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Study on Integration Effect of Ningbo Zhoushan Port

-- Based on the Counterfactual Analysis under Panel Data

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Abstract

This paper uses the counterfactual analysis method to evaluate the integration effects of Ningbo Zhoushan Port, based on the monthly data of 14 scaled ports' cargo throughput in China. The result shows that the integration of Ningbo Zhoushan Port has a significant positive effect on the cargo throughput. The average cargo throughput can be increased by about 8.44% per month.

Keywords

Ningbo Zhoushan Port, port integration, counterfactual analysis, policy evaluation.

1. Introduction

On September 29, 2015, the establishment of Ningbo Zhoushan Port Group marked that Ningbo Zhoushan Port has become the first port in China which completed the integration. In recent years, the Ministry of Transport of the People's Republic of China has also been encouraging the integrated development of China's ports. In August 2017, the Ministry of Transport of the People's Republic of China issued a notice on promoting the reform of regional port integration by learning from the experience of Zhejiang Province. What is the effect of the integration of Ningbo Zhoushan Port and how long will the promoting effect last?

In this paper, we use the monthly cargo throughput as a quantitative index to study the above problems. Figure 1 shows that the monthly cargo throughput (after logarithmic processing) of Ningbo Zhoushan Port from January 2015 to August 2017. It can be seen from the figure 1 that the monthly cargo throughput of Ningbo Zhoushan Port showed an upward trend after September 2015, but it dropped significantly in some stages. Does it mean that the integration effects of Ningbo Zhoushan Port is not stable and significant? The problem is that we can't see counterfactual results directly in the Figure 1.

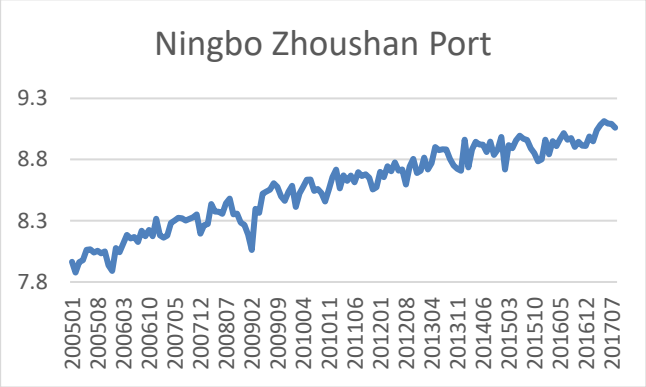

Figure 1. monthly cargo throughput of Ningbo Zhoushan Port (after logarithmic processing)

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This paper uses the counterfactual analysis method to study the effects brought by the integration of Ningbo Zhoushan Port. In this paper, the change of monthly cargo throughput represents this effect. According to the research data, during the 23 months from October 2015 to August 2017, the average monthly cargo throughput of the Ningbo Zhoushan Port which completed integration increased about 8.44%, and maintained a long-term growth trend. The data explains the spurious growth of monthly cargo throughput in Figure 1. Through the port integration, ports in the region can make full use of existing resources and exploit the advantages to achieve the better development of ports. In the context of large-scale port integration in China, the evaluation of the integration effect of Ningbo Zhoushan Port has a realistic and guiding significance for regional ports integration which are undergoing now.

2. Literature Review

2.1. Literature about Micro-econometric Methods

In recent years, many economists have adopted the method of constructing counterfactuals to evaluate the effect of policies. There are some typical method, such as difference in difference (hereafter DID) method, propensity score matching-difference in difference (hereafter PSM-DID) method, the synthetic control method and the Hsiao panel data policy effect evaluation method (hereafter Hsiao method).

Hsiao et al.[1] proposed a panel data policy assessment method, in which the counterfactual value was obtained through the correlation between the cross-sectional units, and the difference between the real value and the "counterfactual" value represented the policy effect. He used this method to study the impact of Hong Kong's economy after it returned. Ouyang and Peng[2] extended the Hsiao method to evaluate the effect of the four trillion yuan fiscal stimulus plan using a semi-parametric method. Liu[3] improved the Hsiao method, relaxed the assumptions and proposed a new estimation method. She used the method to estimate both the economic growth effect of the free trade zone policy on Shanghai and the spillover effect on other provinces. In addition, she replaced the single equation prediction of the Hsiao method with the model average method, taking the average of the prediction results of multiple models as the counterfactual value. She proved that the dispersion degree of the estimate obtained by this method was significantly smaller than Hsiao method.

