

# ***Port Integration under Government Intervention: Analysis Based on the Development of Beibu Gulf Port Cluster***

**Kelly Yujie Wang<sup>1</sup>, Yawei Zhang<sup>1,\*</sup>, Junfeng Wu<sup>2</sup>**

<sup>1</sup>*College of Economics, China-ASEAN Institute of Financial Cooperation, Guangxi University,  
Nanning, 530004, China*

<sup>2</sup>*Shanghai Winjoinit Information Technology Co., Ltd., Shanghai, 200126, China*

*\*Corresponding author*

**Keywords:** Port Consolidation, Concentration, Government Intervention, Beibu Gulf Port Cluster, DID

**Abstract:** Against the background of the continuous downward trend of port power, the port consolidation policy has gradually become the local government's policy for port reform as the problem of homogenization and disorderly competition has become more and more serious in the neighboring ports. In order to study the effect of port integration policy under government intervention, this paper adopts Herfindahl-Hirschman Index (HHI) and Double Difference Difference (DID) to analyze the effect of port integration policy under government intervention on the competitive situation of port group and the effect of port integration policy under government intervention on the comprehensive power of ports, respectively. In this paper, the data of the Beibu Gulf port cluster from 2003 to 2019 is selected as a sample. The results of this paper show that the port integration policy under government intervention can change the competitive situation of port cluster; the port integration policy under government intervention can enhance the cargo throughput of ports. This has implications for the development of other port clusters and provides useful suggestions for local government ports to govern ports and port clusters, as well as useful guidance for the development of small and medium-sized ports.

## **1. Introduction**

During the 40 years of reform and opening up, China's economy has rapidly taken off and China has become more and more connected to the world. Ports, as an important tool for connecting a country to the world, can show the level of openness of a country, and the development of ports is crucial for the development of the country, the economic development of cities, and the development of the national economy. Since 2001, port management has been decentralized from the central government to local authorities, and local governments have increased investment in ports in order to develop local ports, and Chinese ports have grown rapidly, from only two of the top ten global ports in terms of container throughput in 2000 to as many as seven of the top ten global ports in terms of container throughput in 2020. Compared to the centralized model, under the

decentralized model, the comprehensive capacity of ports and social welfare have increased.

As China's ports continue to develop, coastal resources are overdeveloped in areas with more neighboring ports, and port homogenization and disorderly competition are serious, leading to ports facing idle assets and overcapacity<sup>[10,19]</sup>. Ports often only consider their own development problems, and it is difficult to consider problems from the perspective of the region as a whole, so some local governments take administrative intervention to integrate ports from the perspective of the region as a whole, in order to avoid the problems of homogenized competition and disorderly competition, and to achieve the level of common development<sup>[16]</sup>. Port integration has gradually become a means of port governance and has been adopted globally.

With the deepening of the "Belt and Road" and the implementation of the plan for a new land and sea corridor in the west, Beibu Gulf port has become an important interface between western China and ASEAN as well as the world's maritime routes, and has also led to the rising status of ports in the Pan-Beibu Gulf region, becoming an important link to other ports in the world. Under the guidance and intervention of the government, Fangchenggang Port, Qinzhou Port and Beihai Port have been integrated to form Beibu Gulf Port, and with a 2-digit annual growth rate, Beibu Gulf Port will be ranked in the top 10 of the national coastal ports in terms of container throughput in 2020, and Beibu Gulf Port is becoming more and more influential, which has also led to the influence of the entire Pan-Beibu Gulf port group. In the current context of port integration, there are still issues that need to be studied in relation to port integration, the development of ports will have an impact on the port group, so what is the impact of port integration on the competitive dynamics of the regional port group? Does the government intervention type of port integration play a positive role in port development? This paper takes the Beibu Gulf port, which has completed integration under government intervention, as the main research object to study the above questions.

This paper collects the data of the Beibu Gulf port cluster and its cities from 2003 to 2019, and uses the Herfindahl-Hirschman Index (HHI) and Double Difference Difference (DID) methods to systematically study the impact of port integration under government intervention on the development of the Beibu Gulf Port Cluster and the Beibu Gulf Port. The rest of the paper is organized as follows. In Section 2, a discussion of the literature review is provided and the contributions of this paper are described. In Section 3, a model is used to analyze the development history of the Pan-Beibu Gulf port cluster and briefly analyze the impact of government intervention on the port cluster. In Section 4, further empirical research is done using double difference (DID). In Section 5, the results of the empirical study are analyzed, and in Section 6, the study is summarized and future research directions are provided.

