

# Analysis of the Impact of Ports and Port Industries on the Regional Economy: Taking Shanghai as an Example

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## Abstract

Selecting Shanghai as the research object, collecting Shanghai's port indicators, regional economic GDP data from 2009 to 2018, and the main economic indicators of the Shanghai Pilot Free Trade Zone from 2015 to 2018 as samples, using the grey correlation analysis method. Analyze the impact of the port and the port industry formed by the port on the regional economic development. The results show that the port and port industry have a strong correlation to the regional economy. Ports and port-side industries promote regional economic development. Based on the analysis results of the correlation degree, suggestions are made for the development of Shanghai Port, the port industry and the regional economy.

## Keywords

Port Industry, Regional Economy, Shanghai Pilot Free Trade Zone, Grey Correlation Analysis.

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## 1. Introduction

With the development of regional economic integration and trade globalization, ports have become important water and land transportation hubs for urban foreign trade. For a long time, ports have played an important role in promoting regional economic development by virtue of water transportation services. At the same time, the region also provides a broad economic hinterland and sufficient supply of goods for the development of the port. Therefore, it is necessary to do in-depth research on the relationship between the port and the regional economy. In addition, during the development of the port, port industries serving port production activities have formed around the port. When the number, type and scale of port industries continue to expand, industrial clusters are formed [1]. Finally, under the joint planning of the regional government and the port, a port industrial zone will be formed to promote the interactive development of the port and the city. Therefore, to study the impact analysis of the port and the regional economy, it is necessary to study the impact of the port industry formed by the port on the regional economy. Based on the research results, reasonable suggestions are made for the development of Port Industrial Zone.

In previous studies, there have been many studies on the relationship between ports, port industries and regional economies. Due to the different development levels of ports, regional economies, and port industries in various regions, scholars have different perspectives. Some scholars choose to study the relationship between regional economic indicators and port throughput from the perspective of regional economy [2]. Some scholars [3] choose to start from the perspective of port industry, establish a port industry indicator system, and analyze the relationship between port industry and regional GDP data. Other scholars [4,5] use the DEA (Data Envelopment Analysis) model to analyze the input-output index data of ports and cities, and then analyze the relationship between ports and regional economies through linear regression analysis. Previous studies have shown that although scholars have different research methods, perspectives, and data indicators, the results of the research all show that ports and port industries have a driving effect on regional economic development.

The development of the port and the regional economy is a dynamic process. This article adopts the grey correlation analysis method to quantitatively analyze various index data in the process of the port and the regional economic dynamic development. Through the grey correlation analysis method, the correlation between ports, port industries and the regional economy is analyzed. Finally, analyze the degree of influence between the indicators through the value of the correlation degree, and propose reasonable countermeasures based on the results of the analysis.

## 2. Grey correlation analysis model

The grey correlation analysis method is a method of comparative analysis of factors suitable for dynamic processes. It divides all data into a reference sequence and several comparison sequences. In the process of dynamic development, mathematical methods are used to study the relationship between factors. If the changing trends of factors are consistent, then there is a degree of correlation between factors. The specific analysis steps are as follows:

Step 1:

Determine the reference sequence and the comparison sequence. Assuming that there are  $n$  comparison sequences, each sequence has  $m$  data. The reference sequence is  $X_0j$ , and the comparison sequence is  $X_{ij}$  ( $i=1, 2, \dots, n; j=1, 2, \dots, m$ )

Step 2:

Perform a dimensionless method on the index data, the formula is as follows:

$$X_{ij}' = \frac{X_{ij}}{X_{i1}} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (1)$$

Step 3:

Calculate the difference of the sequence, calculate the absolute value of the difference between the comparison sequence and the reference sequence, the formula is as follows:

$$\Delta_{ij} = |X_0j' - X_{ij}'| \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (2)$$

Step 4:

Determine the maximum and minimum values in the calculation result of formula (2), the formula is as follows:

$$M = \max_i \max_j \Delta_{ij}$$

$$m = \min_i \min_j \Delta_{ij} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (3)$$

Step 5:

Calculate the correlation coefficient, the formula is as follows:

$$\delta_{ij} = \frac{m + \rho M}{\Delta_{ij} + \rho M} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (4)$$

Where  $\rho$  is the resolution coefficient, usually 0.5

Step 6:

Calculate the correlation value, the formula is as follows:

$$\gamma_i = \frac{1}{j} \sum_{j=1}^m \delta_{ij} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (5)$$

Sorting the results calculated by formula (5) can analyze the strength of the correlation between the indicators.