2.2. Literature about Port Integration

China first proposed the integration of ports in 1996, but it was not until 2015 that the real integration of Ningbo Port and Zhoushan Port began, and then the trend of integration gradually emerged in China. As for how to understand port integration, Chen[4] believes that port integration refers to the adjustment of management structure and reconfiguration of resources between adjacent ports to achieve a win-win situation. Wang[5] believes that port integration is a kind of trans-regional strategic cooperation by combination or merger in order to avoid the disordered competition caused by ports with duplicate hinterlands. Yang[6] analyzed four typical integration modes of China's port resources. He believed that "government-driven + market-determined" mode is the most suitable mode for China's port integration. Port integration is not only the development trend of Chinese ports, but also the development trend of world ports. Through the port integration, not only can effectively avoid the internal vicious competition, but also can make full use of existing resources to resist the external competition of neighboring ports. Wang and Zhu[7] believed that the layout of large port groups had been preliminarily formed in China's coastal areas, which could improve the overall economic benefits. They also cited the container throughput and cargo throughput of ports in China in 2017 as the evidence of the effects of port integration.

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2.3. Literature about the Integration of Ningbo Zhoushan Port

In August 2015, the formal establishment of Ningbo Zhoushan Port Group marked the preliminary completion of the integration of Ningbo Zhoushan Port. The successful integration of Ningbo Zhoushan Port has become the leader of China's port integration, which plays an important guiding role in China's large-scale port integration. Many domestic scholars began to study the integration of Ningbo Zhoushan Port in various aspects when the thought was first proposed. Li[8] made a detailed analysis on the integration of resources of Ningbo Zhoushan Port through SWOT analysis, and believed that the integration of port resources could consolidate the status of the world's largest port. Song[9] believes that Ningbo Zhoushan Port can maintain an annual growth rate of nearly 10% under the background of slow throughput growth of other ports, which is attributed to the effect brought by port integration. The demonstration effect of Ningbo Zhoushan port promoted the integration of ports in the country and became a successful example.

3. The Model

Suppose the evaluation variable of policy effect is y, which in this paper is the port cargo throughput. At time t, the cargo throughput of the port i is y_{it}. Let y_{it}^1 represents the cargo throughput of the port i which carries out the integration at time t. Let y_{it}^0 represents the cargo throughput of the port i which does not integrate at time t. Since y_{it}^1 and y_{it}^0 cannot be observed simultaneously in the same region, we use the dummy variable d_{it}. $d_{it} = 1$ means that the port i is integrated at time t, and $d_{it} = 0$ means that the port i is not integrated at time t. The established model is shown below:

$$y_{it} = d_{it}y_{it}^1 + (1 - d_{it})y_{it}^0$$

Let the N*1 vector form of y_{it} be $y_t = (y_{1t}, \dots, y_{nt})'$, where N is the number of ports.
Assuming that the first port is not integrated before time T_1, then

$$y_{1t} = y_{1t}^0, t = 1, \dots, T_1$$

Assuming that the first port completes the integration at time $T_1 + 1$, then

$$y_{1t} = y_{1t}^1, t = T_1 + 1, \dots, T$$

The other $N - 1$ regions have not done the integration, then

$$d_{it} = 0 \text{ and } y_{it} = y_{it}^0, i = 2, \dots, N, t = 1, \dots, T_1$$

If in the time period from time $T_1 + 1$ to T, y_{1t}^1 and y_{1t}^0 can be observed simultaneously, then the policy effect Δ_{1t} is:

$$\Delta_{1t} = y_{1t}^1 - y_{1t}^0, t = T_1 + 1, \dots, T$$

In fact, after time $T_1 + 1$, the value of cargo throughput y_{1t}^0 cannot be observed, which leads to the problem of not getting Δ_{1t}. Therefore, we will build the counterfactual value y_{1t}^0 ($\overline{y_{1t}^0}$) in the time period from time $T_1 + 1$ to T to solve this problem. By using the Hsiao method, the cargo