## 2. Literature review

Port integration is gradually being paid attention to by scholars, governments and management authorities around the world<sup>[9]</sup>. Scholars' studies on port integration around the world are also getting richer: Shinohara & Saika used case study method to study the specific cases of Japanese ports and Suruga Bay ports and analyze the development strategy of Suruga Bay ports<sup>[14]</sup>. Knatz used case study and data analysis method to study the reasons for the failure of integration of the Port of Los Angeles and the Port of Long Beach in the United States and pointed out the two ports'<sup>[8]</sup>. Stamatovic et al. used semi-structured expert interviews and data analysis to analyze the development situation of Italy's North Adriatic ports after integration<sup>[15]</sup>. huo et al. used multi-case study method to study in detail the changes in China's ports in recent years, and systematically studied the evolution of integration and cooperation between Chinese and international ports, and listed a large number of Chinese ports<sup>[7]</sup>. Cooperation evolution of Chinese and international ports, listing a large number of examples of integration in China. There are many examples of port

integration along the coast of China, which have been studied by many scholars <sup>[12,18,21]</sup>. Compared with other studies of coastal ports, Zhang, Q studies the integration of inland ports in the Yangtze River Basin, probes the "balance of interests" model of ports, and investigates the "balance of interests" model of ports<sup>[21]</sup>. The study explores the "balance of interests" model of ports and examines the effects of geographic distance and directional development on the integration of internal ports.

In the popularity of port integration, the role of the government cannot be ignored, and a certain degree of government control over ports can effectively improve port efficiency <sup>[2]</sup>, it is very meaningful to explore the mechanism of port integration on port development and the role of the government in port integration. ) describe the diversity of port cooperation (including port integration) and analyze the role played by the government in port cooperation: 1. by enhancing the efficiency of government investment 2. By internalizing the formation of government regulation and reducing external costs. Debrie et al. argue that local governments play an important role in port reform by assessing the relationship between port reform and port governance<sup>[3]</sup>. Guo, L comparatively analyzes the total internal costs of port clusters under different circumstances under the perspective of welfare maximization to determine the optimal size of port clusters, and proposes that port integration needs to balance the overcapacity or undercapacity among ports to achieve rationalization of resource allocation through policy interventions and market mechanisms, which in turn improves the competitiveness of the ports<sup>[6]</sup>. Chen et al. from the perspective of integrating the market structure and capacity (2020) explores the reasons for the diversification of integration policies in some Chinese ports in terms of integration market structure and capacity distribution; therefore, the extent to which the integration policies fit the ports is crucial for the development of port integration<sup>[1]</sup>.

Although port integration is popular, not all ports need to be integrated, and scholars have conducted relevant research studies on whether ports need to be integrated. Zhou, X. used the Hotelling model to simulate and analyze the port competition strategy of three ports, and the results showed that the formation of alliances between ports can gain more market share<sup>[22]</sup>. Dong, G. constructed a three-stage noncooperative game. a three-stage noncooperative game-theoretic model to study the effect of port integration and found that port integration can reduce costs and increase container throughput<sup>[4]</sup>. Ye et al. constructed an evaluation function for guiding the integration of regional ports and constructed a game model based on resource sharing, used a game-theoretic machine-learning algorithm to compute the optimal strategy choice, and concluded that resource integration can enhance port competitiveness<sup>[20]</sup>. However, not all ports are suitable for port integration, Saeed used a two-stage game to study port integration strategies in Pakistan and found that port integration may incur more costs<sup>[13]</sup>. In addition, there are some management problems associated with port integration, Ferretti et al. use the multiple case study method to take multiple Italian ports as an example, and point out that there are problems in port planning and concession management associated with port integration<sup>[5]</sup>.

In summary, the existing literature is relatively rich in research on the evolutionary process of port clusters. But there are still some problems. i. The current scholarly research mainly focuses on the study of mature port clusters, such as the Yangtze River Delta and Pearl River Delta regions in China. And there are fewer studies on developing ports. Second, the current research mainly focuses on the evolution of the case of no government intervention under the free market, and there are fewer case studies on the integration of ports with government intervention and a lack of quantitative research. Therefore, this study analyzes the port development process of Beibu Gulf Port and the Beibu Gulf Port Cluster, which are still under development, by using the HHI index, and analyzes the impacts of port consolidation on ports in the presence of government intervention by using the double-difference-in-differences (DID) method. This is important for understanding the

development of small and medium-sized port clusters in China and the role of port consolidation under government intervention.

### **3. Competitive regionalization of the Beibu Gulf Port Cluster**

#### **3.1. Definition of the Beibu Gulf Port Cluster and the development history of ports in the region**

In this paper, the major ports around the Beibu Gulf sea area are combined into the Beibu Gulf Port Group, which includes Beibu Gulf Port, Haikou Port and Zhanjiang Port, of which Beibu Gulf Port is formed by the integration of Fangchenggang Port, Qinzhou Port and Beihai Port.

