normal of economy, China has a new development goal, that is, to achieve stable growth of domestic economy instead of the previous high-speed growth, to advocate foreign economic activities, to actively participate in all kinds of international exchanges in order to accelerate the development of China's export-oriented economy. In practice, the port competitiveness is still measured by the throughput, berths and other hardware facilities as the main indicators. With the current infrastructure capacity of China, it is not difficult to increase port

infrastructure in a short period of time, but the rationality, efficiency and scientific nature of infrastructure construction cannot be guaranteed. At the same time, the navigation routes, cargo categories, information level and hinterland support capacity that reflect the soft power of port logistics cannot be systematically reflected in the measurement system of port competitiveness in practice, and the same is true in theoretical research.

1.2.2 Beibu Gulf Port Group

The Beibu Gulf Port Group consisting of Fangchenggang Port, Qinzhou Port and Beihai Port as the main ports, is adjacent to the Pearl River Delta in the east, close to the southwest of the motherland, and facing Southeast Asia. It is an important port of export for China's foreign trade to the world. The geographical advantage of this region is that this area has better deep-water conditions, rich port resources, and huge development potential. Before 2018 when the overall plan about "New Western Land-Sea Trade Corridor" was released by the National Development and Reform Commission of China, the direct hinterland of Beibu Gulf Port Group mainly refers to Guangxi.

The scope of the indirect hinterland is the southwest of China, including Yunnan, Guizhou, Sichuan, Chongqing and other places. Although he Beibu Gulf area in

Guangxi and Zhanjiang Port in Guangdong all take the southwest as their economic hinterland, and there is a situation of overlapping hinterlands, the hinterland of this paper is defined Guangxi as the hinterland of Beibu Gulf Port Group.

The development of port and hinterland economy in Guangxi Beibu Gulf promotes the interaction between them and further promotes the opening up and development of the region, which plays an important role in the Greater Southwest Economic Circle and the Pan-Pearl River Delta Economic Circle. Although port development can powerfully drive the development of regional economy, the economic development level of Guangxi is still in a relatively backward position in the country. Therefore, it is very important for how to play the leading role of the Beibu Gulf port.

In May 2020, the Central Committee of the Communist Party of China, issued the "Guiding Opinions on the New Era Promoting the Development of Western Development", and proposed the goal of strengthening the opening up of the western region, perfecting the port construction of Beibu Gulf, and building a group of ports with international competitiveness under the guidance of jointly building "Belt and Road Initiative". The implementation of "Belt and Road Initiative" brings new opportunities for Guangxi, which an international channel facing the ASEAN region

and an important gateway connecting the 21st Century Maritime Silk Road and the Silk Road Economic Belt.

Port development can powerfully drive the development of regional economy, but as the hinterland of Guangxi Beibu Gulf Port Group, the economic development level of Guangxi is still in a relatively backward position in the country. Therefore, it is very important for how to play the leading role of the Beibu Gulf Port Group. At the same time, the development of hinterland economy also provides a cornerstone for the improvement of port infrastructure. As each port region has its own resource endowment, only the investment of advanced equipment or the expansion of the port blindly may not produce economic benefits, or in other worlds, it is not conducive to the port to play a leading role. Therefore, analyzing the interactions between port and hinterland economy and determining the restriction factors is very necessary, which can further promote the interactive development of port and hinterland economy, and the economic development of the Beibu Gulf region and even the whole area of Guangxi.

1.3 Research Objectives

This paper evaluates the international competitiveness of ports based on the current situation of port and hinterland in Beibu region in order to help the port in the face of

increasingly fierce competition can better deal with the competition. The theoretical analysis and research on the factors that affect the international competitiveness of ports is beneficial to the port to clarify its own advantages and disadvantages and make rational use of resources.

Firstly, it is conducive to the Beibu Gulf port to make full use of the advantages of the hinterland, reasonable planning of hinterland industries, and maximize the role of hinterland in supporting the port.

Secondly, the port can integrate more closely with the economic development of the hinterland and improve the port services to play a better gateway role of "Belt and Road Initiative".

Thirdly, it is conducive to the benign interaction between the port and the hinterland economy, promoting the development of foreign enterprises and other export-oriented economy in the hinterland, promoting the rational allocation of port resources, and forming a unique cooperation mode.

Finally, this research will enrich the theoretical literature on the international competitiveness of ports to a certain extent.

1.4 Research Structure

The first chapter is the introduction, which elaborates on the topic selection background, research significance, research objects, research contents of the paper. In addition, the relevant research is summarized and reviewed from the aspects of port competitiveness, hinterland economy, and the interactive development between port and hinterland economy, and the research progress is summarized and the research framework is confirmed.

The second chapter defines the main concepts of this study and finds the classical theoretical basis for port and hinterland economic development, which provides support for the following evaluation of port competitiveness and the study of the connection between port competitiveness and hinterland economy.

The third chapter, based on the action mechanism of port and hinterland economy in the Beibu Gulf region, describes and analyzes the development status of port and hinterland economy in the Beibu Gulf region by collecting relevant data from 2006 to 2018, and presents it in the form of charts.

The fourth and fifth chapter, on the basis of the research of international competitiveness port, port and hinterland economic interaction development model

will be built and analysis will be put forward on the problems existing in the development.

The sixth and seventh chapter puts forward countermeasures and suggestions to promote the interactive development of port competitiveness and hinterland economy in Beibu Gulf region based on the empirical study.

The final chapter will discuss the limitation of the research and put forward the potential improvements that could be done by the future researchers.

2 Literature Review

In the early days, the role of port was just a transportation station, but after subsequent developments it gradually serves as the main window for the implementation of trade. The role of the port has gradually change from simple to complex and improved from the first stage that could only transfer, store, send and receive goods. The types of service need to provide by ports are growing. For example, the original positioning of each port is only an independent platform responsible for the movement of ships and cargo on the shore, and there will be no interference and interaction between each other. Since the port has become the center of logistics activities and the core of city construction, it competes with the neighboring ports or even distant similar ports, so as to absorb more business to

promote port itself and the development of the hinterland. Nowadays, the port has become more internationalized, in particular, many coastal ports are already part of the regions that cannot be bypassed in international foreign trade.

2.1 Port Competitiveness

It is found by Britton (1963) that transportation competition will have an important impact on the port freight. After the lift of the restrictions on the operation of interstate highways, the volume of freight through the port has increased significantly. When analyzing the reasons for the changes of deep-water foreign and domestic trade competition at the United States ports after World War II, Kenyon (1970) found the leading factors affect the fluctuations in the volumes handled by ports: economic changes in the various classes of hinterland, railroad mergers, the rise of truck inland transportation, containerization of oceangoing freight, differential expansion of port facilities and infrastructure, differential efforts to facilitate the business and administrative contacts of ocean trade within the port, and field solicitation of trade.

Fleming & Hayuth (1994) and Veldman & Bückmann (2003) research from different angles to study the factors affecting the competitiveness of ports. They conclude the growth in the number of inter-modal transfer points on the land side, at the sea–land

interface in the seaports and at the connecting points of liner services in transshipment ports leads to an increasing number of routing options for a container flow between two regions somewhere on the globe. The gradually diversified port services make ports and hinterlands more internationalized and ports participate in the supply chain allocating resources which make ports reach more deeply in global economic activities (Veldman & Bückmann, 2003).

In early stage of research, the countries involved in the research on ports are mostly distributed in Europe and the United States. The main reason is that the ports engaged in worldwide freight service are distributed in developed countries such as Europe and the United States, and the shipping centers of the world are still New York Port and Rotterdam Port. After 1978 the implementation of reform and opening up, the port construction has just started. The increasing frequency of foreign trade accelerate port construction of China gradually.

Mostly, the domestic researches related to port competitiveness used qualitative method to analyze the port strength; few quantitative methods were implemented. Zhao (1996) mentioned port competitiveness in his research that the competition is mainly manifested in the competition between the original ports, the public ports and the consignor ports, the wholly owned ports and the foreign-funded ports, the newly built ports and the original ports, and the supply and demand parties of port services

and the ports. The research did by Shao & Li (2019) evaluates China's coastal cruise ports, analyzes the situation of 11 major cruise ports from different aspects, and puts forward reasonable development suggestions. The research on the international competitiveness of ports is gradually refined from the initial exploration attempt.

Wang (2013) analyzed the reasonableness and competitiveness of port establishment from the perspective of port's geographical location, comprehensive facilities, service level and technical personnel when discussing the problem of improving port competitiveness. Sun & Shao (2009) realized that port economy played an important role in realizing China's economic opening and supporting economic and trade development, and discussed that port economic competitiveness was affected by natural conditions of ports, regional economic situation, port operation and management, and hinterland economic development, etc. Yang (2017) evaluate port competitiveness through 15 indicators including natural conditions, infrastructures, service ability, hinterland development, Internet access etc. The results show that the ports with strong competitiveness all have their own obvious advantages and with the promotion of the Maritime Silk Road and the location of ports in strategic routes, its international competitiveness in maritime transportation will continue to improve (Yang, 2017). Hu (2017) adopt TOPSIS method and found by evaluating the

competitiveness of the ports level can seek new breakthrough for more strategic competitiveness.

2.2 Hinterland Economy

The development of hinterland economy cannot be separated from the development of ports and in the meanwhile, it also provides a variety of materials for the development of the ports. The role of ports on a country's development has been determined by Berköz (1999) using the regression analysis that trade being carried out by seaway transportation at ports is one of the fundamental factor directly affecting the macro-economy of any nations and ship visits is closely related to the gross national incomes of cities. The economic interconnection between countries is embodied in international commodity circulation, technology transfer, labor exchange, etc., and these resources must enter the international market through various ports for flow (Wang, 1997).

The economic structure of northern China has gradually changed from a traditional economy to a modern economy. This change is closely related to the opening and development of northern coastal ports. The change in the import and export structure is the main manifestation of this change in the northern society and economy. Through the economic interaction between the port and the hinterland, the modern

northern economic system was gradually structured (Fan, 2003). Wei (2017) conducted research on the economic development of medium-sized coastal cities and compared the development status of the export-oriented economy of Weihai and Lianyungang, both of which are open coastal cities and port cities, and found that the gap between them was widening while their own economic growth was steady. In terms of foreign dependence and foreign capital utilization, Weihai's export-oriented economy is superior to Lianyungang at this stage.

The interaction between port and hinterland is an important manifestation of regional economic development. Li (2002) discussed the role of ports in promoting the economic development of their cities and hinterland. He believes that the port is an important part of the city economy. The production and development of ports can create direct output value, employment opportunities, national income and taxes, and contribute directly to the growth of city economy. Moreover, due to the characteristics of the port industry, the development of the port drives the comprehensive transportation, warehousing, processing, trade, finance, information services and other related industries, especially, it can effectively improve the mobility of various resources, reduce the cost of mobility, and form the location advantage of the port city (Li, 2002). Yang etc. (2016) used Lianyungang as the experimental subject to conduct an empirical analysis of the port's impact on the

hinterland, and select the port's cargo throughput and its hinterland GDP and employment numbers as references. The final results show that the role of ports in the economic development of the hinterland has obvious phase characteristics.

Yang (2019) studies the impact on the construction of free trade ports from the perspective of hinterland and believes that hinterland is the necessary condition and basic element for the success of free trade ports.

2.3 Beibu Gulf Port Group

Research on Guangxi Beibu Gulf Port Group generally began after the 21st century, in 2007, Xie and Bin discussed the interdependent relationship between Guangxi Beibu Gulf Port Group and the economic hinterland, and pointed out that Beibu Gulf Port Group face the problem of port hinterland overlapping, hinterland atrophy and lack of support for hinterland economy. Sui and Zhu (2012) did empirical analysis through the linear regression model and got the result that the degree of logistics development of the Beibu Gulf Port Group has a strong positive correlation with economic development levels, and according to the results put forward relevant countermeasures and suggestions to promote the development of the logistics of Beibu Gulf Port Group.

Zhang (2013) analyzed the main status and existing problems of Southwest Port group, through factor analysis, port competitiveness indicators and weights were formulated, and SPSS analysis software was used to analyze them. Her research conducts competitiveness analysis and ranks the major competitiveness of southwest ports in descending order. This is helpful for each port to clarify its own status and find its own shortcomings. It can promote the port to further improve the port strength.

2.4 Limitation of Research

At present, there is no accepted unified paradigm on how to measure and evaluate the level of port comprehensive development. Port evaluation involves many aspects, including ecological evaluation, social benefit evaluation and competitiveness evaluation, among which the competitiveness evaluation pays more attention to the quantification and comparison of the comprehensive strength and development status of ports, which can objectively reflect the comprehensive development level of ports.

Studies on port competitiveness evaluation mostly focus on hardware facilities of ports, such as Hales (2016) and Ha (2017) and other representative studies, which all focus on measuring factors such as geographical location, telecommunications system, inland transportation, port handling capacity, operation capacity and natural

environment of ports. Some scholars, such as Kuang (2012), believe that most of these hardware indicators are variable in the short run and do not have long-term coupling with the hinterland economy.