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throughput of other ports and Ningbo Zhoushan Port are affected by the common factor, so we can choose other ports as units of control group to predict y_{1t}^0. The estimated value of y_{1t}^0 is $\overline{y_{1t}^0} = \bar{a} + \bar{b} * \overrightarrow{y_t^0}$. $\bar{a}$ and $\bar{b}$ are coefficient estimate or vector, the policy effect $\overline{\Delta_{1t}}$ can be obtained:

$$\overline{\Delta_{1t}} = y_{1t}^1 - \overline{y_{1t}^0}, t = T_1 + 1, \dots, T$$

Hsiao[1] proved that this value was the consistent estimation of the real processing effect, and the error of this value was small. The result was better than the common factor method of Bai and Ng [10] for small samples.

4. The Integration Effects of Ningbo-Zhoushan Port

4.1. The Data Selection

The data were collected from January 2005 to August 2017. On September 29, 2015, the opening ceremony of Ningbo Zhoushan Port Group was held in Ningbo. Ningbo Zhoushan Port group was controlled by Ningbo State-owned Assets Supervision and Administration Commission of the State Council (hereafter SASAC) by 94.47% and Zhoushan SASAC by 5.53%, which represented the completion of port integration between Ningbo Port and Zhoushan Port. Therefore, We classify the period from January 2005 to September 2015 as the pre-policy period. Because of some monthly data are missing when collecting data, we collect T_1=126 monthly data here. The Ministry of Transport of the People's Republic of China released the notice which encouraging to learn from the experience of Zhejiang Province to promote the reform of regional port integration on August 22, 2017. This notice becomes an important symbol of port integration in the whole country. After that, many local governments begin to explore a path which suited to their actual situation. It is inevasible that in this period, progress varies from place to place. Therefore, we choose the data from October 2015 to August 2017 as the period after policy, and there are T_2 =23 monthly data. $T_1 > T_2$ conforms to the requirements of the counterfactual analysis method for the sample time span.

4.2. The Control Group Selection

Since the speed of development and scale of ports are different, this paper selects the monthly cargo throughput data of 14 ports above the scale counted by Ministry of Transport of the People's Republic of China from 2005 to 2017. The 14 ports are shown below: Dalian Port, Qinhuangdao Port, Tianjin Port, Yantai Port, Qingdao Port, Rizhao Port, Shanghai Port, Lianyungang Port, Fuzhou Port, Quanzhou Port, Xiamen Port, Shenzhen Port, Guangzhou Port and Zhanjiang Port. Due to the lack of cargo throughput data in December of the monthly data collected by the Ministry of Transport of the People's Republic of China, this paper obtained cargo throughput data of each port in December by referring to the annual data of <China port Yearbook> and subtracting the cumulative cargo throughput of November from the total cargo throughput of each year. In order to avoid the generation of heteroscedasticity in the process of regression, we process the sample data by taking the logarithm in this paper. Table 1 is a descriptive statistic of the selected data, all of the data are reserved to 3 decimal places.

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Table 1. Descriptive statistic of the selected data

Port	Min	Max	Mean	Std. Dev.
Ningbo-Zhoushan port	7.877	8.994	8.504	0.298
Dalian port	7.000	8.261	7.789	0.321
Qinhuangdao port	7.178	8.005	7.628	0.176
Tianjin port	7.415	8.493	8.072	0.284
Yantai port	5.617	7.760	6.994	0.554
Qingdao port	7.313	8.378	7.913	0.296
Rizhao port	6.399	7.994	7.380	0.461
Shanghai port	6.290	8.745	8.418	0.261
Lianyungang port	6.052	7.467	6.900	0.408
Fuzhou port	5.938	7.161	6.594	0.327
Quanzhou port	5.298	6.913	6.469	0.348
Xiamen port	5.805	7.524	6.888	0.470
Shenzhen port	6.805	7.689	7.431	0.176
Guangzhou port	7.131	8.363	8.044	0.235
Zhanjiang port	5.659	7.719	6.765	0.565

The data source:Ministry of Transport of the People's Republic of China, China Port Yearbook.