Beibu Gulf Port is formed by the integration of Fangcheng Port, Qinzhou Port and Beihai Port. Beihai Port was established in 1953, Fangchenggang Port was built in 1968, Qinzhou Port was put into operation briefly in 1994 and opened to the public in 1997. It was not until the early 1990s that the three ports began to develop and build on a larger scale, gradually becoming an important outlet to the sea in the southwest. Fangchenggang port area as the "left wing", the development of large-scale bulk terminal, focusing on serving the local and Yunnan, Guizhou and Sichuan and other countries and regions. Fangchenggang port area as the "left wing", the development of large bulk cargo terminals, focusing on local services and Yunnan, Guizhou, Sichuan and other southwest regions; North Sea Port area as the "right wing", mainly serving the port enterprises industry and southeast Gui region.

Haikou Harbor was established in 1954, located in the north of Hainan Island, is the largest port in Hainan Province, Haikou Harbor is also China's 21st Century Maritime Silk Road, the southern gate. With the continuous development of the local economy and government support Haikou Port continues to develop, in 2011 Haikou Port container throughput for the first time exceeded 1 million TEU, in 2017 Haikou Port cargo throughput for the first time exceeded 10,000 million tons. Under the "Belt and Road" initiative, Haikou Port has been upgrading its port facilities to enhance the efficiency and specialization of the port.

Zhanjiang Port is located in Zhanjiang City, Guangdong Province, Zhanjiang Port is not the largest port in Guangdong Province, but it is the largest natural deep-water port around the Beibu Gulf. 2014 Zhanjiang Port cargo throughput for the first time exceeded 20,000 million tons in 2018 Zhanjiang Port container throughput for the first time exceeded one million TEUs, Zhanjiang Port cargo transportation is more developed. 2021 Zhanjiang Port construction of 400,000 tons of waterway project, the waterway will be completed, and the port will be able to provide more efficient and professional port facilities. Upon completion, Zhanjiang Port will become the only world-class deep-water channel navigable for 400,000-ton ships in Guangdong Province and the port group around the Beibu Gulf, which will greatly enhance the navigational capacity and improve the international competitiveness of Zhanjiang Port.

#### **3.2. Competitive Situation Analysis of Ports in the Beibu Gulf Port Cluster**

This paper uses concentration to explore the competitive dynamics before and after the integration of the Beibu Gulf port cluster and the Beibu Gulf port. A large number of scholars have used the Herfindahl-Hirschman Index (HHI) to study the concentration of port usage in different regions<sup>[11,17]</sup>, the HHI index is a widely used composite index to measure the concentration of firms in an industry. This paper uses the HHI index to explore the competitive dynamics before and after the integration of the Beibu Gulf port cluster and the Beibu Gulf port. A higher HHI index indicates a higher degree of concentration and a higher degree of monopoly. The HHI index formula can be expressed as:

$$HHI = \sum_{i=1}^{i=n} \left( \frac{T_{it}}{\sum T_{it}} \right)^2 \quad (1)$$

$T_{it}$  in the HHI formula is expressed as the market size of company  $i$  in each year  $t$ , and  $T_{it}$  can be replaced by the throughput of port  $i$  in each year  $t$  in port development. For the general HHI index, the representative 50 companies are taken to calculate the HHI when the number of companies is greater than 50, and all companies are taken to calculate the HHI when the number of companies is less than 50. According to the market structure evaluation index published by the U.S. Department of Justice in 1984, the market structure based on the HHI value is categorized in Table 1.

Table 1: Classification of market structure based on HHI value when the number of companies is greater than 50

market structure	oligarchic		competitive
HHI	high oligarchic	low oligarchic	competitive
	$1 \geq HHI \geq 0.18$	$0.18 > HHI \geq 0.1$	$0.1 > HHI \geq 0$

Table 2: Calculation of HHI Market Classification for Sample 3

market structure	Original HHI Market Classification	computational process	HHI market classification for sample 3
high oligarchic	$HHI \geq 0.18$	maximum values:1 minimum value: $\{0.18/(1-0)\} * (1-0.33) + 0.33 = 0.45$	$1 \geq HHI \geq 0.45$
low oligarchic	$0.18 > HHI \geq 0.1$	maximum values:0.45 minimum value: $\{0.1/(1-0)\} * (1-0.33) + 0.33 = 0.4$	$0.45 > HHI \geq 0.4$
competitive	$0.1 > HHI \geq 0$	maximum values:0.4 minimum value:0.33	$0.4 > HHI \geq 0.33$

In this paper, there are only three ports of data for HHI calculation, according to the calculation method of HHI, the maximum value of HHI is 1 when the sample is 3, and the minimum value of HHI is 0.33 according to the sum-of-squares formula, then the traditional market structure classification table of HHI is not applicable, and this paper takes the number of companies larger than 50 as the benchmark of HHI value in the market structure classification of the HHI in the value domain of the percentage of the market structure. Percentage of the market structure of the sample of 3 to re-construct a classification table, the construction process is shown in Table 2, the results are shown in Table 3.