Among the representative researches on the coordinated development of port and hinterland, Meng (2017) studied the coupling relationship between port and city and its influencing mechanism, and believed that port size and hinterland economic scale had a positive impact on improving the coordination degree of port and city groups. Si(2016) studies the development relationship of port hinterland from the perspective of physical object, logistics and macro economy; Yang Liuxing (2016) used the VAR model and took the cargo throughput, hinterland GDP and employment number of Lianyungang Port as the research variables, and found that the role of seaport on the economic development of hinterland region had obvious stages. Garcia (2017) used GIS system to study the relationship between port hinterland accessibility and port competitiveness and believed that no matter what kind of transportation mode is adopted, the main factor determining port competitiveness is still the transportation distance.

Summarizing the above representative studies, this paper finds that important achievements and progress have been made in the studies on the measurement of port competitiveness and the coordinated development of port and hinterland. At the

theoretical level, a systematic research paradigm and a relatively mature theoretical system of the coupling relationship between port and hinterland have been developed. At the method level, the applicability of various quantitative methods in the measurement of port competitiveness and the study of port-hinterland collaborative development is verified and tested, and the quantitative methods suitable for this research field are developed, such as the data envelopment method based synergy degree model, cloud model, etc. At the practical level, a number of hinterland economic variables that affect port competitiveness have been determined, such as logistics, economic aggregate, population structure and other indicators are no longer controversial, and it is also clear that ports have a practical role in promoting hinterland development.

However, the existing studies still have the following shortcomings: First, most of the studies are qualitative analysis, and the conclusions lack necessary empirical support and empirical tests. Second, in terms of empirical research, most of the studies using statistical methods to compare and analyze the port cross-sectional competitiveness indicators, lack of time depth, and do not establish a standardized research model, and the evaluation index results are greatly affected by samples. Thirdly, most of the literatures only analyze the competitiveness of a certain index of the urban logistics industry and the port competitiveness independently, and there are

few comprehensive researches on the port competitiveness. Fourth, the research on the support of hinterland economic structure to port is not deep enough.

This paper believes that in addition to hardware facilities, port development is also affected by economic soft power factors such as policy, efficiency, interdepartmental patency, scale and structure of supply and demand in hinterland. For example, in addition to the handling scale, a port with strong international competitiveness should also have more complete trade categories, wider ranges of trade objects, and larger trade volume. The improvement of these soft power indicators that reflect the international competitiveness of a port cannot be realized only by expanding the scale of port hardware facilities.

3 Methodology and Research Design

When evaluating the international competitiveness of ports, based on the existing research only considering the strength of hardware facilities, this paper adds the economic soft power index reflecting the port economy and trade ability, so as to give consideration to both hardware and software.

In the process of analyzing the interaction between the international competitiveness of ports and hinterland economy, qualitative analysis combined with quantitative research can enhance the rigor and persuasion of this paper.

3.1 Qualitative Analysis

Qualitative analysis provides the development of various stages of the port and hinterland economy, which provides a basis for further quantitative research. The idea of the study is to introduce the international competitiveness to describe the comprehensive strength level of the ports by selecting suitable indicators to construct an evaluation system.

3.2 Quantitative Analysis

In the selection of international competitiveness evaluation methods, this paper combines the advantages of existing subjective evaluation methods (such as TOPSIS, AHP, etc.) and objective evaluation methods (such as entropy weight method and correlation regression factor analysis, etc.) and overcome the shortcomings of both. Therefore, the entropy weight TOPSIS model is selected and adjusted for evaluation indicators in four aspects closely related to port development of Beibu Gulf Port Group: operational capacity, infrastructure level, development potential and international participation, which basically solves the problems that weight is difficult to determine in subjective evaluation and algorithm is limited in objective evaluation.

Based on the evaluation result, panel data model will be used to study the respective relationship between each indicators of port's international competitiveness and the hinterland economy. The advantage of panel data is that it has both cross-section and time dimensions, which can solve the problem that cross-section data and time series data cannot solve, and it can effectively solve the problem of missing variables caused by unobserved individual differences or "heterogeneity" between ports.

Finally, the study will put forward the suggestions that can improve the comprehensive strength of the Beibu Gulf Port in the future and promote the development of the hinterland economy.

4 Case Background: Beibu Gulf Port Group and its Hinterland Economy

4.1 The Impact of Port's International Competitiveness on Hinterland Economy

As a transportation hub, the port itself is an important economic resource of the country and the region, and each hub port has an important economic value for the region where the port is located. The international competitiveness of ports reflects the economic development of hinterland: (1) The development of ports will promote the infrastructure construction of hinterland accordingly. The construction of public facilities such as roads, railways and waterways is consistent with the improvement of port competitiveness. The development and improvement of the collection and

distribution system is more conducive to the transport and transfer of various resources and industries; (2) The port has different types of industries in different stages. With the renewal of old and new industries, the industrial upgrading of the port has been gradually realized. Although the port focuses on different aspects in different periods, it also promotes the development of hinterland industries by means of its comprehensive competitive strength and leads the diversification of industrial structure and the rationalization of industrial upgrading. (3) In the process of port from single to diversified and comprehensive, various industries emerge at the historic moment, which promotes the development of hinterland economy. The development of these port industries cannot be separated from the demand of investment and consumption, which will promote the development of hinterland industries. Table 1 can clearly describe this relationship.

Port's International Competitiveness { *operational capacity* / *performance capacity* / *development potential* / *international participation* }

↓

Results { *The economic aggregate of hinterland will increase* / *The economic structure of hinterland will improve* / *The economic quality of hinterland will improve*

↓

Hinterland Economy

Table 1 The Impact of Port International Competitiveness on Hinterland Economy

Furthermore, a German scholar Kautz (1934) believed that good hinterland economic conditions can provide necessary and sufficient guarantee for the development and construction of ports. Then, with the development of the hinterland of ports, targeted studies and scholars' attention gradually increased. The specific performance described in this paper is as follows: firstly, the overall economic scale and industrial structure of the hinterland will provide the basis for the development direction of the port. Once the economic structure of the hinterland changes, the throughput scale of the port's goods and commodities will be affected, and then the comprehensive strength of the port will fluctuate to a certain extent. Secondly, the rapid development of the integration process of hinterland economy and the improvement of the port collection and distribution system have laid a material foundation for multi-model transport, and also promoted the progress of related supporting facilities of the port, which further expanded the spatial influence range of the hinterland of the port. Thirdly, as a service industry, the competitiveness of the port attaches great importance to the status of trade activities. The development of hinterland economy catalyzes enterprises to engage in foreign trade import and export, which provides talents for the development of the port.

Based on the above mechanisms, port is the growth pole of hinterland, and the improvement of port competitiveness has an impact on promoting hinterland economic growth, optimizing hinterland economic structure and improving hinterland economic quality. The sound development of the hinterland can bring enough sources of goods and customers for the development of the port and improve the comprehensive strength of the port. Port competitiveness and hinterland regional economy is a kind of benign interactive relationship that can rely on each other to achieve common development. The development of each other is a process of mutual promotion and common promotion.

Therefore, through sorting out the interaction between port international competitiveness and hinterland economy in this paper, the following effects are formed between the two, as shown in Table 2.

$$\text{Hinterland Economy} \rightarrow \begin{cases} \text{Economic Development Scale} \\ \text{Logisctics Accessability} \\ \text{Economic Industrial Structure} \end{cases}$$

$$\downarrow$$

$$\text{Port's International Competitiveness}$$

Table 2 The Impact of Hinterland Economy on Port's International Competitiveness

4.2 The Overall Development Status of Beibu Gulf Port Group

Beibu Gulf Port Group is located in the south of Guangxi of China, bordering Chongqing, Yunnan and Guizhou in the north, Guangdong, Hainan, Hong Kong and Macao in the east, Vietnam in the west and Hainan Island in the south. It is located at the junction of South China Economic Circle, Southwest Economic Circle and ASEAN Economic Circle, and it is the most convenient sea portal for China's inland hinterland to enter the Indo-China Peninsula and ASEAN countries. Qinzhou, Fangchenggang, Beihai three ports located at the top of the Beibu Gulf are the three main coastal ports of Guangxi. The port group of Guangxi Beibu gulf has realized the unified planning, construction, management and operation of Fangchenggang, Qinzhou and Beihai ports by the way of establishing Guangxi Beibu gulf international port group with the government as the leading role and the asset investment as the link.

The three ports have clear positioning: Qinzhou Port is dominated by containers, Fangchenggang Port is dominated by bulk cargo, and Beihai Port is dominated by cruise ships. The main business of the port has thus formed the development layout of "one axis and two wings". The container business takes Qinzhou Port Area as the central axis and carries out the collection of thousands of branch lines between the

three ports in the north of Qinzhou through the "shuttle bus" to cultivate the regional trunk container port.

The port economy of Guangxi Beibu Gulf is a kind of open economy. With Fangchenggang Port, Qinzhou Port and Beihai Port as the center, Beibu Economic Zone of Guangxi as the support, and Yunnan, Guizhou, Sichuan and Chongqing as the economic hinterland, the port industry, tourism, trade and other related industries are combined. After nearly 30 years of reform and opening up, the port is basically equipped with supporting facilities, including infrastructure, railway, logistics, coastal processing parks and so on.

By the end of 2018, the cargo throughput of Beibu Gulf Port had reached 240 million tons, up 9.7% year on year. Among them, the cargo throughput of foreign trade was about 130 million tons, with a year-on-year growth of 8.8%, and the container throughput was 2.9014 million TEUs, with a year-on-year growth of 27.3%. The three ports had 265 production berths with a length of 37,973 meters and a total cargo handling volume of 183 million tons. With the construction of China-ASEAN free trade area, the port of Beibu Gulf of Guangxi is becoming the main sea-going channel in southwest China. Such achievements cannot be separated from the benign competition in the cooperation between the Beibu Gulf Port Group, with clear functional positioning and each giving full play to its core advantages.

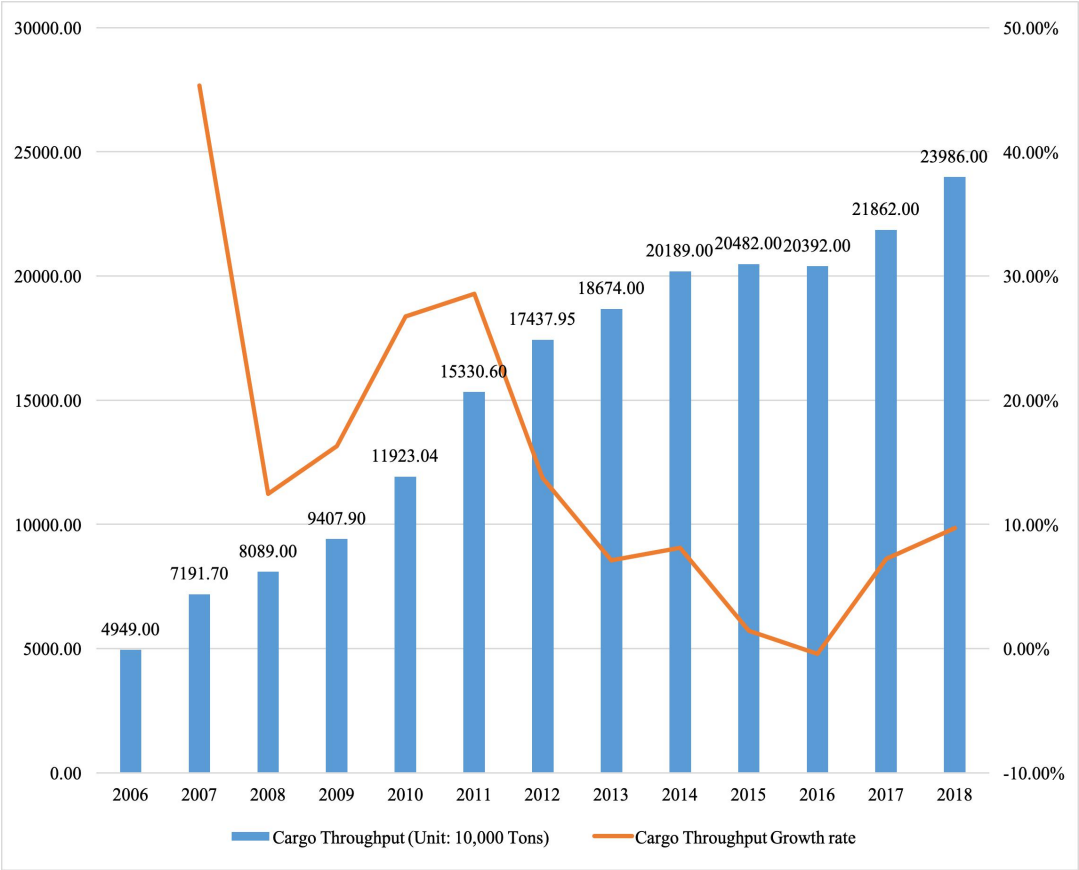

Figure 1 Cargo Throughput and Growth Rate of Beibu Gulf Port Group

The cargo throughput and its every year growth rate is shown in the figure 1, The cargo throughput of Beibu Gulf Port Group continues to grow, with an average growth rate of 14.69 % since 2006. In some good years, the growth rate is near 50%. Since 2010, the overall cargo throughput has maintained an increase, occasionally falling, which shows that the Beibu Gulf port development speed is very rapid.