4.3. The Method Statement

The Hsiao method selects the counterfactual prediction model based on the optimal value of AIC criterion or $\overline{R^2}$, while Liu proposes a new control group unit selection strategy based on the Hsiao method -- model average method. This method can not only make full use of the known sample information, but also average the models with high fitting degree according to the same weight, and the result is better than the single model with the highest fitting degree proposed by Hsiao. The specific steps of the method are as follows:

First, we choose the number of units m in the control group to predict the counterfactual value. In this paper $m = 1,2, \dots ,14$.

Secondly, all the control group combinations were fitted and predicted to obtain all of the predictive equations. We choose $\overline{R^2}$ as the measurement standard and choose the predictive equations which have higher $\overline{R^2}$. (In this paper , $\overline{R^2} > 0.9$ considered as high fitting degree). The estimated value is obtained by using the fitted prediction equation, and the corresponding M counterfactual values are obtained. By averaging the M counterfactual values, a more accurate prediction of the counterfactual values can be obtained. In this step, because of the large sample size, it will take a lot of time to obtain all the predictive equations. Therefore, Liu[3] proposed a simplified method: randomly extract a certain number of equations that meet the requirements from C_{N-1}^{m} prediction equations to estimate. As long as the randomness of the extraction can be guaranteed, the average of the counterfactual value we obtain here can satisfy the previous conclusion.

Finally, we select different numbers of units in each control groups, and repeat the above steps to predict the "counterfactual" value.

4.4. Empirical Results and Analysis

Using the counterfactual analysis method and the new control group unit selection strategy proposed by Liu[3], the number of units in the control group was randomly selected in this paper (m=5,6,8,10,12), and a well-fitting predictive equation was selected from each group for estimation. These predictive equations are estimated by the time before the completion of port

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integration (the valid data from January 2005 to September 2015 are selected). The weight of better control group in each control group with different number of units is shown in Table 2 and Table 3:

Table 2. The weight of better control group(m=5,6,8)

Control group	m=5			m=6			m=8		
	Coef.	Std. Err.	t	Coef.	Std. Err.	t	Coef.	Std. Err.	t
Dalian port	0.244	0.076	3.22	0.275	0.079	3.46	0.212	0.079	2.68
Qinhuangdao port	/	/	/	/	/	/	/	/	/
Tianjin port	0.313	0.065	4.80	0.337	0.065	5.16	0.325	0.065	4.99
Yantai port	0.149	0.043	3.43	0.158	0.046	3.41	0.147	0.045	3.27
Qingdao port	/	/	/	0.084	0.091	0.92	0.080	0.107	0.75
Rizhao port	/	/	/	/	/	/	/	/	/
Shanghai port	/	/	/	/	/	/	/	/	/
Lianyungang port	0.067	0.065	1.03	/	/	/	-0.026	0.079	-0.33
Fuzhou port	0.091	0.026	3.48	0.097	0.026	3.78	0.090	0.025	3.54
Quanzhou port	/	/	/	-0.061	0.052	-1.17	-0.087	0.051	-1.71
Xiamen port	/	/	/	/	/	/	/	/	/
Shenzhen port	/	/	/	/	/	/	/	/	/
Guangzhou port	/	/	/	/	/	/	/	/	/
Zhanjiang port	/	/	/	/	/	/	0.096	0.028	3.47
Cons	1.976	0.327	6.04	1.627	0.368	4.42	2.066	0.449	4.60
$\overline{R^2}$	0.9564			0.9564			0.9599		

Table 3. The weight of better control group (m=10,12)

Control group	m=10			m=12		
	Coef.	Std. Err.	t	Coef.	Std. Err.	t
Dalian port	0.210	0.080	2.61	0.241	0.084	2.86
Qinhuangdao port	0.052	0.063	0.82	0.094	0.069	1.36
Tianjin port	0.303	0.068	4.44	0.303	0.072	4.21
Yantai port	0.132	0.048	2.78	0.103	0.051	2.01
Qingdao port	/	/	/	0.053	0.118	0.45
Rizhao port	-0.018	0.069	-0.25	0.059	0.073	0.80
Shanghai port	/	/	/	/	/	/
Lianyungang port	0.025	0.079	0.32	-0.031	0.095	-0.32
Fuzhou port	0.090	0.030	3.00	0.111	0.032	3.50
Quanzhou port	-0.088	0.052	-1.70	-0.052	0.056	-0.93
Xiamen port	0.055	0.063	0.88	0.100	0.066	1.51
Shenzhen port	/	/	/	0.041	0.065	0.63
Guangzhou port	/	/	/	-0.119	0.069	-1.73
Zhanjiang port	0.083	0.030	2.73	/	/	/
Cons	2.085	0.569	3.66	1.674	0.714	2.34
$\overline{R^2}$	0.9598			0.9576		