### 3. Case analysis

#### 3.1 Correlation analysis of Shanghai Port and Shanghai GDP

##### 3.1.1 Selection of analysis data

As the economic center of the Yangtze River Delta Region, Shanghai has maintained rapid economic development in the past 10 years. The vast economic hinterland and superior water and land transportation have made Shanghai's economic development more diversified and the Urban GDP is also increasing year by year. Therefore, to study the impact of Shanghai ports on regional economic development, it is necessary to analyze the correlation between port indicators and regional economic GDP from the perspective of ports. This paper selects the Shanghai GDP from 2009 to 2018 as the reference sequence, and selects the three port indicators of Shanghai port cargo throughput, terminal length, and port berths from 2009 to 2018 as the comparison sequence. All selected analysis data are shown in Table 1:

Table 1. Urban GDP and port index data from 2009 to 2018

| years | Shanghai GDP (100 million yuan) | Port cargo throughput (10,000 tons) | Length of wharf (ten thousand meters) | Number of berths (a) |
|-------|---------------------------------|-------------------------------------|---------------------------------------|----------------------|
| 2009  | 15 287.56                       | 59 205                              | 11.68                                 | 1145                 |
| 2010  | 17 436.85                       | 65 339                              | 11.92                                 | 1218                 |
| 2011  | 19 539.07                       | 72 758                              | 11.97                                 | 1226                 |
| 2012  | 20 558.98                       | 73 559                              | 12.29                                 | 1245                 |
| 2013  | 22 264.06                       | 77 575                              | 12.40                                 | 1253                 |
| 2014  | 24 068.20                       | 75 529                              | 12.60                                 | 1282                 |
| 2015  | 25 659.18                       | 71 740                              | 12.69                                 | 1300                 |
| 2016  | 28 183.51                       | 70 177                              | 10.92                                 | 1152                 |
| 2017  | 30 632.99                       | 75 051                              | 10.61                                 | 1078                 |
| 2018  | 32 679.87                       | 73 048                              | 14.92                                 | 1978                 |

##### 3.1.2 Analysis of the Correlation between Port Index and Regional Economic GDP

The calculation process and results of the gray correlation analysis model between ports and regional economy are as follows:

First, determine the reference sequence and comparison sequence. Take Shanghai GDP as the reference sequence and others as the comparison sequence. Assume that Shanghai's GDP is  $X_0j$  ( $j=1,2,\dots,m$ ) and the port cargo throughput is  $X_{1j}$  ( $j=1,2 \dots M$ ), the length of the wharf is  $X_{2j}$  ( $j=1,2,\dots,m$ ), and the number of berths is  $X_{3j}$  ( $j=1,2,\dots,m$ ). In the sample data, the size of  $m$  is equal to 10.

Then calculate and solve in turn according to formulas (1), (2), (3), and (4) to obtain the correlation coefficient between regional economic GDP and port indicators. Finally, use formula (5) to average the correlation coefficients to obtain the calculation results of the correlation between indicators and regional GDP, correlation coefficient and correlation value are shown in Table 2:

From the data in Table 2, it can be seen that the correlation value  $\gamma_i$  between the three indicators of the port and the regional GDP is greater than 0.5, which indicates that the port of Shanghai has a strong correlation with the development of the regional economy. The greater the correlation, the stronger the influence of the port on the regional economy. Sort the correlation values of the three indicators in Table 2, where  $\gamma_1$  represents the correlation value between port cargo throughput and regional GDP,  $\gamma_2$  represents the correlation value between terminal length and regional GDP, and  $\gamma_3$  represents the correlation value between the number of berths and regional GDP,  $\gamma_1 > \gamma_3 > \gamma_2$ . According to the ranking results, among the various indicators of the port, cargo throughput has the

greatest impact on the regional economy. Continuing to analyze the changes in the correlation coefficients in Table 2 over the past 10 years, the data results show that the correlation coefficients between the three port indicators and regional GDP are gradually decreasing. After 2015, the correlation coefficients between the three port indicators and regional GDP have appeared values below 0.5, which indicates that the impact of Shanghai ports on the regional economy has changed. Merely studying the correlation between the three indicators of the port and the regional GDP is not enough to analyze the impact of the Shanghai port on the regional economy. Therefore, this article collects the port industry data of Shanghai port to further analyze the influence of port industry on the regional economy.

Table 2. Correlation coefficient and correlation value between ports and regional GDP

| years      | X1j     | X2j     | X3j     |
|------------|---------|---------|---------|
| 2009       | 1.00000 | 1.00000 | 1.00000 |
| 2010       | 0.93674 | 0.82023 | 0.87697 |
| 2011       | 0.91760 | 0.68379 | 0.72537 |
| 2012       | 0.84252 | 0.65180 | 0.66588 |
| 2013       | 0.78945 | 0.58117 | 0.60205 |
| 2014       | 0.64713 | 0.52497 | 0.54638 |
| 2015       | 0.53992 | 0.48058 | 0.50212 |
| 2016       | 0.45417 | 0.37608 | 0.39541 |
| 2017       | 0.42661 | 0.33333 | 0.34019 |
| 2018       | 0.37732 | 0.38900 | 0.57179 |
| $\gamma_i$ | 0.69315 | 0.58410 | 0.62262 |