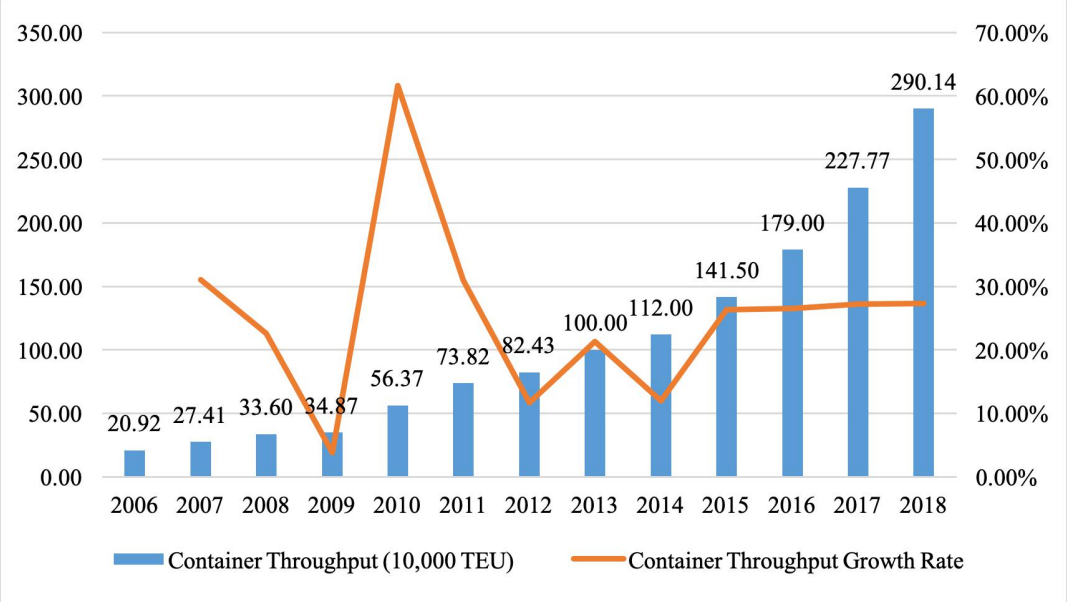

Figure 2 Container Throughput and Growth Rate of Beibu Gulf Port Group

The container throughput and very year growth rate of Beibu Gulf Port Group is shown in figure 2. The container throughput of ports keeps growing continuously. Since 2006, except for 2008, it has maintained an annual growth rate of more than 10%. In 2008, even under the impact of the financial crisis, it still has an annual growth rate of more than 3%. The average growth rate since 2006 has reached 25.2 percent. It can be seen that in terms of container throughput, the Beibu Gulf Port Group has also maintained a rapid growth.

4.2.1 Fangchenggang Port

After nearly 20 years of construction, the annual cargo throughput of Fangchenggang Port has exceeded 10 million tons. In 2018, the cargo throughput of Fangchenggang

Port exceeded 100 million tons. By the end of 2018, the port had 46 berths, including 31 deep-water berths with a maximum berthing capacity of 200,000 tons, a storage area of more than 4 million square meters and an annual actual handling capacity of more than 100 million tons.

The port has built a number of large-scale special storage and loading and unloading ship systems for iron ore, coal, sulfur, grain, cement, chemical fertilizer, wood chips, oil and gas, phosphoric acid, asphalt, vegetable oil and other types of cargo, with the ability to load and unload various kinds of general cargo, bulk cargo, container, petrochemical products and other functions of storage, transit and combined transportation. Railways and expressways can reach the port and all kinds of storage and loading and unloading equipment are complete.

In addition, Fangchenggang Port has pioneered new container routes to Northeast Asia, Southeast Asia, Hong Kong and Macao and it has trade contacts with 250 ports of more than 100 countries and regions in the world, which play an important role in the foreign trade of the whole southwest region. Besides, Fangchenggang Port plays the most important role in the import and export of bulk goods in southwest China, and it is also an important transit base of coal, iron ore and grain in China. The trend of cargo throughput and container throughput of Fangchenggang Port is shown in Figure 3 and Figure 4.

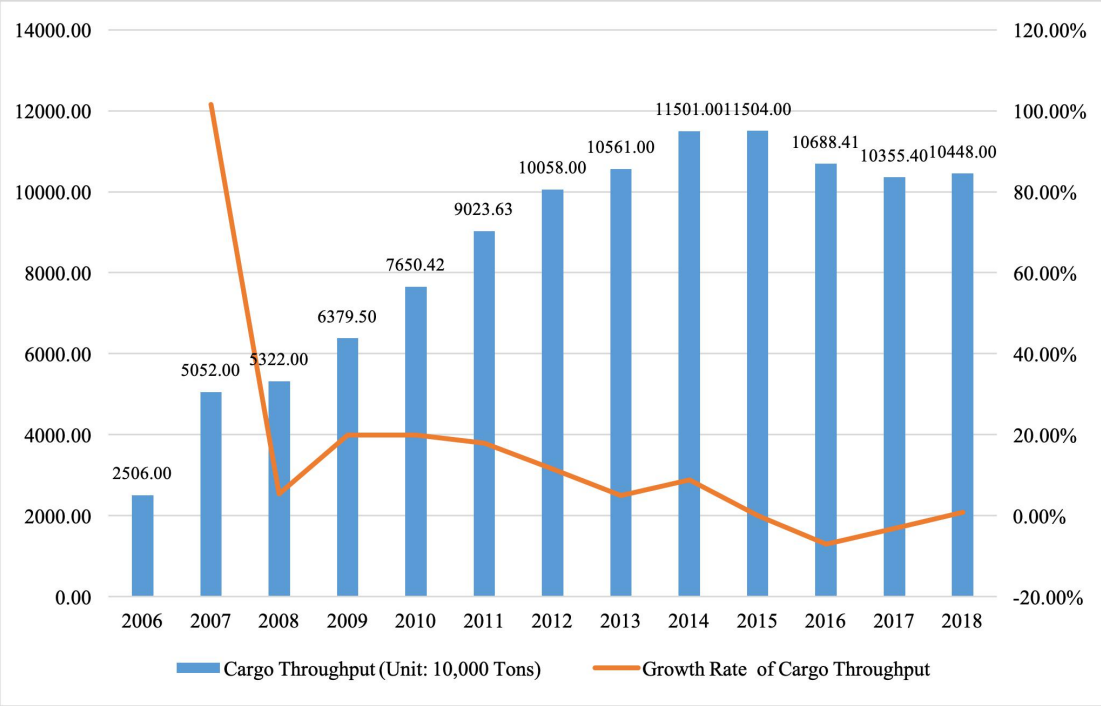

Figure 3 Cargo Throughput and Growth Rate of Fangchenggang Port

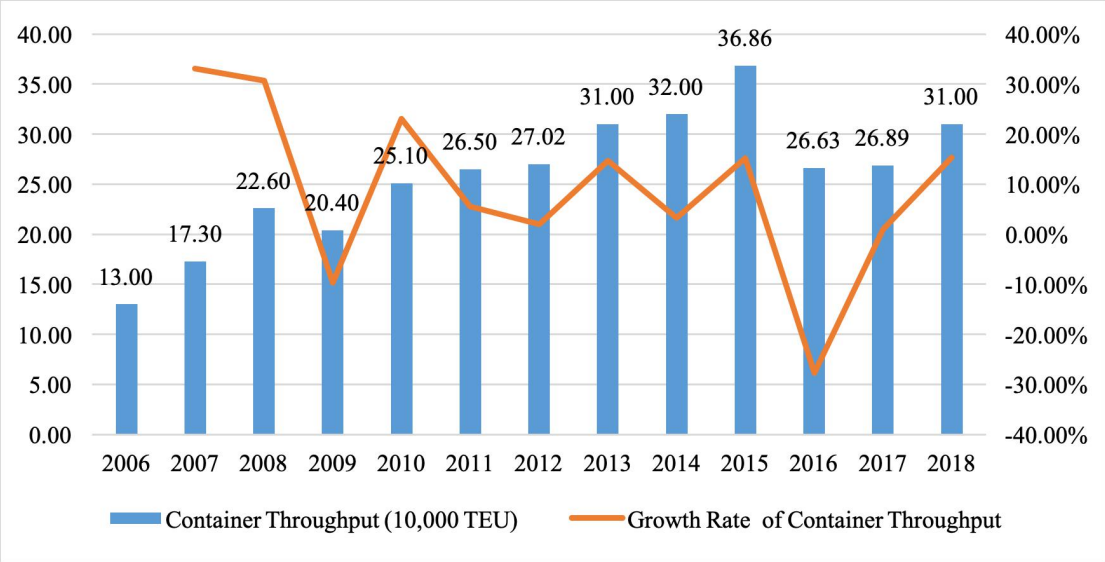

Figure 4 Container Throughput and Growth Rate of Fangchenggang Port

4.2.2 Qinzhou Port

On May 29, 2008, the State Council officially approved the establishment of Guangxi Qinzhou Bonded Port Zone, located in Qinzhou Port. The main commodities imported at Qinzhou Port are ore, yellow soybean, liquefied petroleum gas and anthracite, etc., with the import value exceeding 100 million US dollars. The original wharf in Qinzhou Port is small in scale, berths and other infrastructure are relatively scarce, and the total annual transit capacity is only about 200,000 tons. Qinzhou Port mainly has a fishing port, Longmen Port and some other small docks, can only dock 100 to 1,000 tons of small ships. However, due to the need of coastal defense construction and historical reasons, Qinzhou Port had not been developed before 1992. In 1992, the decision to develop and build Qinzhou Port was finally made.

In 2011, the cargo throughput of Qinzhou Port completed 47.162 million tons, with a year-on-year growth of 56.1% and completed 117.9% of the annual planned task (40 million tons). Among them, domestic trade reached 30.564 million tons, up 58.7%; Foreign trade reached 16.598 million tons, up 51.4 percent. Containers exceeded 400,000 TEU and completed 402,200 TEU, an increase of 60.2%, realizing the rapid growth of port throughput year after year, and the container throughput continued to rank first among Guangxi coastal ports.

At the end of 2012, with the completion of the 300,000-ton main channel of Qinzhou Port and the completion of the hydraulic part of the 300,000-ton oil terminal, Qinzhou Port has stepped into the ranks of large ports with a handling capacity of over 100 million tons. After more than 20 years of construction, by the end of 2018, Qinzhou Port had a total length of 13,464 meters and 79 production berths, including 32 berths above 10,000-ton class. In 2018, the actual cargo throughput reached 101.51 million tons, an increase of 21.74% over the previous year, among which the container completed 2.32 million TEU, an increase of 31.07% over the previous year. The trend of cargo throughput and container throughput of Qinzhou Port is shown in Figure 5 and Figure 6 below. On December 26, 2018, the cargo throughput of the port exceeded 100 million tons, an increase of 20% year on year, and 2.32 million TEUs of containers were completed, both of which hit a record high.

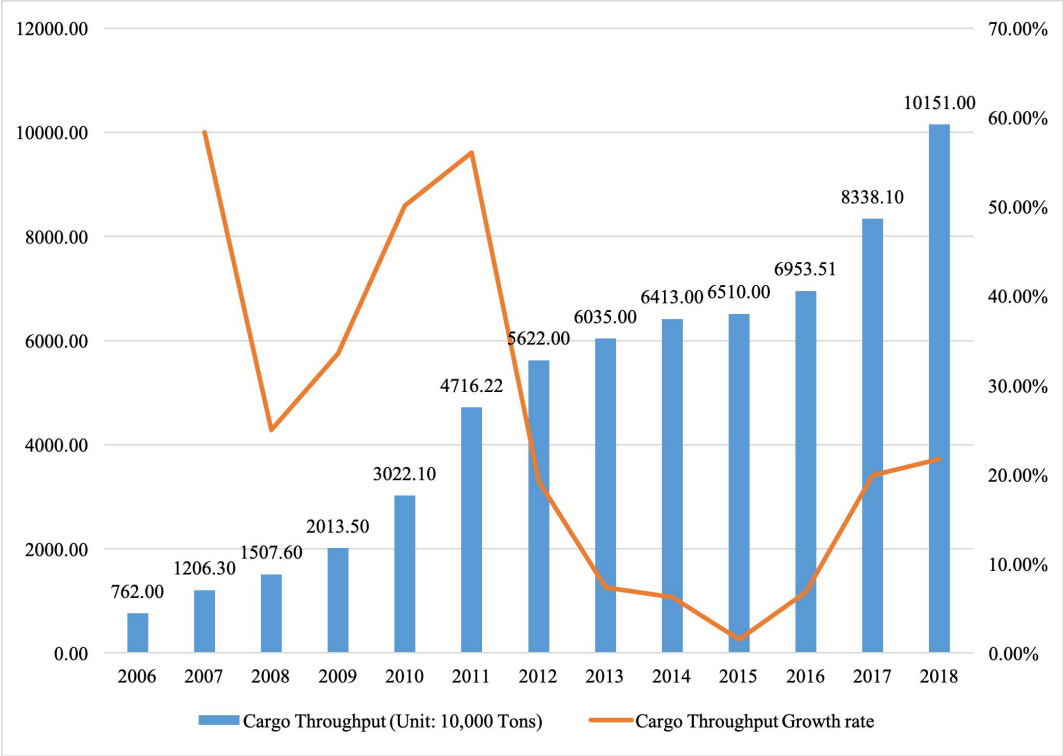

Figure 5 Cargo Throughput and Growth Rate of Qinzhou Port

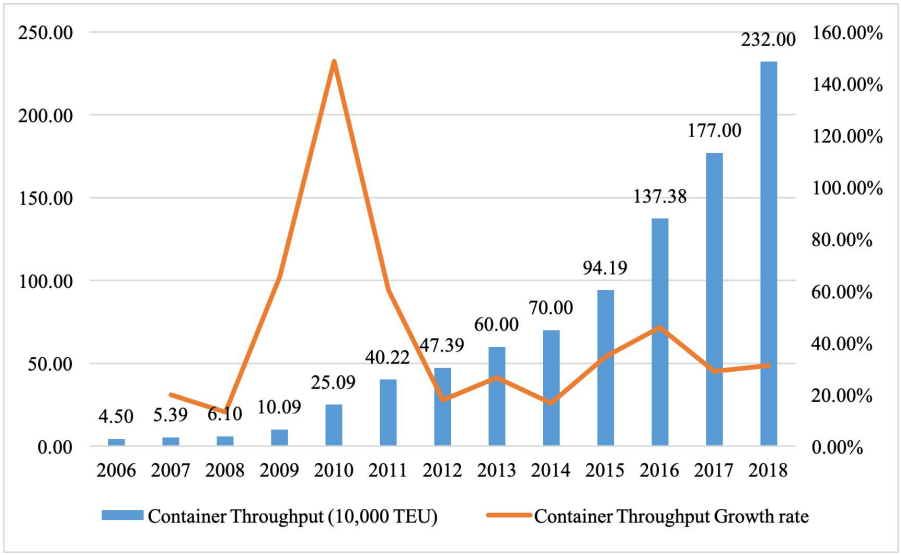

Figure 6 Container Throughput and Growth Rate of Qinzhou Port

4.2.3 Beihai Port

As early as the Qin and Han dynasties, Beihai was one of the ports of departure of the "Maritime Silk Road". Therefore, Beihai Port is also the one with the longest history among the coastal ports of Guangxi. In the Qin Dynasty, Beihai had a permanent port, and then it became a foreign trade port. In 1984, Beihai was one of the 14 open coastal cities in China, and the construction of Beihai ports has been accelerating over the years. In recent years, Beihai Port has further expanded its development space and developed Tieshan Port Area.

