

Research on the Relationship Between Port Logistics and Economic Development in Ningbo

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ABSTRACT. Based on the statistical yearbook data of Ningbo from 2005 to 2017. First, Pearson correlation coefficient is used to judge that the correlation between container throughput and GDP is higher than that between port cargo throughput and GDP. Secondly, the relationship between container throughput and GDP and the three industries is studied by linear regression analysis. The results show that the development of port logistics can promote the development of economy, and the increase of container throughput can promote the increase of GDP. It has the largest impact on the second industry, followed by the third industry, and has a weak impact on the first industry.

KEYWORDS: Pearson Correlation Coefficient, Port Logistics, Economy, Univariate linear regression, Ningbo

1. Introduction

Ningbo port is located in the middle of China's coastline. Since President Xi Jinping proposed the strategic vision of building the new Silk Road Economic Belt and the twenty-first Century Maritime Silk Road, Ningbo port is located at the junction of the two wings of the "Silk Road Economic Belt" and the "maritime Silk Road in twenty-first Century". Ningbo port area, with its outstanding advantages and convenient internal and external radiation, is an ideal distribution center for cargo transportation between China and other continents. With the advantage of port location, Ningbo port logistics has developed rapidly in recent years. At present, Ningbo port consists of Beilun port, Zhenhai port, Ningbo port, Daxie port and Chuanshan port. It is a multi-functional and comprehensive modern deep-water port integrating inland port, estuary port and seaport.

According to statistics [1], Ningbo port has been navigable with more than 600 ports in more than 200 countries and regions in the world, with 322 productive berths (99 above 10000 tons), 111 ocean trunk lines, 66 near ocean branch lines and 33 domestic trade lines. In 2018, the cargo throughput of Ningbo port was 576.515 million tons, a year-on-year increase of 4.5%, and the container throughput was 26.351 million TEUs, a year-on-year increase of 6.5%.

2. Selection of evaluation indexes

GDP reflects the economic strength and market scale of a country (or region) in a certain period, which consists of the first industry, the second industry and the third industry [2]. Therefore, this paper takes the total GDP and the three major industrial economies as the evaluation indexes of Ningbo's economic development. Port logistics has the functions of economic trade, comprehensive service and circulation, which has a direct and indirect impact on the economic development of regions and countries [3]. In this paper, cargo throughput and container throughput are selected as the indexes to evaluate the scale of port logistics.

The data source of the evaluation index is the 2018 statistical yearbook of Ningbo, as shown in table 1, the relevant data of Ningbo's total GDP, port cargo throughput and container throughput from 2005 to 2017.

Table 1 Port logistics and GDP of Ningbo from 2005 to 2017

Time	GDP/ (Billion yuan)	Primary industry/ (Billion yuan)	Second industry/ (Billion yuan)	Tertiary industry/ (Billion yuan)	Port cargo throughput/ (10000 t)	Container throughput/ (10000 TEUs)
2005	2447.32	132.25	1341.87	973.20	26881	520.8
2006	2874.42	139.31	1580.70	1154.41	30969	706.8
2007	3418.57	150.92	1894.14	1373.51	34519	935.0
2008	3946.52	166.85	2190.78	1588.89	36185	1084.6
2009	4334.33	183.53	2356.68	1794.12	38385	1042.3
2010	5181.00	219.13	2856.74	2105.13	41217	1300.4
2011	6074.94	255.23	3315.76	2503.95	43339	1451.2
2012	6601.21	268.51	3475.08	2857.62	45303	1567.1
2013	7164.51	272.06	3680.97	3211.48	49592	1677.4
2014	7610.28	275.70	3980.41	3354.17	52646	1870.0
2015	8003.61	284.68	4098.22	3602.71	51005	1982.4
2016	8686.49	302.06	4455.33	3929.10	49619	2069.6
2017	9842.06	305.81	5119.45	4416.82	55151	2356.6

3. Analysis on the correlation between port logistics and economy in Ningbo

3.1 Time sequence analysis of port logistics and economy

As shown in Figure 1, the timing changes of Ningbo's GDP, port cargo throughput and container throughput from 2005 to 2017 are shown. It can be seen from the figure that from 2005 to 2017, the total GDP and container throughput of Ningbo gradually increased. Port cargo throughput continued to grow between 2004 and 2014, but began to decline in the next two years, until 2016-2017 began to grow significantly. Therefore, in order to further understand the correlation between port cargo throughput, container throughput and GDP. Pearson correlation coefficient is used to find out the highest degree of correlation with GDP, which is the decisive index of port logistics scale.