Table 3: Classification of market structure based on HHI values at sample 3

market structure	oligarchic		competitive
Sample is the HHI value for 3	high oligarchic	low oligarchic	competitive
	$1 \geq HHI \geq 0.45$	$0.45 > HHI \geq 0.4$	$0.4 > HHI \geq 0.33$

In order to facilitate the study of the concentration of Beibu Gulf port and Pan-Beibu Gulf port group, this paper will Fangchenggang port, Qinzhou port and Beihai port as a group of data to study the change of the concentration of the Beibu Gulf port before and after the integration of the Beibu Gulf port, and Beibu Gulf port, Haikou port and Zhanjiang port as a group of data to study the Pan-Beibu Gulf port group to carry out HHI calculations, respectively, and the results of the calculation are shown in Figure 1 and 2.

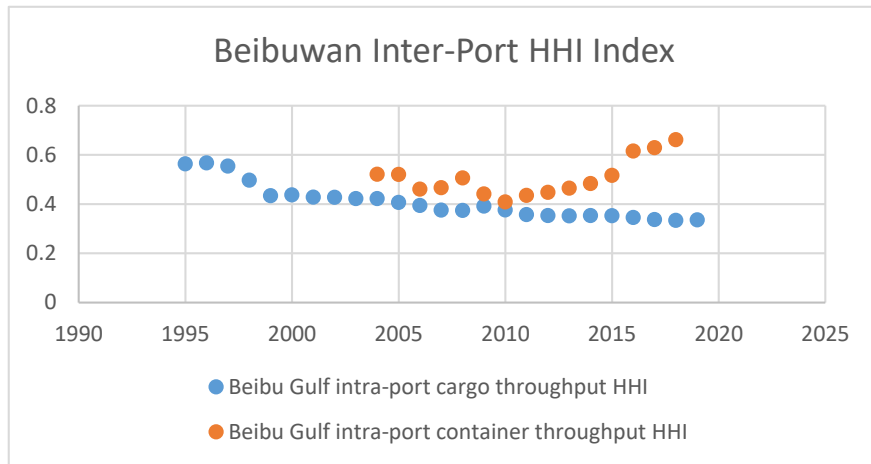


Figure 1: Cargo Throughput and Container Throughput of Beibu Gulf Port HHI

Through Figure 1, it is found that before the Beibu Gulf Port was proposed, the cargo transportation market structure and container transportation market structure of the three ports of Fangchenggang, Qinzhou Port and Beihai Port have been in the high oligopoly type, with relatively little competition, Fangchenggang Port is the leader of cargo transportation in the Beibu Gulf region, and Qinzhou Port is the leader of container transportation. And after the government proposed the construction of Beibu Gulf port, the HHI index has gradually declined, and has been gradually transformed from 2009-2010 cargo throughput market structure in high oligopoly type, to 2011-2015 cargo throughput market structure in low oligopoly type, and further transformed to 2016-2019 cargo throughput market structure in competition type. The change trajectory of container throughput HHI before the government proposed the construction of the Beibu Gulf port was consistent with the change of cargo throughput HHI, but after the government proposed the construction of the Beibu Gulf port, it diverged from the cargo throughput HHI, and the market structure of the cargo throughput within the Beibu Gulf port tended to be decentralized, while the container throughput within the Beibu Gulf port tended to be centralized. It is worth noting, however, that the shift of the market structure to a competitive one within the Beibu Gulf ports is not the result of intense competition among Fangchenggang, Qinzhou and Beihai ports, but rather the result of cooperation and division of labor among Fangchenggang, Qinzhou and Beihai ports under the guidance of the policy, and the tendency of the market structure to be highly oligopolistic within the Beibu Gulf ports is mainly due to the allocation of the major container business to Qinzhou port under the regulation of the policy, resulting in the concentration of container throughput in Qinzhou port, which leads to the high share of container throughput in Qinzhou Port.