At present, Beihai has become a comprehensive port, and with trade, tourism and other features. Beihai has built 61 production berths, including 15 berths of 10,000-ton class and above, with a total length of 7597m quays and an annual cargo transit capacity of 51.64 million tons and an annual passenger transit capacity of 4.36 million. In 2018, the cargo throughput of the city's ports reached 32.48 million tons, up 2.5% year on year, and the container throughput reached 260,000 TEUs, up 8.88% year on year. The trend of cargo throughput and container throughput of Beihai Port is shown in Figure 7 and Figure 8.

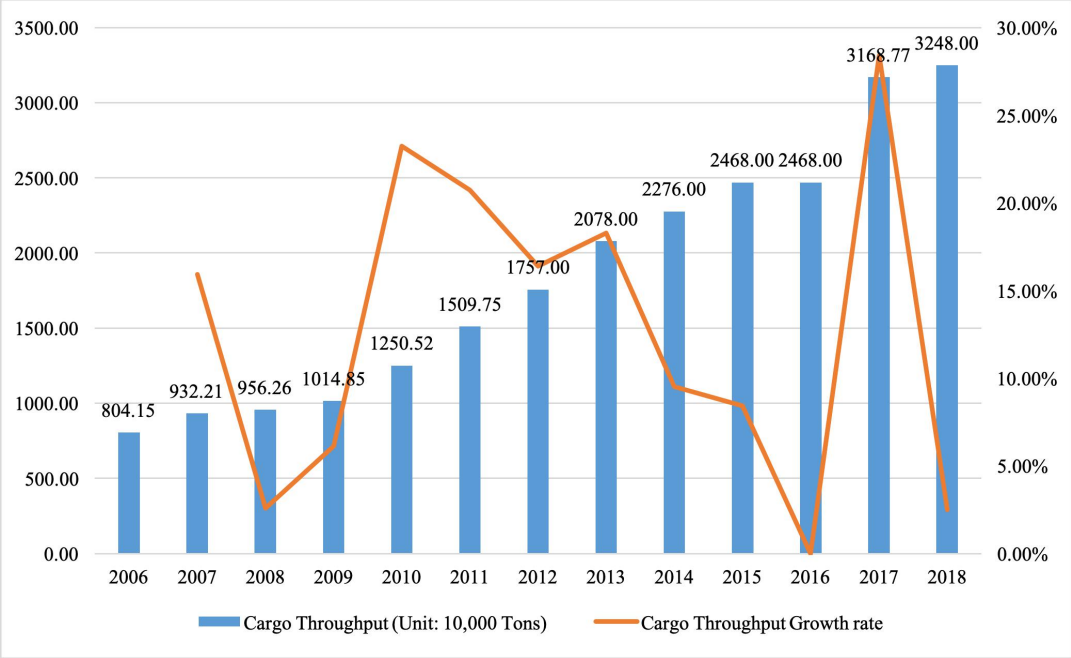

Figure 7 Cargo Throughput and Growth Rate of Beihai Port

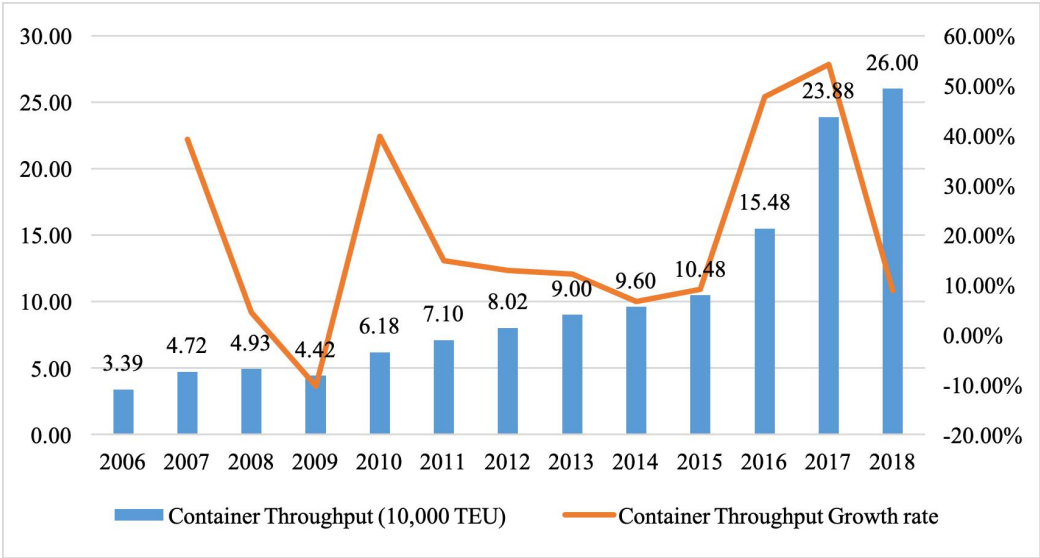

Figure 8 Container Throughput and Growth Rate of Beihai Port

Comparing the three major ports, as shown in the Table 3, Fangchenggang Port is superior to Qinzhou Port and Beihai Port in terms of the length of productive berth, the quantity of productive berth and the annual passing capacity, but the biggest difference between Fangchenggang Port and Qinzhou Port lies in the following three aspects:

First, the annual container passing capacity: the annual container passing capacity of Fangchenggang Port is only 550,000 TEUs, while that of Qinzhou Port is 4.2 million TEUs, about 7 times more than that of Fangchenggang Port.

Second, the warehouse area and inventory capacity: the warehouse area and inventory capacity of Fangchenggang Port are lower than Qinzhou Port;

Third is the maximum lifting capacity: although Fangchenggang Port has more than 1,200 sets of loading and unloading machines, the maximum lifting capacity is only 40 tons, while Qinzhou Port has only 599 sets of loading and unloading machines, the maximum lifting capacity is 500 tons.

	Length of Productive Berth (meters)	Quantity of Productive Berth	10000 DWT Berths	Annual Passing Capacity of Berths (10000 tons)
Fangchenggang	14837	118	34	15000
Qinzhou Port	12686	76	29	5700
Beihai Port	5980	55	11	3000

	Annual Container Passing Capacity of Berths (1000 tons)	Storage Space (10000 Squre Meters)	Invenotry Capacity (10000 Tons)	Loader (Set)	Max Lifting Capacity (Ton)
Fangchenggang	55	120	2000	1200	40
Qinzhou Port	420	195.4	2600	599	500
Beihai Port	25	191	2500	50	50

Table 3 Comparison of Infrastructure of the Three Major Ports

4.3 Port Hinterland Economy Development Analysis

4.3.1 GDP and Growth Rate

As shown in Table 4, from 2006 to 2018, the GDP and growth rate of the hinterland of the three major ports show that the GDP of Fangchenggang District falls far behind that of Beihai and Qinzhou, and the growth rate slows down. In 2018, the GDP of Fangchenggang District was 79.65 billion yuan, while Qinzhou's was 142.51 billion yuan and Beihai's was 133.19 billion yuan. The GDP of Beihai is very similar to that of Qinzhou. Although Qinzhou's GDP has remained the first in this decade, its overall growth rate is not as fast as that of Beihai. On the whole, in terms of economic hinterland strength, the ranking of the three major ports from strong to weak should be Qinzhou, Beihai and Fangchenggang port.

Year	2006	2007	2008	2009	2010	2011	2012
Fangchenggang District	115.69	159.07	212.18	251.4	320.4	413.8	444
	17.10%	20.30%	20.10%	25.00%	16.90%	16.00%	9.80%
Qingzhou District	245.1	303.92	377.4	396.2	520.7	646.7	691.3
	15.30%	17.10%	15.60%	15.20%	18.00%	20.10%	11.80%
Beihai District	199.64	246.58	313.88	321.1	401.41	496.6	630.1
	9.90%	23.51%	27.29%	17.30%	19.60%	25.00%	25.70%

Year	2013	2014	2015	2016	2017	2018
Fangchenggang District	525.2	588.9	620.7	676.1	741.6	796.5
	12.40%	10.40%	10.20%	9.10%	6.70%	7.40%
Qingzhou District	757.5	855	944.4	1102.1	1309.8	1425.1
	7.90%	9.80%	8.40%	9.00%	8.80%	6.00%
Beihai District	735	856	892.1	1006.7	1229.8	1331.9
	16.70%	16.50%	11.40%	12.80%	22.20%	8.30%

（Unit: 100 million RMB）

Table 4 2006-2018 GDP and growth rate of Hinterland of the Three Major Ports

4.3.2 Foreign Trade Capacity

As shown in Table 5, from 2006 to 2018, the total import and export volume and growth rate of the hinterland of the three major ports show that Fangchenggang District always focuses on the transportation of foreign trade goods and bulk goods. Therefore, the total import and export volume of Fangchenggang City is higher than that of Qinzhou City and Beihai City, and the gap is widening.

In 2018, the total import and export volume of Fangchenggang city was $10.64 billion, while Qinzhou's was $3.353 billion and Beihai's was $4.73 billion. The total imports and exports of Beihai and Qinzhou are relatively close. Qinzhou's total import and export volume was higher than that of Beihai from 2011 to 2017 but was lower than that of Beihai in 2018.

The growth rate of Beihai's total imports and exports is 38.9%, while the total imports and exports of Qinzhou does not increase but decreases, with a decrease rate

of 33.2%. On the whole, in terms of the development level of foreign trade, although its growth rate is not stable, Fangchenggang should have the highest foreign trade level. The foreign trade level of Qinzhou and Beihai is relatively close. Qinzhou was higher than Beihai before 2017, but it can be seen from 2018 that Qinzhou is likely to be surpassed by Beihai in the next few years, indicating that Beihai has a great potential in foreign trade.

Year	2006	2007	2008	2009	2010	2011	2012
Fangchenggang District	10.29	14.59	22.07	21.7	28	41.1	49
	21.10%	41.80%	50.30%	-1.80%	28.70%	46.80%	19.20%
Qingzhou District	4.41	8.42	12.72	8.86	13.14	29.82	37.67
	29.80%	91.10%	51.30%	-30.30%	48.30%	127.50%	26.10%
Beihai District	2.92	4.99	7.11	7.96	13.7	17.12	20.78
	45.26%	70.89%	42.48%	12.10%	72.10%	25.00%	21.40%

Year	2013	2014	2015	2016	2017	2018
Fangchenggang District	43	54.7	53.6	85.38	113.4	106.4
	-12.20%	27.30%	-2.00%	8.40%	32.40%	-6.20%
Qingzhou District	35.3	53.34	36.16	43.5	50.17	33.51
	-6.30%	51.10%	-32.20%	20.30%	13.30%	-33.20%
Beihai District	26.98	35	23.64	29.99	34.05	47.3
	29.80%	29.70%	-32.50%	26.90%	13.50%	38.90%

(Unit: 100 million USD)

Table 5 Total Import and Export Volume and Growth Rate of Hinterland of Three Major Ports

5 Data analysis

The sample data collected are mainly from 2007 to 2018 Guangxi Statistical Yearbook and China Port Yearbook.

5.1 Evaluation on International Competitiveness of port

5.1.1 Establish Indicators in Four Aspects

In this paper, both the hard power and the soft power of ports should be considered simultaneously when evaluating the international competitiveness of ports. In the process of index construction, this paper follows the principles that firstly, the index has objectivity and horizontal and vertical comparability; Second, the most representative key indicators should be selected to reflect the comprehensive strength of ports. Considering the above principles, this paper starts from the following first level indicators in the subsequent evaluation process of the international competitiveness of ports: operational capacity, infrastructure level, international participation and development potential. Each first level indicator can be broken down into more comprehensive and detailed second level indicators. See the Table 6.