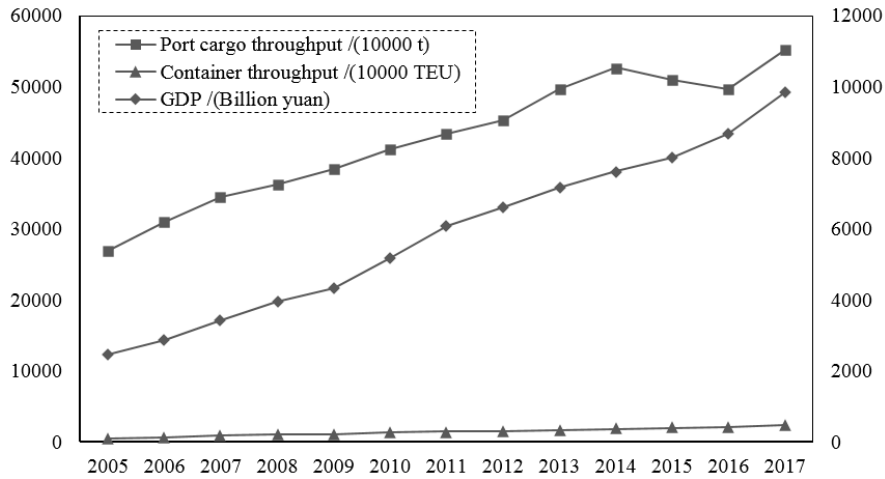


Figure. 1 Port logistics and economic GDP of Ningbo in 2005-2017

Pearson correlation coefficient, also known as Pearson product moment correlation coefficient, is used to measure the correlation between two variables. Its formula is:

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \tag{1}$$

Where: x_i is throughput; \bar{x} is the average throughput; y_i is the total GDP; \bar{y} is the average of GDP; r_{xy} is the correlation coefficient, if $0 < |r_{xy}| < 1$, the more close $|r_{xy}|$ is to 1, the higher the correlation degree of x and y is; when $|r_{xy}|$ is close to 0, the lower the correlation degree of x and y is.

As shown in table 2, it is the result of correlation analysis between port logistics and GDP. It can be seen from the table that the significance level of container throughput, port cargo throughput and GDP is less than 0.05, indicating that there is significant correlation. However, the Pearson correlation between container throughput and GDP is 0.995, which is larger than that between port cargo throughput and GDP. Therefore, this paper selects the container throughput, which is more significantly related to GDP as the evaluation index of port logistics scale.

Table 2 Correlation between port logistics and GDP

		Container throughput /(10000 TEUs)	Port cargo throughput /(10000 t)
GDP/ (100 million yuan)	Pearson Correlation	.995**	.974**
	Sig.(2-tailed)	.000	.000
	N	13	13

** . Correlation is significant at the 0.01 level (2-tailed).

3.2 Regression analysis of container throughput and GDP

Through Pearson correlation coefficient, it is known that container throughput has a significant correlation with GDP. Furthermore, the paper explores the specific correlation form by drawing the scatter relationship between container throughput and GDP. As shown in Figure 2, the total GDP increases with the increase of container throughput. By adding a trend line, it can be preliminarily judged that the container throughput and the total GDP show a certain linear relationship. Therefore, the linear regression analysis is used to fit the mathematical model of packing throughput and GDP.