The $\overline{R^2}$ of five better control groups randomly selected in this paper are 0.9564,0.9564,0.9599, 0.9598 and 0.9576. The fitting conditions are good, so it can be used to predict monthly cargo

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throughput data of Ningbo Zhoushan Port. Through the prediction equation obtained by the five control groups, we can obtain the predicted cargo throughput of Ningbo Zhoushan Port for each group from October 2015 to August 2017. Then we average predicted values from five groups, and this value is what we choose in this paper.

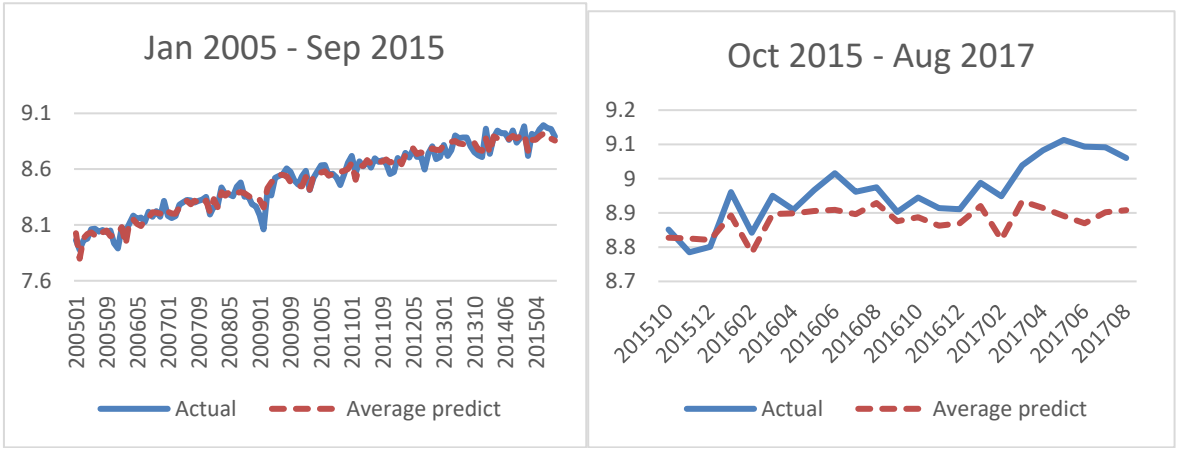

Figure 2. Comparison between real and predicted cargo throughput of Ningbo Zhoushan Port before the integration(left)

Figure 3. Comparison between real and predicted cargo throughput of Ningbo Zhoushan Port after the integration(right)

Figure 2 describes the actual cargo throughput of Ningbo Zhoushan Port before the integration fits well with the predicted value, and the trend is consistent at the inflection point. Therefore, we believe that the prediction equation obtained by the above method can accurately predict the counterfactual value of cargo throughput of Ningbo Zhoushan Port after the integration. Figure 3 describes the real and predicted cargo throughput of Ningbo Zhoushan Port after the integration. It can be found that the average predicted value (dotted line) after October 2015 is basically below the real value (solid line). This trend indicates that the monthly cargo throughput of Ningbo Zhoushan Port after the integration is better than the predicted monthly cargo throughput assuming that there is no integration. In addition, we can also find that since February 2017, the gap between the real value and the average predicted value has become more obvious, which shows that port integration has a long-term positive pull effect on monthly cargo throughput of Ningbo Zhoushan Port and the effect is more and more significant. Specific policy effects are shown in Table 4 and Figure 4 below:

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Table 4. The integration effect of Ningbo Zhoushan Port