Port operation capacity is an important index reflecting the current production and operation status of a port. It is mainly manifested in the cargo throughput and container throughput of a port. The throughput of a port is usually the most direct and important basis to measure the ranking of a port, which reflects the business and trade strength of a port to a certain extent.

Port infrastructure level includes the number of productive berths, the length of berths, number of million ton-level berths and annual throughput capacity, which can reflect the working capacity and infrastructure level of the port.

International participation measures a port's ability to integrate into the international market and foreign activities, including foreign actual direct investment (FDI), amount of foreign capital actually utilized, foreign trade throughput, import and export volume.

The development potential of the port is the demonstration of the sustainable development ability of the port. It can be reflected through the growth rate of cargo throughput, the growth rate of Container throughput, the growth rate of foreign trade throughput, the growth rate of total import and export value by city, total investment in fixed assets and the growth rate of investment in fixed assets. If the port wants to achieve better development in the future and maintain sustainable competitiveness, it must plan the future development trend scientifically on the basis of ensuring the existing conditions. The port should have accurate judgment to the requirement of the market. On the premise of ensuring the existing advantages, the port should carry out higher development and obtain stronger advantages in line with future expectations. Port construction is characterized by large investment and long construction period, and the scale of investment will affect the resource supply of

port development, which is the mandatory requirement of port economic development.

The index system shown in Table 6 is more authentic and comprehensive than previous studies that only evaluate the competitiveness of port hardware facilities. By comparing the criterion layer, the strengths and weaknesses of the international competitiveness of each port can be clarified.

Criterion Layer	Index Layer
Operation Capacity	Cargo Throughput (Unit: 10000 Tons) Container Throughput (10000 TEU)
Infrastructure Level	Number of Productive Berths Number of Million Tons Level Berths Length of Berths (Meters) Annual Throughput Capacity (10000 tons)
International Participation	Foreign Actual Direct Investment（USD 10000） Amount of Foreign Capital Actually Utilized (USD 10000) Foreign Trade Throughput (10000 Tons) Export（10000 USD） Import（10000 USD） Total Import & Export Value by City (10 000 RMB)
Development Potential	Growth Rate of Cargo Throughput (%) Growth Rate of Container Throughput (%) Growth Rate of Foreign Trade Throughput (%) Growth Rate of Total Import and Export Value by City (%) Total Investment in Fixed Assets (100 million yuan) Growth Rate of Investment in Fixed Assets (%)

Table 6 Port International Competitiveness Indicators

5.1.2 Evaluation Method—TOPSIS

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a classical multi-attributes and decision-making method. It is chosen for the reason that

the research is limited to the number of natural samples for international competitiveness evaluation and TOPSIS requires a smaller sample number compared with the factor analysis method and the structural equation method. However, the TOPSIS method has certain subjectivity and incompleteness in terms of the weighted average of the indicators. Therefore, to improve the weakness of the TOPSIS method. This paper uses entropy weight method (EWM) to determine the weighted of attributes.

EWM is an objective weighting method which determines the index weight according to the difference of the information order degree contained in each index and avoids the deviation caused by human factors. Current entropy weight method is almost applicable to all disciplines. The specific steps of processing the original data using entropy weight TOPSIS are described below. The original data used can be found in the appendix 1.

Step 1: Determine the normalized matrix. Take the port infrastructure level as an example, under which there are four indicators used to represent the infrastructure level of Fangchenggang Port, Qinzhou Port and Beihai Port, then let X_{ij} be the j th indicator for i th place. The normalized result is:

$$Y_{ij} = \frac{[X_{ij} - \min X_j]}{[\max X_j - \min X_j]}$$

Step 2: Standardize the results.

$$P_{ij} = \frac{Y_{ij}}{\sum_{j=1}^{n} Y_{ij}}$$

Step 3: Determine the entropy weight of attributes.

$$E_i = -\ln n^{-1} \sum_{j=1}^{n} P_{ij} \ln P_{ij}$$

Step 4: Take the coefficient of differentiation.

$$h_i = 1 - E_i$$

Step 5: Take the weight of attributes.

$$W_i = \frac{h_i}{\sum h_i}$$

The corresponding weight obtained will be used as the weight of the weighting matrix constructed in TOPSIS.

Step 6: Calculate the weighting matrix.

$$Z_{ij} = W_i N$$

Step 7: Find positive and negative ideal solutions

$$S^{+} = \mathrm{MAX}\ (M_1, M_2, M_3 \ldots M_n$$

$$S^{+} = \mathrm{MAX}\ (M_1, M_2, M_3 \ldots M_n$$

Step 8: Find the distance between all the positive solutions and the positive and negative ideal solutions.

$$D_i^{+} = \sqrt{\sum_j^n (M_{ij} - S^{+})^2}$$

$$D_i^{-} = \sqrt{\sum_j^n (M_{ij} - S^{-})^2}$$

Step 9: Obtain the relative proximity degree between each scheme and the optimal scheme

$$C_i = \frac{D_i^{-}}{D_i^{-} + D_i^{+}}$$

After getting results, ranking the port. The larger the C_i value is, the stronger the international competitiveness of the corresponding port.

5.1.3 Evaluation Result

(1) Score of Criterion Layer Indicators.

Fangchenggang, Qinzhou, Beihai port in the Beibu Gulf region were evaluated from the above 4 aspects and 18 specific indicators and the corresponding ranking was shown. Due to the huge port data over the years and the lack of the latest year data

(2018). This paper selects the statistical data of 2017 for display, as shown in Table 7.

Index / Port	Operation Capacity		Infrastructure Level		International Participation		Devlopment Potential	
	Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking
Fangchenggang	0.918	1	1	1	0.999	1	0.002	3
Qinzhou	0.721	2	0.757	2	0.203	2	0.973	2
Beihai	0	3	0	3	0	3	0.998	1

Table 7 2017 Score by Port

According to the evaluation result shown in Table 7, Fangchenggang port ranking the top in the aspect of operation capacity, infrastructure level, international participation, Qinzhou and Beihai ranking followed. Fangchenggang handles the most cargo and containers and has a stronger operation capacity than other two ports, which benefits from its strategical positioning of becoming a feeder port, in which the corresponding infrastructure construction is obviously different.

Fangchenggang port has more loading and unloading machines, more productive berths and the longest berth length. Therefore, Fangchenggang Port focuses on serving bulk cargo, builds several dedicated terminals and develops a professional logistics system while becoming a feeder port. When Beihai Port becomes a feeder port, it focuses on the development of trade, tourism and port-adjacent industries. Therefore, it is reasonable that Beihai Port has no outstanding advantages in terms of

the length and quantity of productive berths, the annual throughput capacity of containers and loading and unloading capacity.

In the aspect of international Participation, although the growth rate of foreign trade throughput is not stable, Fangchenggang has the highest foreign trade level. The foreign trade level of Qinzhou and Beihai is relatively close. Qinzhou was higher than Beihai before 2017, but it can be seen from 2018 that Qinzhou is likely to be surpassed by Beihai in the next few years, indicating that Beihai has a great potential in foreign trade.

In the aspect of development potential, in terms of the proportion of foreign investment, the ranking of the ability to attract the foreign investment is Beihai, Qinzhou City and Fangchenggang City. Although the financing capacity of Fangchenggang City is higher than that of the other two cities, most of it comes from domestic financing. Compared with Beihai City and Qinzhou City, its ability to attract foreign investors is weak.

The overall ability of the three major ports are relatively low in attracting foreign investors. In the future, each city should pay more attention to improving the ability of attracting investment and make full use of its superior geographical location and policy opportunities to attract foreign investment.

(2) Comprehensive Score Analysis

Based on the evaluation on criterion layer index, apply the data again into the Step 1 to 9 and get the following result shown in the Table 8 and more information is shown in Appendix 2.

Year	Fangchenggang	Qinzhou	Beihai
2006	0.1403	0.1325	0.0769
2007	0.1853	0.1476	0.0651
2008	0.1514	0.1008	0.0948
2009	0.1913	0.1542	0.0634
2010	0.2160	0.1830	0.1026
2011	0.2374	0.2346	0.1044
2012	0.2572	0.2462	0.1011
2013	0.2667	0.2590	0.1120
2014	0.2889	0.3417	0.1421
2015	0.3035	0.3405	0.1636
2016	0.6052	0.5431	0.3817
2017	0.6700	0.5260	0.3638

Table 8 Port Development Evaluation Result

From 2006 to 2013, the international competitiveness of the three major ports in the Beibu Gulf region continued to rise. Although the change is different from year to year, it can be found that the international competitiveness of Fangchenggang Port in the Beibu Gulf region has been more prominent than that of other ports over the years. Qinzhou and Beihai are slightly inferior, but they are all improving.

In 2014 and 2015, Qinzhou Port was rated higher than Fangchenggang Port. After 2016, the advantages of Fangchenggang have gradually become prominent again.

As mentioned in previous chapter, port international competitiveness is a comprehensive index used to measure port strength and there is a certain relation between the hinterland economy and port competitiveness. The improvement of city economy can enhance the competitiveness of ports. The development of ports can contribute directly to the growth of city economy.

Therefore, the competitiveness of ports with better economic development in hinterland region is gradually enhanced, while the competitiveness of ports with limited economic development in hinterland region is insufficient. Next chapter carries on the further exploration and analysis to the port competitiveness and hinterland economy development.

5.2 Study on the interaction between port international competitiveness and hinterland economy

5.2.1 Build Panel Model

Based on the relationship between the international competitiveness of ports and the economic development of hinterland region, this paper explores whether the improvement of the international competitiveness of ports in the Beibu Gulf region can drive the economic growth of hinterland region, and whether the sound

hinterland economy can help to increase the attractiveness of ports. This chapter analyzes the relationship between the international competitiveness of ports and hinterland economy through panel data model based on the evaluation of the comprehensive strength of ports in Beibu Gulf region.

Based on the previous research as a reference to build the panel model. According to the Kautz's (1934) theory, comprehensive consideration should be made on port infrastructure, operation capacity, logistic system between port and hinterland, and economic level and structure of hinterland. The model is constructed as follows:

$$\textbf{Model I}: C_i = \beta_0 + \beta_1 \ln PGDP + \beta_2 SY + \beta_3 TY + \beta_4 I + \beta_5 \ln GDP + \beta_6 IE + \beta_7 \ln WA + \beta_8 \ln RO + \varepsilon$$

where:

- C_i *is* the dependent variable (DV)
- $\beta 0$ is the intercept
- $\beta 1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8$ are the regression coefficient
- GDP, SY, TY, I, IE, WA, RO are the independent variable (IV)
- ε is the error term

Model II：$\ln GDP = \beta_0 + \beta_1 C_i + \beta_2 \ln WA + \beta_3 \ln RO + \varepsilon$

where:

- GDP is the dependent variable (DV)
- $\beta 0$ is the intercept
- $\beta 1$, β_2, β_3 are the regression coefficient
- C_i, WA, RO are the independent variable (IV)
- ε is the error term

The contribution rate of economic growth of the secondary and tertiary industries, gross domestic product (GDP) and per capita gross domestic product (GDP) are selected to reflect the economic aggregate and structure of hinterland. Note that the contribution rate of secondary and tertiary industries to GDP growth refers to the contribution rate of secondary and tertiary industries to GDP growth, which is equal to the ratio of the increment of added value of each industry to the increment of GDP （Expressed by formula:$\frac{\Delta \, Value\ of\ Secondary\ Industry}{\Delta \, GDP}$; $\frac{\Delta \, Value\ of\ Tertiary\ Industry}{\Delta \, GDP}$）. Increments in value added are calculated at constant prices. The volume of water and land freight turnover represents the level of logistics connectivity between the port and the hinterland. The amount of investment in fixed assets and total import and export

value are used to show the development level of investment hinterland and trade. The international competitiveness of ports is expressed by the relative proximity (Ci) of the entropy TOPSIS evaluation results. Indicators of each aspect are shown in the Table 9.

	Meanings	Indicators
Hinterland Economic Structure	Contribution of Secondary industry to Economic Growth (%)	SY
	Contribution of Tertiary industry to Economic Growth (%)	TY
Economic Aggregates	GDP (current prices,100 million yuan) Per Capita GDP (yuan/person)	GDP PGDP
Trade	Total Investment in Fixed Assets (100 million yuan)	I
	Total Import & Export Value (10000 USD)	IE
Logistics Accessibility	Turnover of Cargo Transport by Waterway (Billion tons	WA
	Turnover of Road Cargo Transport (Billion tons)	RO

Table 9 Indicators of Hinterland and Its Meanings

The original data came from Guangxi Statistical Yearbook from 2006 to 2018 and the relative proximity index of all ports calculated in Section 5.1 of this paper. In order to facilitate the subsequent data processing and make the model more efficient, this paper adopts logarithmic original data for some indicators in the panel model, such as GDP, GDP per capita, turnover of cargo transport by waterway and turnover

of road cargo transport. Besides, for the reason that some indicators like GDP has large data value, logarithmic processing can out to prevent heteroscedasticity and make the data smother than before.