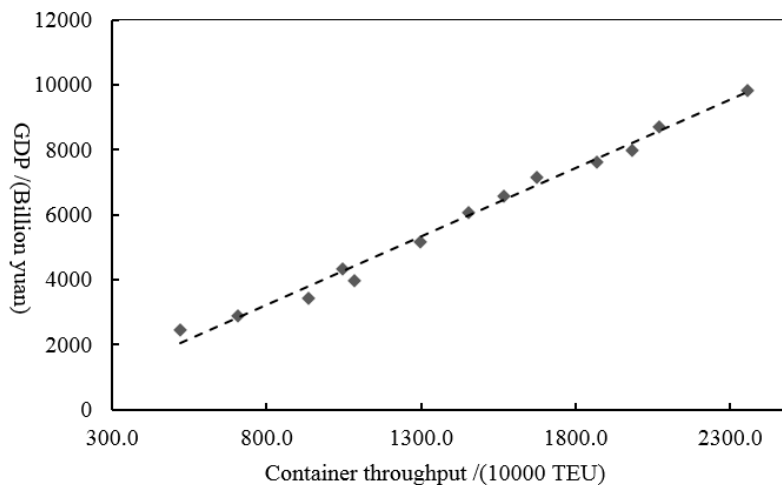


Figure. 2 Scatter diagram of container throughput and GDP

Univariate linear regression only involves two variables, x and y . Through the independent variable x to estimate the dependent variable y , a mathematical model is fitted so that the x estimate y can be calculated by a functional formula [4] and the model is as follows:

$$y_i = \beta x_i + \alpha \tag{2}$$

Where: y_i is the total GDP; x_i is the container throughput; β and α are the parameters to be estimated.

Spss24.0 is used to import the total GDP as the dependent variable and the container throughput as the independent variable. As shown in table 3 is the regression coefficient of the fitted mathematical model, the parameter β to be estimated is 4.209 and the parameter α to be estimated is - 150.445, so the mathematical model is:

$$y_i = 4.209x_i - 150.445 \tag{3}$$

Formula (3) from the perspective of economics, for every 10000 standard containers increased in container throughput, the total GDP will increase by 420.9 million yuan.

Table 3 Regression coefficient of mathematical model ^a

Model	Unstandardized Coefficients		standardized Coefficients	t	Sig.
	B	Std.Error	Beta		
(Constant)	-150.445	202.447		-.743	.473
Container throughput / (10000 TEUs)	4.209	.133	.995	31.710	.000

a. Dependent variable: GDP /(100 million yuan)

In order to evaluate the fitting effect of the above mathematical model, decision coefficient and variance analysis are selected as the evaluation basis. As shown in table 4 is the summary of mathematical model [5], there is a correlation coefficient (absolute value) r (the larger R is, the higher the correlation degree is), the determination coefficient R (the larger R is, the higher the fitting degree is). After adjustment, R has no actual value for simple regression model, so we will not discuss it. From table 3, it can be seen that the determination coefficient is 0.988, indicating that the mathematical model has a good fitting effect. Table 5 is the result of variance analysis on the mathematical model, F value is 1005.523, and P value is less than 0.05, indicating that the mathematical model has practical statistical significance.

Table 4 Summary of mathematical model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
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Container throughput and GDP	.995 ^a	.989	.988	256.29509
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a. Forecast variables:(Constant), Container throughput /(10000 TEU)

Table 5 ANOVAa

Model	Sum of Square	df	Mean Square	F	Sig.
Between Groups	66049937.090	1	66049937.090	1005.523	.000 ^b
Within Groups	722558.883	11	65687.171		
Total	66772495.980	12			

a. Dependent variable: GDP/ (Billion yuan)

b. Forecast variable: (Constant), Container throughput/ (10000 TEUs)

4. Analysis of the influence of container throughput on three industries

In order to further study which industry of the three industries is the most affected by container throughput, the regression mathematical models of container throughput and the three industries are respectively fitted by the above methods. Figure 3 shows the time sequence changes of container throughput and three major industries from 2005 to 2017. It can be seen that with the annual growth of container throughput, in addition to the slow growth of the first industry, the growth trend of the second and third industries is similar to that of container throughput.