Figure 2 shows that before the implementation of the Beibu Gulf port integration policy, during 1995-2002, each port was undergoing continuous improvement and development, and the ports built later were improved more through continuous infrastructure construction, and the gap between the ports was less and less, and the HHI index of cargo transportation in the Beibu Gulf port group showed a downward trend, from low oligopoly to competition; during 2003-2008, the structure of Beibu Gulf port tended to be high oligopoly, mainly because the main container business was allocated to Qinzhou port under the policy regulation, resulting in a high proportion of container throughput in Qinzhou port. During the period of 2003-2008, the rapid development of Beibu Gulf Port and Zhanjiang Port made these two ports dominant in the Pan-Beibu Gulf Port Group, which made the HHI index of cargo transportation in the Pan-Beibu Gulf Port Group fluctuate, but the overall trend remained stable, and the market structure has been in the competitive type. With the maturity of container technology, various ports began to introduce container technology, the first port to introduce container technology gained the first opportunity, and the ports that introduced

container technology later continued to catch up, so that the HHI index of container transportation in the Pan-Beibu Gulf port group in the time period showed a general downward trend, with local fluctuations, and the market structure has changed from the beginning of the low-oligopoly type to the competitive type.

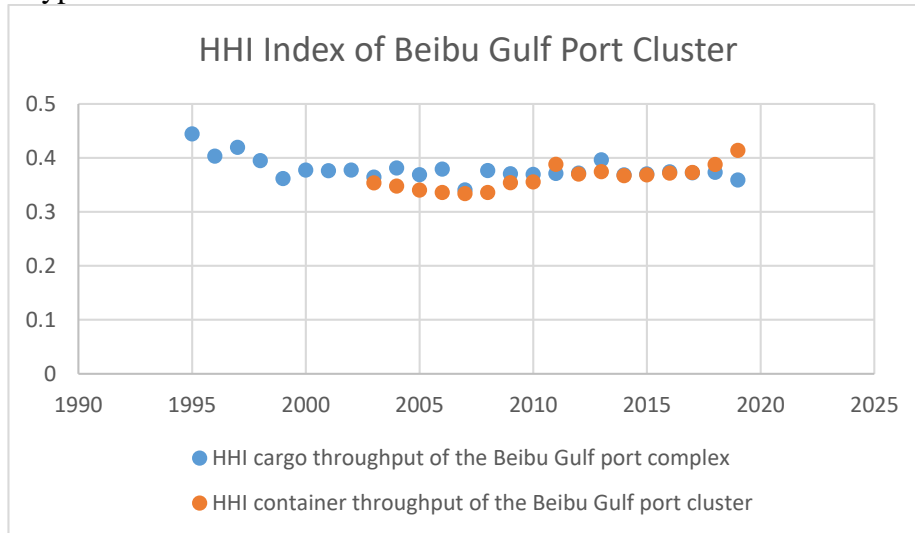


Figure 2: HHI index of the Beibu Gulf port cluster

After the implementation of the Beibu Gulf port consolidation policy, the development of ports during the period of 2009-2019 has converged towards a technical direction, and in terms of the mode of cargo transportation, the ports have been developing smoothly. The HHI index of cargo transportation in the Beibu Gulf port cluster started to stabilize and the market structure has been in the competitive type. During this period of time, port container technology is developing towards maturity, among which Beibu Gulf port vigorously develops container technology and improves port division of labor to enhance port efficiency by virtue of its own integration advantage, which makes the container level of Beibu Gulf port stand out and gradually dominate in the Pan-Beibu Gulf port group, and the HHI index of Pan-Beibu Gulf port group's container transportation has a tendency to increase in the period, and the market structure has gradually transformed from competitive to low-oligopoly type. The market structure gradually changed from competitive to low oligopoly.

One of the objectives of the Beibu Gulf port integration is to integrate resources and clarify the division of labor: to develop Qinzhou Port into a regional container trunk port. Therefore, theoretically, the container HHI index of Beibu Gulf should increase after the integration. From the above HHI index analysis results can be found, among them, Figure 1 Beibu Gulf port internal HHI index in 2009 around the time of the obvious changes in the container throughput HHI index from the state of decline to the state of rising, the theory and the results are consistent with the results can be proved that the port integration can indeed have an impact on the internal development of the port. Another purpose of Beibu Gulf port integration is to enhance the competitiveness of Beibu Gulf ports, but the above analysis does not fully validate this purpose, so this paper constructs a double difference model (DID) to analyze whether the port integration policy of Beibu Gulf ports under the government's intervention can enhance the comprehensive strength of Beibu Gulf ports.