In the first model, the port competitiveness is taken as the dependent variable to analyze the impact of hinterland regional economic development on the international competitiveness of ports. The second model is mainly to measure the impact of port comprehensive competitiveness and inter-port logistics access on the overall level of hinterland economic development. In the second model, port competitiveness and logistics accessibility as the key items of consumption and investment have an impact on the actual access of hinterland economy according to macroeconomic theory.

5.2.2 Model Test

Apply the processed data into the STATA Software to run the panel model. Unlike usual regression, panel model has to go through a precise estimation modeling steps which are explained as follows.

(1) Descriptive Statistics Analysis

As shown in table 10, the total (unbalanced) observations is 314 with the lack of data of turnover of cargo transported by road and waterway in 2006, 2007 and 2018.

Variables	Sample Number	Mean	Standard Error	Minimum	Maximum
Ci	36	0.235939	0.1536878	0.0633832	0.670025
lnPGDP	36	1.087815	0.63856	-0.3414974	2.071296
SY	36	0.631225	0.1205014	0.418	0.8542
TY	36	0.2910028	0.0978405	0.1076	0.449
lnGDP	36	6.176168	0.6095054	4.810429	7.177643
I	36	516.9028	300.4756	67.24	1099.68
IE	36	89.51066	166.2134	2.9167	768.5445
lnWA	31	4.866502	0.9636054	1.65058	5.825823
lnRO	31	4.221103	0.7829092	2.691921	5.423495

Table 10 Descriptive Statistics Analysis

(2) Correlation Coefficient Matrix

As shown in the Table 11, it is preliminarily determined that GDP, GDP per capita, the investment in fixed asset, the import and export value and turnover of cargo transported by waterway are positively correlated with C_i. SY and TY are negatively related to C_i. Since the GDP and the value of secondary and tertiary industry increase year over the year, therefore, the reason behind the negative relationship between SY, TY and Ci is that although the total value of each factor increase, the ratio decreases according to $\frac{\Delta\ Value\ of\ Secondary\ Industry}{\Delta\ GDP}$ and $\frac{\Delta\ Value\ of\ Tertiary\ Industry}{\Delta\ GDP}$.

Besides, the analysis of the ratio does not indicate that it has a negative effect on the international competitiveness of ports, because the proportion of the growth value of the secondary and tertiary industry is fluctuating.

Variables	Ci	lnPGDP	SY	TY	lnGDP	I	IE	lnWA	lnRO
Ci	1								
lnPGDP	0.5728*	1							
SY	-0.084	0.4726*	1						
TY	0.1384	-0.3392	-0.9485*	1					
lnGDP	0.6080*	0.6362*	0.2074	-0.1764	1				
I	0.5891*	0.6775*	0.1577	-0.1109	0.9580*	1			
IE	0.8834*	0.5210*	-0.1057	0.1694	0.4441*	0.4327*	1		
lnWA	0.4762*	0.4478	0.1863	-0.159	0.7299*	0.5788*	0.284	1	
lnRO	0.4123	0.2582	0.0148	-0.0459	0.8056*	0.7426*	0.1795	0.7596*	1

Note: Significant at 1% level

Table 11 Correlation Coefficient Matrix

(3) Scatter Fitting Diagram

The X axis represents the core independent variable, and the Y axis represents the dependent variable. The result we get from the two figure 9 and 10 showed that the relationship between GDP and C_i and the relationship between GDP per capita and C_i are up-sloping lines. The figure more intuitively shows that there is a positive correlation between GDP, GDP per capita and C_i, which indicates the international competitiveness of ports, and verify the preliminary analysis in the correlation coefficient matrix.

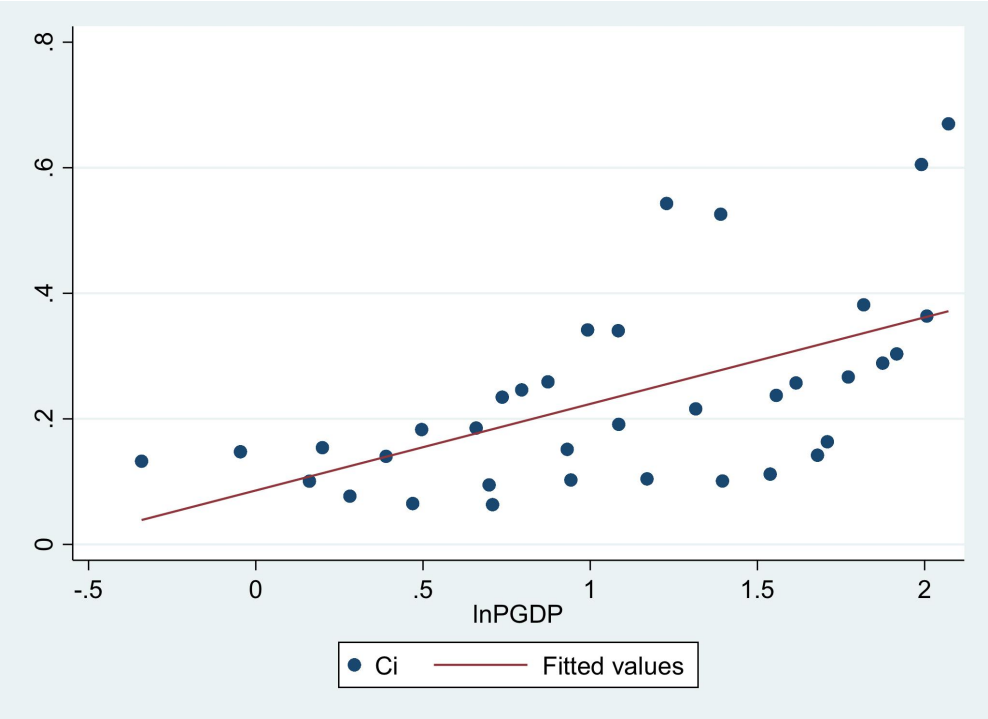

Figure 9 Scatter Fitting Diagram Ci & lnPGDP

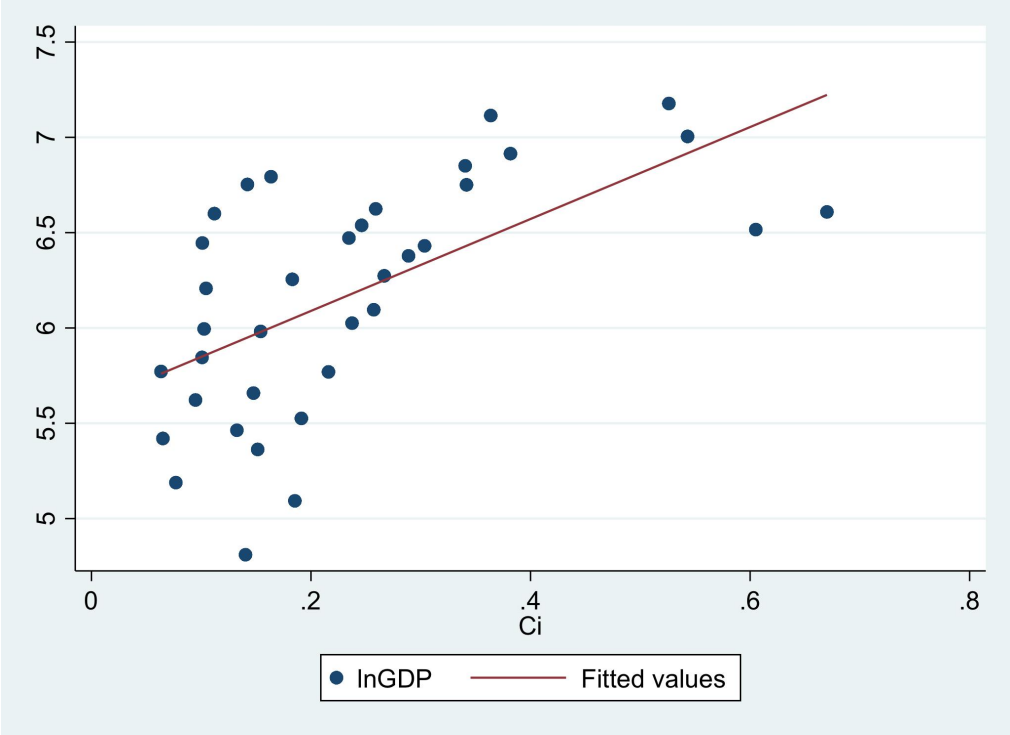

Figure 10 Scatter Fitting Diagram lnGDP &Ci

(4) Model Specification

Panel models can be further divided into three types: Fixed Effect Model, Mixed model and Random Effect model. F test, LR test and Haussmann test were conducted respectively to determine which model should be used in the further analysis.

(i) Model I

From the test result of Model I, it can be concluded that in the F test, $p=0.0000<0.01$, significantly reject the null hypothesis (H0)—the mixed model and choose FEM, meaning that there is no individual and random effect. In the LR test, $p=0.0000<0.01$, significantly reject the null hypothesis (H0) that there is no individual random effect in the model, so mixed regression should be chosen, so accept H1, choose REM. Next, Haussmann test help to find one model of the two that will be used in future analysis. According to Haussmann test, as $p=0.0005<0.01$, reject the null hypothesis, reject REM and choose FEM as the regression model in future use.

Statistical Test	Statistical Indicators	Statistical Value	P value	Results
F test	F (2, 20)	21.51	0.0000	Reject H0, choose Fixed Effect Model (FEM)
LR test	chibar2(01)	16.23	0.0000	Reject H0, choose Random Effect Model (REM)
Haussmann test	chi2(7)	23.97	0.0005	Reject REM, Choose FEM

Table 12 Statistical Test of Model I

(ii) Model II

Follow the same logical process explained as Model I, in F test LR test, significantly reject null hypothesis and in Haussmann test finally choose FEM as the regression model for future use.

Statistical Test	Statistical Indicators	Statistic al Value	P value	Results
F test	F (2, 25)	22.74	0.0000	Reject H0, choose Fixed Effect Model (FEM)
LR test	chibar2(01)	19.44	0.0000	Reject H0, choose Random Effect Model (REM)
Haussmann test	chi2(3)	16.00	0.0011	Reject REM, Choose FEM

Table 13 Statistical Test of Model II

(5) Regression (Stepwise Regression)

The goal of applying stepwise regression is to find a set of independent variables that can significantly influence the dependent variables. The process of stepwise regression involves in the selection of independent variables to be used in the final model by adding and removing potential explanatory variables, which can ensure the completeness of the analysis and make the model more robust.

The independent variables are introduced one by one under the condition that the sum of squares of partial regression is significant after testing. After each new independent variable is introduced, the old independent variables should be tested

one by one. Insignificant independent variables should be eliminated, until neither new variables are introduced nor old variables are deleted.

5.2.3 Result Analysis

(i) Model I

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
lnPGDP	0.199***	0.231***	0.236***	0.423	0.418	0.466**	0.698**	0.711*
	(6.79)	(8.5)	(8.25)	(0.9)	(0.87)	(2.35)	(2.1)	(2.06)
SY		-0.444***	-0.698	-0.759	-0.762	-0.366*	-0.727**	-0.714**
		(-3.38)	(-1.60)	(-1.62)	(-1.60)	(-1.84)	(-2.34)	(-2.20)
TY			-0.306	-0.367	-0.361	-0.356	-0.714**	-0.699*
			(-0.61)	(-0.69)	(-0.67)	(-1.60)	(-2.22)	(-2.07)
lnGDP				-0.174	-0.156	-0.426**	-0.595*	-0.605*
				(-0.40)	(-0.33)	(-2.21)	(-1.96)	(-1.93)
I					0.001	0.001**	0.001*	0.001
					(0.14)	(2.28)	(1.99)	(1.66)
IE						0.001***	0.001***	0.001***
						(11.8)	(10.46)	(10.11)
lnWA							-0.015	-0.017
							(-1.02)	(-0.97)
lnRO								0.004
								(0.22)
_cons	0.02	0.265***	0.509	1.437	1.344	2.541**	3.739**	3.768**
	(0.56)	(3.36)	(1.25)	(0.6)	(0.53)	(2.45)	(2.47)	(2.42)
个体	YES	YES	YES	YES	YES	YES	YES	YES
N	36	36	36	36	36	36	31	31
Adj-R^2	0.552	0.662	0.655	0.645	0.632	0.938	0.95	0.948

* p<0.1, ** p<0.05, *** p<0.01 t statistics in parentheses

Table 14 Regression of Model I

From the regression result shown in Table 14, at 5% confidence level, when P<0.01, PGDP and IE are significant positive correlated to Ci. When P< 0.05, PGDP, IE, SY and TY are statistically significant. Adding the independent variables drives the adjusted R Square increase and gradually gets close to 1. Adjusted R square is the ability of predictor variables simultaneously in explaining the response variable by observing the standard error. The explanation is the same as R Square but this value has been corrected with standard error. As the increase of adjusted R square, the standard error decreases and the goodness of fit of the model increases, meaning that more plots of PGDP can be explained by the model.

(ii) Model II

Variables	Model 9	Model 10	Model 11
Ci	3.166***	1.829***	1.621***
	(6.8)	(5.71)	(5.19)
lnWA		0.346***	0.241***
		(6.75)	(3.58)
lnRO			0.218**
			(2.23)
_cons	5.429***	4.103***	3.750***
	(42.71)	(18.1)	(14.24)
个体	YES	YES	YES
N	36	31	31
Adj-R^2	0.553	0.826	0.849

t statistics in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 15 Regression of Model II

The Same logic applied to Model II regression shown in Table 15, at 5% confidence level, when $p< 0.01$, both Ci and WA has significant positive relationship with GDP are statistically significant. When adding more potential independent variables, the adjusted R square increase, meaning that the goodness of fit of the model increase. More plots Ci can be explained by the model.