### 3.2 Analysis of the Correlation Degree between Shanghai Pilot Free Trade Zone and Shanghai GDP

#### 3.2.1 Selection of analysis data

With the reform and opening up and the rapid growth of Shanghai Port's water transportation business, Shanghai Port has developed into one of the largest ports in China. During the development process, a large-scale port industry cluster has gradually formed around the port. In order to better serve the development of the port and the regional economy, Shanghai Port and the Shanghai Municipal Government jointly planned the distribution of the port industry and formally established the "China Shanghai Pilot Free Trade Zone" in 2013. The calculation results of the correlation coefficient in Table 2 above show that the correlation between port indicators and the regional economy has changed after 2015, and the correlation coefficient has appeared to be less than 0.5. Therefore, In order to further analyze the changes in the correlation between the port and the regional economy, this article selects the port industry data of the Shanghai Pilot Free Trade Zone from 2015 to 2018 as the comparison sequence, and uses the Shanghai GDP from 2015 to 2018 as a reference Sequence, analyze the correlation between the port industry and the regional economy. All selected analysis data are shown in Table 3:

Table 3. 2015-2018 Shanghai GDP and port industry economic indicators data

| Year | Shanghai GDP (100 million yuan) | Public revenue (100 million yuan) | Total fixed investment (100 million yuan) | Total industrial output value (100 million yuan) | Service industry revenue (100 million yuan) | Total import and export (100 million yuan) |
|------|---------------------------------|-----------------------------------|---|--|---|--|
| 2015 | 25 659.18                       | 444.74                            | 563.11                                    | 3901.03  | 3599.06                                     | 7415.46                                    |
| 2016 | 28 183.51                       | 559.38                            | 607.93                                    | 4312.84  | 4167.59                                     | 7836.80                                    |
| 2017 | 30 632.99                       | 578.48                            | 680.31                                    | 4924.95  | 5157.74                                     | 13500.00                                   |
| 2018 | 32 679.87                       | 648.16                            | 638.07                                    | 4965.00  | 5723.97                                     | 14600.00                                   |

### 3.2.2 Analysis of the correlation between the port industry and regional economic GDP

The calculation process and results of the gray correlation analysis model of port industry and regional economy are as follows:

First, determine the reference sequence and comparison sequence. Take Shanghai GDP as the reference sequence and others as the comparison sequence. Assume that Shanghai's GDP is  $X_0j$  ( $j=1,2,\dots,m$ ) and the public revenue of the port industry is  $X_4j$  ( $j=1,2,\dots,m$ ), the total fixed investment is  $X_5j$  ( $j=1,2,\dots,m$ ), the total industrial output value is  $X_6j$  ( $j=1,2,\dots,m$ ), and the service industry revenue is  $X_7j$  ( $j=1,2,\dots,m$ ), the total import and export is  $X_8j$  ( $j=1,2,\dots,m$ ). In the sample data, the size of  $m$  is equal to 4.

Then calculate and solve in turn according to formulas (1), (2), (3), and (4) to obtain the correlation coefficients between regional economic GDP and the economic indicators of the port industry, and finally use formula (5) to average the correlation coefficients, Get the correlation degree between each index and regional GDP, the correlation coefficient and correlation degree calculation results are shown in Table 4:

Table 4. Correlation coefficient and correlation value of the port industry and regional GDP

| year       | $X_4j$  | $X_5j$  | $X_6j$  | $X_7j$  | $X_8j$  |
|------------|---------|---------|---------|---------|---------|
| 2015       | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| 2016       | 0.68563 | 0.94873 | 0.97975 | 0.85368 | 0.89321 |
| 2017       | 0.76485 | 0.96052 | 0.83512 | 0.59234 | 0.35679 |
| 2018       | 0.65416 | 0.71217 | 0.99750 | 0.52320 | 0.33333 |
| $\gamma_i$ | 0.77616 | 0.90536 | 0.95309 | 0.74231 | 0.64583 |

From the data in Table 4, we can see that the correlation between the economic indicators of the port industry and Shanghai's GDP is greater than 0.5, and the correlation value of the individual indicators is close to 1. Therefore, it can be concluded that the port industry formed by the port has a strong correlation with the development of the regional economy, and the port industry promotes the development of the regional economy. Sort the correlation values of the port industry indicators in Table 4, where  $\gamma_4$  represents the correlation value between public revenue and regional GDP,  $\gamma_5$  represents the correlation value between fixed investment and regional GDP, and  $\gamma_6$  represents the correlation between total industrial output value and regional GDP. Correlation value, where  $\gamma_7$  represents the correlation value between service industry revenue and regional GDP,  $\gamma_8$  represents the correlation value between total import and export volume and regional GDP,  $\gamma_6 > \gamma_5 > \gamma_4 > \gamma_7 > \gamma_8$ . From the ranking results, it can be seen that among the various indicators of the port industry, the gross industrial output value and fixed investment have the greatest impact on regional economic GDP, and the correlation between total import and export and regional GDP is the smallest. However, on the whole, the rapid development of the port industry is an important factor for regional economic growth.

## 4. Conclusion

From the calculation results of the correlation between ports, port industries and regional economic GDP. It can be seen that there is a high degree of correlation between Shanghai's ports, port industries and regional economic GDP. Both the Shanghai port and the port industry have promoted the development of the regional economy. The calculated correlation value shows that the correlation degree between the current port industry indicators and the regional economy is far greater than the correlation degree between the port indicators and the regional economy. Therefore, for the development of Shanghai Port, the port industry and the regional economy, vigorously developing the port industry is the best choice to promote regional economic development

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