Point-in-time	Actual value	Counterfactual value	The effect
201510	8.851	8.827	0.024
201511	8.785	8.825	-0.040
201512	8.801	8.821	-0.020
201601	8.961	8.892	0.069
201602	8.842	8.784	0.058
201603	8.950	8.896	0.053
201604	8.909	8.899	0.011
201605	8.966	8.905	0.061
201606	9.016	8.909	0.107
201607	8.962	8.896	0.065
201608	8.975	8.929	0.046
201609	8.903	8.876	0.027
201610	8.945	8.887	0.057
201611	8.914	8.863	0.051
201612	8.911	8.869	0.041
201701	8.988	8.920	0.068
201702	8.948	8.822	0.127
201703	9.039	8.934	0.104
201704	9.082	8.914	0.168
201705	9.113	8.891	0.222
201706	9.093	8.870	0.224
201707	9.091	8.902	0.190
201708	9.060	8.908	0.152
Mean			0.081

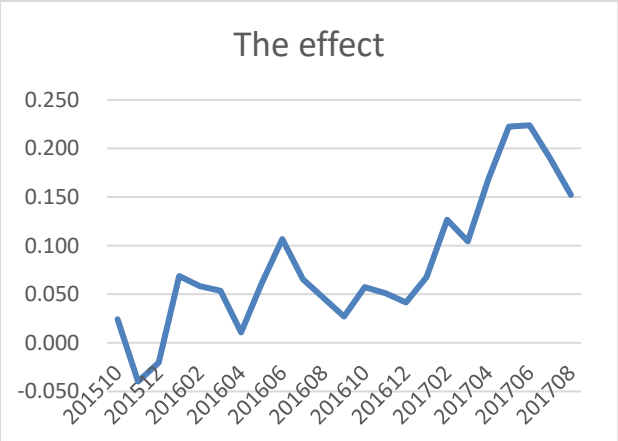

Figure 4. The integration effect of Ningbo Zhoushan Port

It can be seen from Table 5 and Figure 4 that in the initial stage of port integration of Ningbo Zhoushan Port, the effect is not significant, and even negative policy effect appears in some months. However, according to the overall situation from October 2015 to August 2017, after the integration of Ningbo Zhoushan Port, its cargo throughput growth shows an upward trend. The data show that: in the 23 months from October 2015 to August 2017, the integration has a significant positive effect on the cargo throughput of Ningbo Zhoushan Port, with an average increase about$(e^{0.081} - 1) * 100\% = 8.44\%$. The empirical study shows that the integration of

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Ningbo Zhoushan Port can make full and effective use of existing resources and has a significant pull effect on cargo throughput.

4.5. Robustness Test

The robustness of the counterfactual analysis method is restricted by the exogenous hypothesis, but it is impossible for Ningbo Zhoushan Port to carry out port integration policy without any impact on other ports. Therefore, it would be better to choose ports that are less affected by the policy as far as possible. Finally, we choose the ports which have the same monthly cargo throughput rank as Ningbo Zhoushan Port to be the units of the control group for prediction. For this reason, ports near Zhejiang Province are excluded, such as ports in Fujian Province, Shanghai and Jiangsu Province. In addition, the ports which monthly cargo throughput less than 10 million tons are also excluded. At this time, ports in the control group are: Dalian Port, Qinhuangdao Port, Tianjin Port, Qingdao Port, Rizhao Port, Shenzhen Port and Guangzhou Port. Taking these ports as the units of the new control group, we can obtain the new counterfactual value of Ningbo Zhoushan Port, and the new $\overline{R^2} = 0.9502$. We can indicate that this prediction equation estimated by the new control group which exclude some ports can also fit well. Figure 5 and Figure 6 shows the real and predicted cargo throughput of Ningbo Zhoushan Port under the new control group. After excluding some ports that may be greatly affected, the port integration effect of Ningbo Zhoushan Port is significantly positive. Therefore, we consider that the significant positive policy effect obtained above is robust.