6 Discussion

According to the results of the panel model， GDP per capita and the trade of import and export have a positive boost to the international competitiveness of ports. It is worth noting that the coefficient of the SY and TY in each region is negative. The reason may be that although the output value of the secondary and tertiary industry still maintains a relatively stable growth trend, the ratio keeps decreasing. In addition, the analysis of the ratio does not indicate that it has a negative effect on the international competitiveness of ports, because the proportion of the growth value of the secondary and tertiary industry is fluctuating all the time.

In the aspect of transportation between port and hinterland, the results of the turnover of cargo transported by waterway and road show that port competitiveness is affected by transport capacity. The better the level of logistics is, the better the competitiveness of the port will be. Otherwise, the port will be restricted, and the

hinterland will be hindered. However, the coefficient of road cargo turnover is not significant. Combined with the actual analysis, this result may be the lack of specific records of the volume of overland cargo turnover generated by port trade. Therefore, the promotion of port's international competitiveness depends on the development of hinterland economy.

From the aspect of factors that affect the hinterland economic development, there is a significant positive correlation between the turnover of cargo transported of the hinterland as the dependent variable and the international competitiveness of the ports as the independent variable. This indicates that the improvement of port international competitiveness and the accessibility of logistics have a promoting effect on the economic development of hinterland, which is consistent with the previous cognition. This also proves that hinterland region economic development and improvement can be realized with the help of ports. Paying attention to the port as the hinterland and inland portal construction, supporting the port transformation and upgrading, carrying out cooperation with all parties can finally make the port become the leading driving force of the regional economic development.

7 Conclusion and Implications

7.1 Conclusion

The relationship between the international competitiveness of the port and economic development of its hinterland region is interdependent. It is of great theoretical and practical significance to explore the synergistic mechanism and interactive mechanism between the international competitiveness of ports and the economic development of hinterland and to study the promoting effect of ports on the economic development of hinterland regions, as well as the boosting effect of economic development indicators of hinterland on the international competitiveness of ports.

When measuring and evaluating the international competitiveness of ports, this paper not only considers the hard power of ports, such as operation capacity and infrastructure level but also innovatively considers the soft power of ports, such as international participation and development potential. In terms of competitiveness evaluation method, this paper uses the evaluation model of port comprehensive competitiveness based on entropy weight TOPSIS which combines subjectivity and objectivity. It basically solves the problem that weight is difficult to determine in subjective evaluation method and objective evaluation method is limited by algorithm.

Different from the previous research which only focused on a certain aspect of port competitiveness, the innovation point of this paper is that it evaluates and compares the comprehensive competitiveness of the three major ports in Beibu Gulf region of China.

Besides, on the basis of the criterion level evaluation, this paper further carries out the secondary level of port comprehensive evaluation, and obtains the relative proximity index representing the international competitiveness of Fangchenggang, Qinzhou, Beihai port over the years. The relative proximity index is introduced into the panel model as a quantitative index of the comprehensive competitiveness of the three ports in the Beibu Gulf region to investigate the correlation between the international competitiveness of port and economic development of Guangxi.

The results of the panel model show that: firstly, the increase of the secondary and tertiary industries in hinterland region has a significant boost to the international competitiveness of ports, which indicates that the economic structure of hinterland has a significant impact on the comprehensive competitiveness of ports. Second, the main factors influencing the improvement of port comprehensive competitiveness are not only the hinterland economic aggregate but also the import and export value. Third, the trade and logistics conditions of hinterland have a significant role in promoting port international competitiveness. Fourth, the improvement of port

comprehensive competitiveness can significantly promote the development of hinterland secondary and tertiary industries, indicating that the improvement of port comprehensive competitiveness is conducive to the improvement of regional economic structure.

Based on the evaluation of the international competitiveness of ports in the Beibu Gulf and the empirical model, this paper concludes that there is indeed a mutually promoting and influencing relationship between Chinese ports and their hinterland regions. The support of hinterland to port competitiveness is mainly realized through the rationality of hinterland economic structure and the development level of hinterland regional trade and logistics. The economic aggregate of hinterland region is not the only important factor to improve the comprehensive competitiveness of ports. Therefore, in practice, hinterland region should take structural adjustment and quality as the main development goal, instead of focusing only on GDP to meet the requirement of China's New Normal Development.

7.2 Suggestions

7.2.1 Suggestion on Beibu Gulf Port Group

（1）Improve the port infrastructure construction

From the analysis this paper conclude that the port infrastructure construction level has always had a great impact on the hinterland economy, so it is very necessary to improve the port infrastructure construction. Based on the advantage of geographical location of Beibu Gulf port, the strategic role of Beibu Gulf can be better played by improving the infrastructure construction.

Beibu Gulf port should pursue a higher level of port infrastructure, broaden the financing channels, improve the port investment environment, establish a new port construction investment mechanism. Guangxi Beibu Gulf Port is the solid foundation of the port industry development of Guangxi Beibu Gulf Economic Zone. The port also bears the task role of promoting economic and social development. Therefore, accelerating the development of the Beibu Gulf Port Group to accelerate development can meet the needs of regional economic development.

The development of Guangxi Beibu Gulf Port has entered a new stage, and the funds are needed in the process of its development. Therefore, it is very important to formulate and improve the corresponding preferential policies to encourage domestic and foreign investment and financing entities to enter the Beibu Gulf region. One enterprise and one policy can be formulated, especially for well-known shipping enterprises, logistics companies and terminal operating companies at home and

abroad. The government needs to support the port development and land utilization financially.

(2) Improve the Port Handling Quality

Beibu Gulf port has always neglected the improvement of port handling quality. Even though cargo throughput has soared in recent years, the throughput structure is still in a relatively low state. Although the container throughput of Beibu Gulf Port Group has been growing rapidly in recent years, it is still in a backward position. In 2018, the container throughput of the Beibu Gulf Port Group was only 3.05 million TEU, even only about 7% of that of Shanghai Port in the same year, showing no advantages compared with developed ports. It is mainly affected by the hinterland economic structure. Hinterland economy as the foundation of port economy severely limited the development of container throughput of Beibu Gulf Port Group.

The handling quality and structure of the port can directly affect the sustainable development of the port. During 2011 to 2018, the handling structure of Beibu Gulf Port Group has been improved to a large extent, and this improvement is also reflected in the indicators of hinterland economy. It is important to further improve the handling structure.

First of all, Beibu Gulf Port Group needs to diversify port functions with the help of local port industry, port and hinterland logistics industry, build comprehensive ports with multiple functions, renew the management concept that ports are not only used as transmissions but other functions, and further improve the port to hinterland economy promoting effect.

Secondly, taking the opportunity of the rapid development of export-oriented economy in Beibu Gulf region, the Beibu Gulf Port Group should actively develop container transportation, increase the corresponding hardware input of the ports, and improve the function of productive berth in order to meet the growing demand of container transportation.

In addition, it is necessary to strengthen the alliance between different ports, and continue to open new routes for domestic and foreign trade, and open up more routes for container transport, so as to promote the growth of container throughput and promote the optimization of port handling structure.

Finally, the port of Beibu Gulf should also improve the bulk cargo structure. The cargo of Beibu Gulf port is mainly raw materials, and the industrial added value of this basic industry is low, which is the fundamental reason for the poor handling and handling structure of the port. In order to optimize the handling structure, it is

necessary to cooperate with the improvement of industrial structure of hinterland economy, the development of intensive economy, port and hinterland complement each other and develop together.

(3) Promote the Port Corporation within Beibu Gulf region.

The benefits of port cooperation within the port group are enormous, for example, corporation help expand economies of scale and reduce operating costs, jointly invest in equipment, and jointly provide services that are difficult to achieve in a single port. This can not only improve the quality and efficiency of service, but also can share the risk to reduce the corresponding loss. The direction of port cooperation in the Beibu Gulf is to strive towards the overall goal of Guangxi port, understanding its further development trend and formulating future development plans in combination with its current situation and existing problems. From the overall point of view, comprehensive planning should be carried out, and the functions and roles of the three ports should be clearly defined, so as to further promote the reasonable division of labor and cooperation of the ports and promote the transformation of the ports to the new pattern of coordinated development. The function orientation of the three port cities within the Beibu Gulf Port is as follows.

The transportation goods of Fangchenggang port are mainly bulk goods. Due to the economic development of the hinterland, the transportation input of the hinterland cities of the port is naturally increasing, and the transportation system is also gradually improved. The container transportation of Fangchenggang port itself is also in the process of vigorously promoting the development, and the handling structure is further transformed as well. Fangchenggang port is gradually becoming a modern comprehensive port with various functions such as transportation organization, transfer and replacement, loading and unloading, storage and transportation, modern logistics and bonded, distribution and processing.

Qinzhou Port is an important regional port, whose function is to serve the port industry. The recently formed intensive and large-scale port area of Qinzhou Port is mainly due to the promotion and development of the port industry, which mainly focuses on the transportation of energy, raw materials and other bulk materials. The long term goal of Qinzhou port is still base on port industry but enriching more functions of port.

Different from Qinzhou Port, the purpose of the Beihai Port's development is to form a comprehensive port mainly for trade and tourism, and the transportation of goods is mainly for clean materials. In recent years, Tieshan Port District has been merged into Beihai Port. The function orientation of Tieshan Port District is similar to that of

Qinzhou Port, which mainly serves the port industry. However, the future development direction of Tieshan Port District is to strive to build a comprehensive port with multiple functions, such as logistics, processing and bonded etc.

Relying on the advantages of each port, each port can give full play to its own advantages according to its own conditions, perform its own duties in terms of function and coordinate with each other, which can also reduce vicious competition.

In addition, it is necessary to speed up the process of information resource sharing among ports and promote port integration. The scale of the port can be further expanded, resulting in economies of scale effect, which can save costs and improve efficiency. The pulling effect will increase on hinterland, further promoting the interaction between port and its hinterland.

Guangxi should continue to increase the intensity of capital investment and attract the inflow of funds through preferential policies and measures. The capital attracted should be put into high and new technology, so as to promote the development of labor-intensive industries into capital and technology-intensive industries, and further promote the optimization and upgrading of regional industrial structure and the development of Beibu Gulf Port Group.

7.2.1 Suggestion on Hinterland Economy

(1) Consolidate the Supporting Industry.

No matter from the perspective of economic aggregate, industrial structure, or industrial development level, the industrial foundation of Guangxi is weak. If the development of supporting industries of port economy cannot keep up, the interaction between ports and hinterland will be difficult to improve. Therefore, in addition to the adjustment of hinterland industrial structure and the improvement of port infrastructure construction, it is necessary to accelerate the development of supporting industries.

First, Beibu Gulf region must speed up the development of the port industry matching with ship building, parts manufacturing industry; actively promote the combination of the city's the third industry and regional economy, such as financial, information and tourism service; actively implement the development strategy of "bringing in and going out"; introduce large logistics enterprises with advanced management and abundant funds into the city, and speed up the development of a batch of modern logistics enterprises by way of sole proprietor, joint venture or cooperation.

Secondly, Beibu Gulf region needs to support the development of local logistics enterprises by introducing modern management concepts, actively explore the surrounding market, enhance their own strength and improve their market competitiveness. The government play an essential role in strengthening the support, for example, putting more investment. It can guide the development direction of supporting industries and provide a favorable economic atmosphere for the interactive development of Beibu Gulf port and hinterland economy.

(2) Opening Up Further to the Outside World

The interaction between Beibu Gulf port and its hinterland economy in the aspect of foreign trade runs through all the time, so it will be a long-term strategy to expand opening to the outside world and develop foreign trade.

Beibu Gulf region needs to actively open to the outside world. Participating in more international activities can attract more foreign direct investment and bring in foreign high technology by accepting more transfer of international industry. to improve the economic extroversion degree of the Beibu Gulf region.

Finally, Beibu Gulf region needs to improve the existing platform, promote international cooperation to implement projects to drive inter-regional investment and trade corporation, including deepening the China-ASEAN Expo, Pan-Beibu Gulf

Forum cooperation process, promote the construction of Nanning Singapore Economic Corridor and so on.

8 Limitation of the Research

The weakness of this paper lies in the difficulty of data collection and the lack of new data., which leads to a relatively small number of sample number and indicators. Since Beibu Gulf Port was still in its infancy in 2006 and the Beibu Gulf (Guangxi) Economic Planning Area was just constructed, some index data could not be collected in several years like the turnover of cargo transported by waterway and road. Therefore, in order to achieve the principle of objectivity in data selection, the port indexes were finally determined to be eighteen and the sample period was set to be 12 years. If the data could be collected more fully, the sample number could be further enriched. The latest data is the data of 2017. 2018 data collection is difficult because it is lack of information in the yearbook. There is no way to get all the indicators data in 2018, so it might have a little influence on model results. If the data updated, the analysis of the current situation of three ports in Beibu Gulf region can be more objective, then more precise measurement and suggestions can be put forward to the Beibu Gulf Port Group and Guangxi.