## 4. Methods and data

### 4.1. Model

In this paper, double difference model (DID) is selected to explore the net effect of port integration policy under government intervention. In this regard, in order to examine the impact of Beibu Gulf port integration policy on the cargo throughput of Beibu Gulf port, this paper constructs a specific model set as follows:

$$Y_{ct} = \beta_0 + \beta_1 \text{post}_t \times \text{treat}_c + \beta_2 X_{ct} + \gamma_c + \theta_t + \mu_{ct}$$

Where:  $Y_{ct}$  is the core explanatory variable, denoting the level of cargo throughput at port  $c$  at time  $t$ ;  $\text{post}_t \times \text{treat}_c$  is the core explanatory variable;  $\text{post}_t$  is a time dummy variable;  $\text{treat}_c$  is a grouping dummy variable; the coefficient  $\beta_1$  measures the net effect of the Beibuwan Port port consolidation policy affecting the port throughput;  $X_{ct}$  is the control variable;  $\gamma_c$  and  $\theta_t$  denote the individual and time fixed effects, respectively;  $\mu_{ct}$  is the random disturbance term.

### 4.2. Subjects and data

The data on the number of industrial enterprises, volume of waterborne cargo, GDP per capita and average wages of employees in Guangdong Province, Guangxi Autonomous Region and Hainan Province from 2003-2019 covered in this paper are mainly from Guangxi Statistical Yearbook, Guangdong Statistical Yearbook and Hainan Statistical Yearbook.

Among them, the data on the number of industrial enterprises, water cargo volume, GDP per capita and average salary of employees are all from the city where the port is located. Since Beibu Gulf Port involves three cities, Qinzhou City, Beihai City and Fangchenggang City, this paper averages the total data on the number of industrial enterprises, the volume of waterborne cargo, GDP per capita and the average salary of employees in Qinzhou City, Beihai City and Fangchenggang City. In addition, this paper in the empirical analysis, for the Beibu Gulf port container throughput and cargo throughput data needed before 2009, by the Fangchenggang port, Qinzhou port and the North Sea port container throughput and cargo throughput totaled; in the DID analysis, this paper, the experimental group for the Beibu Gulf port, selected around the Beibu Gulf port cluster of the port of Zhanjiang and Haiphong port as a control group.

### 4.3. Description of variables

#### 4.3.1. Explanatory Variable

Cargo throughput is usually used as an indicator to reflect the operation and comprehensive capacity of the port, so the cargo throughput ( $Y$ ) of the port is selected in this paper to measure the impact of the port consolidation of Beibuwan Port on the port development of Beibuwan Port.

#### 4.3.2. Core explanatory variables

$\text{Post}_t$  denotes the time dummy variable after the port integration of Beibu Gulf port is proposed, according to the Ministry of Transportation in 2009 issued the "Announcement on Enabling the Name of Guangxi Beibu Gulf Port" ①, this paper selected 2009 as the policy year of Guangxi Beibu Gulf Port Integration, so 2003-2008 is the window period before the implementation of the policy  $\text{post}_t$  takes the value of 0, and 2009-2019 after the implementation of the policy window period  $\text{post}_t$  takes the value of 1;  $\text{treat}_c$  is a grouping dummy variable to determine whether the Beibu Gulf port consolidation policy occurs in port  $c$ . If port  $c$  has occurred the Beibu Gulf port



consolidation policy in the sample period, it is defined as the treatment group with  $treat_c=1$ , and conversely, if the Beibu Gulf port consolidation policy did not occur in the sample period, it is defined as the control group with  $treat_c=0$ . If  $post_t \times treat_c=1$ , it means that port  $c$  is the port where the Beibu Gulf port consolidation policy occurred in period  $t$ .

### 4.3.3. Control variable

Not only the Beibu Gulf port integration will have an impact on the Beibu Gulf port, but also other variables will have an impact on the port. Comprehensive existing studies can find that there is a certain connection between port hinterland and port. Therefore, this paper selects the following control variables:

1) The number of industrial enterprises (NIE). The number of industrial enterprises can measure the level of industrial development of a city, the port's cargo volume will be affected by the source of goods, the more the number of industrial enterprises in the city of the source of goods is relatively more. Therefore, this paper selects the number of urban industrial enterprises as a control variable to avoid the interference of its port cargo throughput.

2) Water cargo volume (WCV). The volume of waterborne cargo is the total amount of goods actually transported by urban transportation vessels, including departure volume, arrival volume and transit volume. Water cargo volume can describe the size of a city's cargo transportation capacity. Therefore, this paper takes waterborne cargo volume as a control variable to avoid its interference with port cargo throughput.

3) GDP per capita (GDPC). GDP per capita can represent the level of economic development of a region, and the level of economic development will affect the construction of regional ports. Therefore, this paper takes GDP per capita as a control variable to avoid its interference with port cargo throughput.