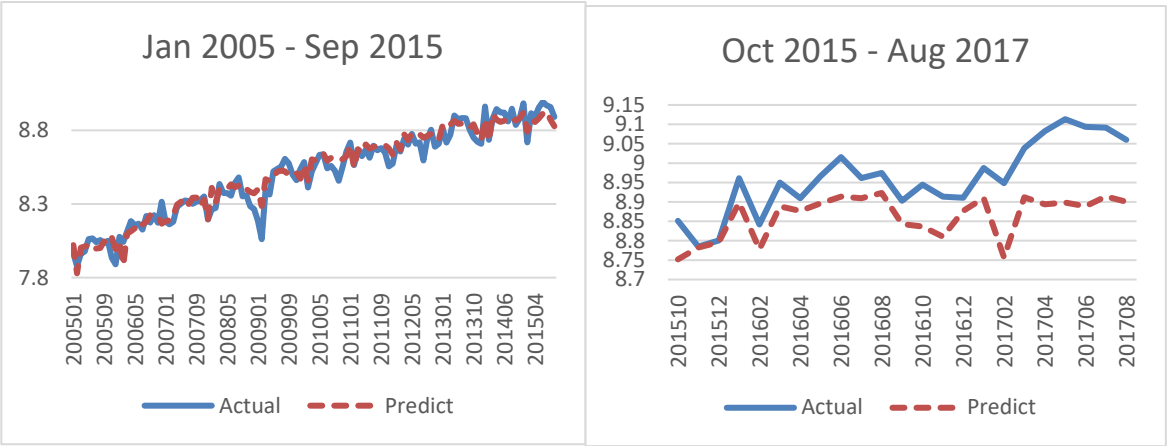

Figure 5. comparison of real and predicted cargo throughput of Ningbo-Zhoushan Port before the integration (under new control group)(left)

Figure 6. comparison of real and predicted cargo throughput of Ningbo-Zhoushan Port after the integration (under new control group)(right)

5. Conclusions and Discussion

In this paper, we use a policy evaluation method based on panel data proposed by Hsiao to study the integration effects of Ningbo Zhoushan Port. By using the model average method proposed by Liu, five control groups with different number of units are selected to predict the counterfactual value of monthly cargo throughput of Ningbo Zhoushan Port from October 2015 to August 2017, so as to evaluate the effect brought by the integration. The result shows that the average monthly cargo throughput of Ningbo Zhoushan Port can be increased by about 8.84% by carrying out integration, which results in the effect of "1+1>2". The empirical results of this paper draw the following two conclusions:

The first one is that the results we gain from this paper affirm the effect of port integration of Ningbo Zhoushan Port. First of all, Ningbo Port does not have enough deep water coastline

resources and the layout of large specialized wharf is scattered. Secondly, Zhoushan port has a good deep water coastline, but it is separated from the land, the costs of investment and development are too high. Therefore, through the integration, Ningbo Zhoushan Port can make full use of their respective advantages, optimize the layout of the port and improve the overall benefit. By studying with the monthly cargo throughput data of Ningbo Zhoushan Port, this paper quantifies the effect of integration into specific data, which is more intuitive.

The second is that the port integration is not only an inevitable trend of China's port development, but also an effective way for China's port to become bigger and stronger. In recent years, Zhejiang Province has deepened the supply-side structural reform of ports, promoted the integration of port resources, accelerated the upgrading of ports to improve the quality and efficiency, and coordinated the integrated development of regional coastal ports, inland river ports and inland waterless ports. The notice introduces Zhejiang province's experience in promoting the reform of regional port integration from three aspects: main measures, main results and the experience. At present, the development of China's ports has reached a new stage, and port integration has become an inevitable trend. The traditional "one city, one port" gradually transforms into "one province, one port". With the successful example of Ningbo Zhoushan Port, ports across the country are in action. First of all, through the integration, we can not only promote complementary advantages of ports, give play to synergistic effects and promote port development, but also reduce internal consumption and vicious competition, and jointly resist competition from neighboring ports. Secondly, the competition among ports in the world today stems from their desire to become regional or global hub ports, so as to improve the reputation of the cities where ports are located and promote the economic development of cities. Through the integration of ports with different administrative divisions, there will be a Provincial Seaport Group to manage all local ports. By the unified planning management, local ports can improve their competitiveness to be the regional or global hub ports eventually.

At present, most domestic and foreign scholars adopt qualitative methods in the study of port integration. This paper studies the integration effect of Ningbo Zhoushan Port in a quantitative way by using the method of counterfactual analysis in order to provide references for future studies.

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