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APPENDICES

Appendix I The Original Data for TOPSIS Calculation

Port	Year	Cargo Throughput (Unit: 10000 Tons)	Container Throughput (10000 TEU)	Quantiy of Productive Berths	Quantiy of Million Tons Level Berths
Fangchen	2006	0.243917334	0.055353954	0.505882353	0.470588235
Fangchen	2007	0.399366971	0.080122113	0.505882353	0.470588235
Fangchen	2008	0.424501955	0.110650308	0.788235294	0.470588235
Fangchen	2009	0.52294731	0.097978227	0.811764706	0.5
Fangchen	2010	0.641260473	0.1250504	0.847058824	0.588235294
Fangchen	2011	0.769096071	0.133114452	0.847058824	0.588235294
Fangchen	2012	0.865388196	0.136109671	0.905882353	0.735294118
Fangchen	2013	0.91221374	0.159034618	0.917647059	0.764705882
Fangchen	2014	0.999720722	0.164794655	0.941176471	0.823529412
Fangchen	2015	1	0.192788434	0.952941176	0.852941176
Fangchen	2016	0.92407466	0.133863257	0.964705882	0.882352941
Fangchen	2017	0.893073915	0.135360866	1	1
Qinzhou	2006	0	0.006393641	0	0.117647059
Qinzhou	2007	0.041361013	0.011520074	0.035294118	0.147058824
Qinzhou	2008	0.069409793	0.0156097	0.094117647	0.205882353
Qinzhou	2009	0.116505306	0.038592247	0.164705882	0.264705882
Qinzhou	2010	0.210398436	0.1249928	0.2	0.264705882
Qinzhou	2011	0.36810836	0.212142158	0.317647059	0.470588235
Qinzhou	2012	0.452429715	0.253441622	0.376470588	0.5
Qinzhou	2013	0.490876932	0.326075687	0.376470588	0.5
Qinzhou	2014	0.52606591	0.383676056	0.447058824	0.676470588
Qinzhou	2015	0.535095885	0.523011347	0.482352941	0.764705882
Qinzhou	2016	0.576383355	0.771787339	0.482352941	0.764705882
Qinzhou	2017	0.705278347	1	0.458823529	0.911764706
Beibu	2006	0.00392385	0	0.058823529	0.029411765
Beibu	2007	0.01584528	0.007660849	0.058823529	0.029411765
Beibu	2008	0.018084156	0.008870457	0.141176471	0
Beibu	2009	0.023538447	0.005932838	0.164705882	0.058823529
Beibu	2010	0.045477565	0.016070503	0.164705882	0.058823529
Beibu	2011	0.069609942	0.021369737	0.164705882	0.058823529
Beibu	2012	0.092627071	0.026668971	0.2	0.147058824
Beibu	2013	0.122509775	0.032313807	0.2	0.147058824
Beibu	2014	0.140942096	0.035769829	0.2	0.147058824
Beibu	2015	0.158815863	0.040838661	0.235294118	0.176470588
Beibu	2016	0.158815863	0.069638846	0.270588235	0.264705882
Beibu	2017	0.224052318	0.118023155	0.294117647	0.264705882

Length of Berths (Meters)	Annual Throughput Capacity （10000 tons)	Foreign Actual Direct Investment （USD 10 000）	Amount of Foreign Capital Actually Utilized (USD 10 000)	Foreign Trade Throughput (10000 Tons)
0.386758515	0.221114481	0.056356108	0.063313657	0.300901734
0.386758515	0.217210008	0.074020503	0.083650036	0.433317919
0.558744738	0.279833207	0.058670379	0.066042694	0.168589595
0.606352851	0.30030326	0.038218012	0	0.544508671
0.677841561	0.33631539	0.046592779	0.028098973	0.626138728
0.677841561	0.33631539	0.02180477	0.026764777	0.735818497
0.811863758	0.429567854	0	0.00238538	0.812683237
0.830845771	0.452312358	0.006689689	0.009864963	0.894104046
0.884730195	0.545489007	0.010667342	0.012108838	1
0.912514351	0.585216073	0.016814623	0.02280262	0.974104046
0.937543054	0.864821835	0.129110995	0.146539177	0.902745665
1	1	1	0.13590604	0.833106358
0	0.058074299	0.096096476	0.109828576	0.003745665
0.13065442	0.126914329	0.233632863	0.263604755	0.032739884
0.187523919	0.275435936	0.293008371	0.005458074	0.039017341
0.28166858	0.271190296	0.366956553	0.389504326	0.039491329
0.321469575	0.285595148	0.541557432	0.020194873	0.098272832
0.508381171	0.403866566	0.710209912	0.192103986	0.163450867
0.572598546	0.43040182	0.82301253	0.224751354	0.25734104
0.572598546	0.43040182	0.941691226	0.239144497	0.270751445
0.720091848	0.625473844	0.891735522	1	0.30416185
0.77964026	0.710386657	0.778770182	0.872644942	0.303121387
0.77964026	0.710386657	0.866947513	0.971698876	0.332441618
0.872960582	0.785064443	0.385796163	0.43373494	0.37017341
0.062456946	0	0.07002477	0.065982049	0
0.062456946	0	0.096006075	0.066628932	0.017943353
0.086949866	0.041546626	0.127357211	0.144780464	0.011506358
0.138078837	0.140106141	0.057278201	0.052336864	0.009252023
0.138078837	0.140106141	0.146160661	0.109262554	0.022013873
0.138078837	0.140106141	0.132094234	0.08569176	0.045008092
0.206812093	0.187869598	0.06100273	0.029817256	0.060462428
0.206812093	0.187869598	0.1205048	0.135036791	0.084971098
0.206812093	0.187869598	0.201594677	0.266212501	0.08716763
0.260313816	0.245489007	0.303042904	0.34121048	0.089017341
0.331725985	0.337680061	0.346236598	0.389504326	0.089942197
0.233813241	0.351023503	0.119419986	0.13590604	0.099134104

1-2

Export (10000 USD)	Import (10000 USD)	Total Import & Export Value by City (10 000 RMB)	Growth Rate of Cargo Throughput (%)	Growth Rate of Container Throughput (%)
0	0.012520177	0.009630397	0.454149718	0.287693563
0.006875789	0.017898688	0.015248271	1	0.344813892
0.016488518	0.027669229	0.025020904	0.114403539	0.330976774
0.023965374	0.025729067	0.024491666	0.248054235	0.102140279
0.057631205	0.029437903	0.032714982	0.248528887	0.287915854
0.071937816	0.046981048	0.04981781	0.230380559	0.188936421
0.061838674	0.06090654	0.060167486	0.170698713	0.168442638
0.083583923	0.047906073	0.052357425	0.111243753	0.240814685
0.14207243	0.02532433	0.067617581	0.147124047	0.175604939
0.190705003	0.094920989	0.108534852	0.065470432	0.243408957
0.960937595	0.714397675	0.752318163	0	0
0.989341484	1	1	0.036564147	0.162854011
0.016478269	0.000592363	0.001942524	0.485708582	0.594922448
0.017285453	0.006602514	0.007186181	0.601704303	0.269428623
0.034645344	0.010131096	0.012803924	0.29504155	0.231987308
0.009561482	0.008664833	0.007782372	0.373979591	0.528090733
0.018250895	0.01366282	0.013348653	0.526117542	1
0.172935309	0.011942113	0.035142271	0.581008144	0.49914248
0.076940048	0.040898654	0.045386152	0.241938307	0.258370503
0.081329053	0.036505243	0.042301886	0.132821054	0.308150865
0.120658116	0.059270122	0.065864902	0.122859521	0.251793509
0.204956892	0.049894203	0.072302887	0.079147178	0.353204414
0.912133041	0.283466307	0.377708855	0.127913415	0.41724056
1	0.342085264	0.440880804	0.248438392	0.320795575
0.006917482	0	0	0.106082138	0.396130621
0.016550188	0.001477496	0.002707713	0.21175271	0.379709398
0.028017886	0.002699906	0.005473939	0.088967581	0.18253939
0.031044415	0.003478653	0.00659276	0.121603898	0.098680755
0.062721166	0.006683752	0.014087655	0.278893607	0.383030906
0.08816923	0.007433611	0.018556667	0.25596168	0.241704071
0.092741508	0.012236356	0.023334184	0.215911432	0.230769756
0.108575106	0.018946314	0.031433812	0.233327641	0.226584782
0.164600282	0.049460502	0.041906655	0.152899599	0.195109213
0.154263146	0.027622641	0.045698576	0.142847316	0.209280287
0.947736705	0.143312256	0.263613338	0.065230432	0.427760026
0.999680357	0.174133406	0.297692168	0.326481201	0.464908886

Growth Rate of Foreign Trade Throughput (%)	Growth Rate of Total Import and Export Value by City (%)	Total Investment in Fixed Assets (100 million yuan)	Growth Rate of Investment in Fixed Assets (%)
0.367637845	0.085079253	0.001665956	0.519005693
0.431390977	0.119391916	0.035149742	0.44639197
0.042136591	0.135104689	0.076333734	0.382946096
0.186325188	0.047060311	0.180988726	0.613411772
0.220316416	0.098268046	0.299872148	0.43360031
0.239974937	0.127722808	0.410706675	0.307986077
0.187030075	0.082094265	0.467969083	0.179616926
0.18452381	0.029867505	0.395383751	0
0.198621554	0.095139866	0.4190752	0.13137218
0.088972431	0.145061221	0.467339506	0.165147236
0.09570802	1	0.516155903	0.159546364
0.059915414	0.104401631	0.586503816	0.180093528
1	0.099500653	0.049048855	0.276714615
0.810463659	0.201214811	0.09558909	0.380786277
0.189379699	0.134791972	0.175961799	0.445541357
0.30372807	0	0.297750959	0.449093168
0.786419173	0.129700412	0.372283135	0.239174693
0.511591479	0.260648539	0.475669288	0.260860383
0.492481203	0.093697029	0.566957886	0.213553641
0.145363409	0.039710888	0.525434892	0.049344685
0.196193609	0.13480847	0.638981442	0.229985057
0.106281328	0.065419891	0.773885165	0.229513386
0.177969112	0.715238565	0.855885088	0.163785866
0.190946115	0.077550345	0.989510286	0.196944221
0.519110276	0.125127645	0	0.306125671
0.215225564	0.167922571	0.019526558	0.305300435
0	0.120460726	0.128888846	1
0.064536341	0.070080531	0.246609972	0.520237822
0.373903509	0.169536065	0.404885514	0.450884778
0.465695489	0.091495025	0.519110069	0.265527461
0.273182957	0.085510924	0.637441401	0.237177634
0.324718045	0.099566569	0.58856689	0.046632307
0.123903509	0.099361059	0.707518112	0.222771727
0.121240602	0.063852409	0.838111658	0.213705857
0.114818296	0.779725837	0.914203247	0.154338739
0.169407895	0.071227123	1	0.156694789

Appendix II The Comprehensive Score of Three Ports

The Comprehensive Score	Year	D+	D-	Ci	Ranking
Fangchenggang	2006	0.257463993	0.042031583	0.140341248	26
Fangchenggang	2007	0.25183003	0.057290139	0.185332905	19
Fangchenggang	2008	0.254623292	0.045443903	0.151445756	23
Fangchenggang	2009	0.251707171	0.059526427	0.191259643	18
Fangchenggang	2010	0.245890854	0.067732055	0.215966543	17
Fangchenggang	2011	0.241993835	0.075335203	0.237404062	15
Fangchenggang	2012	0.241616063	0.083656013	0.25718781	13
Fangchenggang	2013	0.242363115	0.088161626	0.266732306	11
Fangchenggang	2014	0.239094404	0.097114948	0.288852607	10
Fangchenggang	2015	0.228559466	0.099599827	0.30351061	9
Fangchenggang	2016	0.129883786	0.199134266	0.605238116	2
Fangchenggang	2017	0.117523456	0.238635243	0.670025031	1
Qinzhou	2006	0.266175689	0.040664367	0.132526266	27
Qinzhou	2007	0.258071042	0.044682587	0.147587289	24
Qinzhou	2008	0.261807305	0.029340963	0.100776705	32
Qinzhou	2009	0.254824578	0.046445085	0.154164493	22
Qinzhou	2010	0.251981334	0.056439716	0.182995669	20
Qinzhou	2011	0.233900814	0.071672289	0.234550385	16
Qinzhou	2012	0.233592492	0.076275855	0.246155685	14
Qinzhou	2013	0.234295661	0.08188693	0.258986207	12
Qinzhou	2014	0.218051068	0.113170177	0.341675478	7
Qinzhou	2015	0.214321311	0.110634544	0.340460226	8
Qinzhou	2016	0.144203756	0.171385116	0.54306451	3
Qinzhou	2017	0.150754101	0.167304722	0.526018176	4
Beibu	2006	0.269587673	0.02245828	0.076899816	34
Beibu	2007	0.268039623	0.018672267	0.065125542	35
Beibu	2008	0.266252342	0.027883616	0.094798393	33
Beibu	2009	0.268141841	0.018145827	0.063383193	36
Beibu	2010	0.260306257	0.029776839	0.102649342	30
Beibu	2011	0.259833339	0.030291259	0.104407758	29
Beibu	2012	0.260468313	0.029280531	0.101054869	31
Beibu	2013	0.255377182	0.032224148	0.112044502	28
Beibu	2014	0.247514439	0.040994209	0.142090051	25
Beibu	2015	0.246405189	0.048198371	0.163604171	21
Beibu	2016	0.199984994	0.123478171	0.381737967	5
Beibu	2017	0.207360624	0.118550751	0.363751498	6