4) Average employee salary (AEA). The average salary of employees represents the income level of residents, and a higher income level has a stronger purchasing power, which in turn affects the transportation of goods to a certain extent. Therefore, this paper takes the average salary of employees as a control variable to avoid its interference on the port cargo throughput.

## 5. Analysis of did results of port consolidation policy in Beibu Gulf port

### 5.1. Return to baseline

As can be seen from the results of the benchmark regression of the Beibuwan port port integration policy affecting port cargo throughput (Table 4), after adding the control variables, the coefficient of  $post_t \times treat_c$  and port cargo throughput is 4069.739, which passes the significance level of 5%, indicating that the Beibuwan port integration policy has a significant positive impact on the cargo throughput of the Beibuwan Port, specifically, other conditions remain unchanged in the Specifically, compared to the control group, the average increase in port cargo throughput of Beibu Gulf port after the Beibu Gulf port integration policy was proposed was 4069.739 tons.

Table 4: Benchmark regression results on the impact of port consolidation policy on port cargo throughput in Beibu Gulf port

variable name	Throughput of cargo	
post×treat	4713.439 (0.96)	4069.739 ** (4.94)
NIE		19.571*** (11.48)
WCV		0.357 (0.47)
GDPC		-0.293** (-6.41)
AEA		-0.341 (-2.23)
cons	-2116.709 (-0.57)	6768.63** (6.06)
PORT FE	YES	YES
YEAR FE	YES	YES
N	51	51
R2	0.9184	0.9789

Note: (1) \*\*\* indicates significant at the 1% level, \*\* indicates significant at the 5% level, and \* indicates significant at the 10% level; (2) t-statistics in parentheses

## 5.2. Parallel trend test

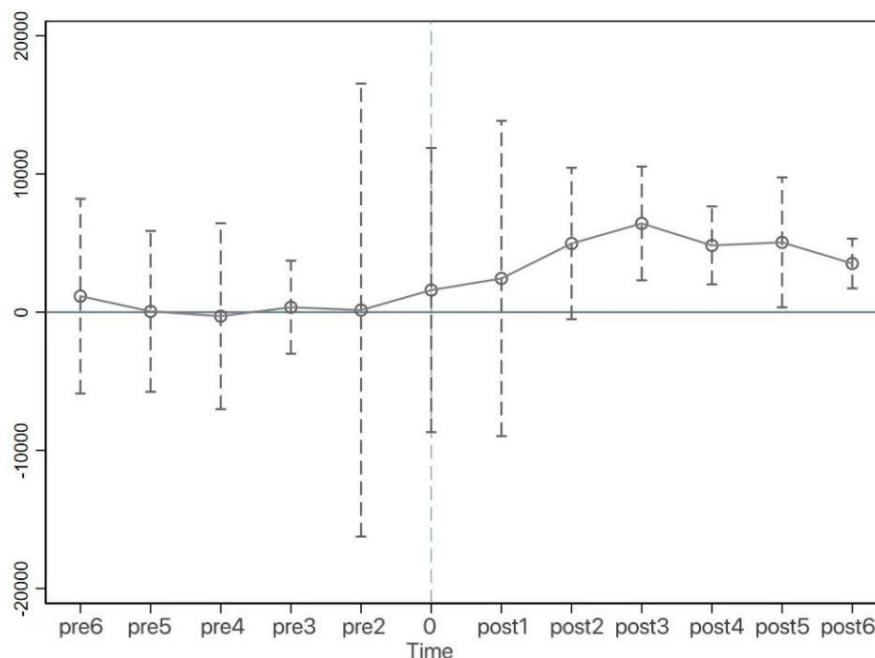


Figure 3: Parallel trend test of port throughput in Beibu Gulf port

In order to ensure the identifiability of the regression results, this paper selects the data of five years before and five years after the implementation of the Beibu Gulf port port integration policy for the parallel trend test (Figure 3). From Figure 3, it can be found that the coefficient estimates of

the periods before the implementation of the Beibu Gulf port port integration policy do not show obvious trend changes, and none of them are statistically significant. The port consolidation policy of Beibu Gulf port started to have a significant promotion effect on the port throughput of Beibu Gulf port 1 year after the implementation of the policy. At the same time, the coefficient estimates of the periods after 1 year of the implementation of the Beibu Gulf port integration policy are significantly positive, but from the coefficient point of view, this positive effect increases first and then decreases. Overall the Beibu Gulf port port integration policy has a significant promotion effect on the Beibu Gulf port, but there is a certain lag in this impact effect.