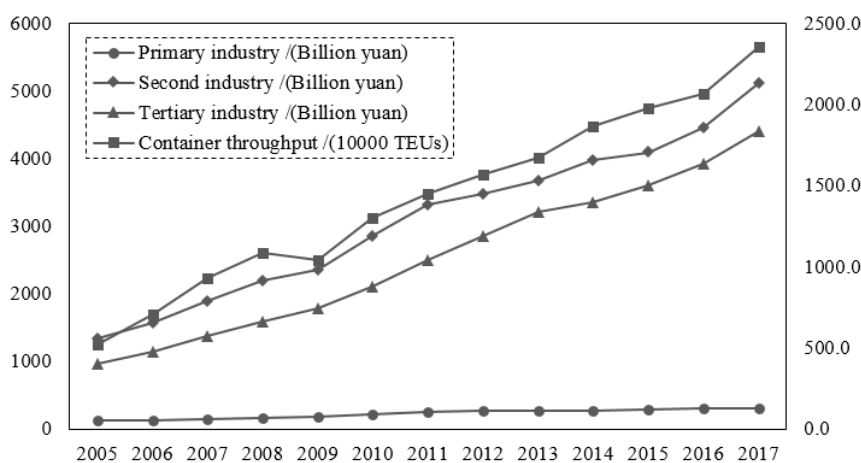


Figure. 3 Relationship between container throughput and three major industries

Table 6 shows the mathematical model and regression parameters of container throughput and three industries respectively. According to the fitted mathematical model, for every 10000 TEUs of container throughput increased in Ningbo, the first industry, the second industry and the third industry increased by 112 million yuan,

209.4 million yuan and 2001 million yuan respectively. It can be seen that container throughput has the greatest impact on the second industry, followed by the third industry, and the weakest impact on the first industry.

Table 6 Mathematical model and regression coefficient

	Primary industry	Second industry	Tertiary industry
(Constant)	67.405	113.915	-329.332
Container throughput/ (10000 TEUs)	.112	2.094	2.001
Model	$y_i = 0.112x_i + 67.405$	$y_i = 2.094x_i + 113.915$	$y_i = 2.001x_i - 329.332$

Dependent variable: Three industries/ (Billion yuan)

As shown in Table 7, it is the correlation coefficient and determination coefficient of container throughput after fitting with the three industries. It can be seen from the table that the decision coefficient of container throughput and the first industry is 0.634, with general fitting effect. The decision coefficients of container throughput, secondary industry and tertiary industry are 0.990 and 0.983 respectively, indicating that the fitting effect is very good. The correlation between container throughput and the second industry is slightly greater than that between container throughput and the third industry.

Table 7 Summary of mathematical model

Model	R	R Square	Adjusted R Square
Container throughput and primary industry	.676 ^a	.634	.928
Container throughput and second industry	.995 ^a	.990	.989
Container throughput and tertiary industry	.992 ^a	.983	.982

a. Forecast variable: (Constant), Container throughput /(10000 TEUs)

5. Conclusion

In order to understand the relationship between port logistics and economic development in Ningbo, this paper uses the container throughput from 2005 to 2017 to make a linear regression analysis with the total GDP and three major industries of Ningbo, and draws the following conclusions:

(1) The correlation between container throughput and economy in Ningbo is greater than that between port cargo throughput and economy. Container throughput can be used as the evaluation index of port logistics in Ningbo.

(2) The increase of container throughput can drive the increase of GDP, which has the greatest impact on the second industry, followed by the third industry, and has a weak impact on the first industry.

Ningbo municipal government can further promote the growth of GDP by optimizing the industrial structure. At the same time, it needs to take certain measures to improve the effect of container throughput on the primary industry.

References

- [1] Ningbo Municipal Bureau of statistics. 2018 statistical yearbook [EB/OL]. <http://vod.ningbo.gov.cn:88/nbtjj/tjnj/2018nbnj/indexch.htm>
- [2] Zhou Baogang, Jiang Shan, Zhang Lifeng, Pan Chao. Research on the interactive development and efficiency evaluation of Liaoning port economy and regional economy [J]. Science, technology, and management, 2018, 20 (04): 8-13.
- [3] Wu Jinghong, LV nengfang. Empirical Study on the correlation between Wuhu port logistics and regional industrial economy [J]. Financial theory and teaching, 2018 (03): 53-57.
- [4] Li Zinai, pan Wenqing. Econometrics [M]. Beijing: Higher Education Press, 2015.
- [5] Zhang Wentong, Dong Wei. Advanced course of SPSS statistical analysis [M]. Beijing: Higher Education Institute, 2018.