### 5.3. Robustness check

#### 5.3.1. Placebo testing

This paper validates the robustness of the port integration policy DID estimation method using a placebo test by constructing a dummy legislation time. In this paper, we set the dummy variables for spurious policy time two years prior to policy implementation and three years prior to policy implementation, in that order, and then form an interaction term with the dummy variables to introduce the baseline regression model (Table 5). Through Table 5, it can be found that the regression coefficients of the  $f_{post} \times treat$  term of the dummy variable of spurious policy time two years and three years before the policy implementation are insignificant, regardless of whether control variables are added or not. This result indicates that the port integration policy of Beibuwan Port can cause the cargo throughput of Beibuwan Port, and it also indicates that the results of the previous study are not interfered by other policies or factors, and that the regression results of the previous paper have good robustness.

Table 5: Placebo test for the effect of port consolidation policy on port cargo throughput in Beibu Gulf port

variable name	2 years prior to policy implementation		3 years prior to policy implementation	
post $\times$ treat	3639.577 (0.81)	2358.4 (1.69)	3399.238 (0.78)	1890.092 (1.21)
NIE		22.279** (5.99)		22.92** (5.68)
WCV		0.315 (0.37)		0.308 (0.47)
GDPC		-0.24 (-2.53)		-0.223 (-2.10)
AEA		-0.399 (-2.88)		-0.413 (-2.81)
cons	-2205.598(-0.59)	6578.149* (3.27)	-2200.209(-0.57)	6446.169 (2.60)
PORT FE	YES	YES	YES	YES
YEAR FE	YES	YES	YES	YES
N	51	51	51	51
R2	0.9091	0.9749	0.9067	0.9740

Note: (1) \*\*\* indicates significant at the 1% level, \*\* indicates significant at the 5% level, and \* indicates significant at the 10% level; (2) t-statistics in parentheses

### 5.3.2. Adjustment of sample intervals

The sample interval of this paper is 2003-2019, the Beibuwan port port integration policy occurred in 2009, given the policy occurred after the selection of a longer period of time, this part of the exclusion of 2016-2019 data, making the retention of 2003-2015 data, the data range in the policy before the implementation of the before and after the six years within the baseline regression estimation of the retention of the data, the results are shown in Table 6. After adjusting the sample interval, after adding the control variables, the coefficient of  $\text{post} \times \text{treat}$  and port cargo throughput is 3293.081, which passes the 5% significance level, and the size of the regression coefficient is adjusted compared with the baseline results but the regression coefficient is still significantly positive, which once again proves the robustness of the baseline regression.

Table 6: Results of adjusted sample intervals for the impact of port consolidation policy on port cargo throughput in Beibu Gulf port

variable name	Throughput of cargo	
post×treat	4808.381 (1.21)	3293.081 ** (4.68)
NIE		11.535 (2.53)
WCV		-0.015 (-0.05)
GDPC		-0.353* (-3.93)
AEA		-0.593** (-4.44)
cons	-1147.675 (-0.43)	14312.09** (4.73)
PORT FE	YES	YES
YEAR FE	YES	YES
N	39	39
R2	0.9227	0.9850

Note: (1) \*\*\* indicates significant at the 1% level, \*\* indicates significant at the 5% level, and \* indicates significant at the 10% level; (2) t-statistics in parentheses

## 6. Conclusion

This paper argues that the vicious and disorderly competition of ports in the region will lead to unnecessary duplication of labor, port overcapacity and waste of scarce port resources, in China with the continuous decentralization of port authority, the local government began to embark on the development of ports to make plans, so different forms of port integration slowly into the public's field of vision and began to become popular, which is the background of the emergence of port integration.

From the analysis of the above results, this paper argues that port integration can indeed bring positive impacts on port development and the economic development of the city where it is located, so this paper suggests that the governments of all parties can intervene appropriately in the ports of excessive competition or ports with serious deformities in the development of the port group, and set up different forms of port integration or ordinance cooperation through the examination and research of multiple ports to ensure the sound and orderly development of the port, which is the background for the emergence of port integration. This is extremely important for the development of the port itself and the development of the city.

The perspective explored in this paper is mainly on the impact of two waves of port integration on the economic development of ports and their locations, even though the nature of the differences in the analysis is done, it is not difficult to find the shortcomings of this paper. For example: 1) This paper fails to explain in detail how port integration affects the economic development of cities, and subsequent studies will continue to research in this area. 2) This paper fails to explain in detail what kind of role local governments play in port integration and what kind of assistance or funding they provide, and their economic growth in port integration trials. The findings of this paper can provide some support for port and city development, and can contribute to the improvement of the Theoretical level of port integration to contribute to the research.

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