

# Evaluation of Efficiency Value of Port to Urban Economy

## --Taking Suzhou as an Example

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### Abstract

With the increasing of global trade, the role of port in the city is particularly important, prosperous cities around the world can be found through study that the rapid development of coastal cities along the Yangtze river is because it has a port, port city's economic development at the same time bring a stable supply of goods to the port, so its development should be a two-way relationship, this thesis mainly port to Suzhou and Suzhou city as the research object, from the actual situation of Suzhou port economy and regional economic development, focus on analysis of port economic status and role in the development of regional economy in Suzhou. The method of longitudinal comparative analysis was adopted to collect the input-output index data of Suzhou Port from 2010 to 2019, establish the data envelope analysis and evaluation model, and use LINGO software to conduct empirical analysis on the input-output efficiency and effectiveness of Suzhou Port, and draw conclusions on its development status.

### Keywords

Port city economy; Suzhou port; Input-output; Data envelope analysis.

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## 1. Introduction

As our country is open to the world level gradually increased in recent years, city's economic development is very rapid, at the same time around the ports have also obtained the full development, become a regional influence important index of the GDP of the third industry, this article selects Jiangsu province Suzhou city as the research object, the core position of Suzhou city is located in the Yangtze river delta region, is also China's economic development center of southern Jiangsu model representatives of big brother, at the same time, Suzhou port is located in the Yangtze estuary, owner its reputation as the "world's first inland port", due to its high throughput than many harbor, 2002 opening port of national first class original Taicang port, Changshu Port and Zhangjiagang three ports were set up in one. In this context, the movement data envelopment analysis of this paper has been sent to study the input-output index data of Suzhou port and Suzhou city.

## 2. Research status of scholars at home and abroad

Luo Fang and Song Peipei used relative concentration index for quantitative calculation of port city relationship in Comparative Analysis of Port City Relationship between Qingdao Port and Shanghai Port (2013), and concluded the dependence degree and driving effect of port on the city [1]. In a study on The Relationship between Port Economy and Urban Economy Based on the Grey System Theory (2009), Wang Jike [2] studied the interaction between port and urban economy and obtained the correlation coefficient based on the grey correlation analysis method. Du Qidong et al. focused on the

requirements of ports in international economic centers and the role of ports in promoting the development of economic centers in one of a series of studies on port And City Relations of International Economic Centers (1996) [3]. In Theoretical Research on The Establishment and Development of Port Cities (2002), Song Bingliang [4] elaborated the main connotation and practical significance of the theoretical model of port city development based on the new trade theory under the current situation from multiple perspectives and combined with the history of urban development since the opening of Shanghai Port. William Seabrooke et al. used regression analysis to predict cargo volume growth and the development of Hong Kong's port. This paper analyzes the factors affecting the port cargo throughput, and studies the influence of future port development on regional economy [5]. Gilbert R. Yochum et al. [6] analyzed the interactive development relationship between ports and regional economy in this paper. Port has been regarded as the catalyst of economy, obviously the related development of port will produce economic benefits, this paper elaborates the position and function of the development of port economy in the development of regional economy.

### 3. Selection of indicators

#### 3.1 Selection of Suzhou port indicators

Suzhou port there are a variety of measures, but due to the Suzhou port of statistics in its infancy, the lack of some information system, on port throughput, berth length data comprehensively, at the same time, the port throughput reflects both the size of, also reflects the configuration of hinterland of productivity and regional economic development conditions. Therefore, the selection of port cargo throughput as a measure of the level of Suzhou port logistics index has a certain comparability. Berth number says the number of its ports have production berths, can reflect the size of the target port, port berths in the construction of port construction investment and ship at the port of loading and unloading in the port has significant influence and waiting for loading and unloading expenses, promote the economic benefits of port, can be used as an important port is put into target. In the statistical yearbook of Suzhou from 2010 to 2019, we can find the corresponding annual cargo throughput, container throughput and the number of berths at the wharf.

#### 3.2 Selection of Indicators in Suzhou

Urban economic indicators can reflect the status of a city's economic operation. There are many urban economic indicators, and several indicators that can best reflect the effectiveness of urban economy are selected. For example, GDP, industrial output value, total import and export of goods, fixed asset investment, number of employees on the job, GDP as a regional economic development of the speed, can be reflected through the GROWTH rate of GDPTake GDP as the main output index of urban economy. Gross industrial output value is refers to industrial enterprises in money form during the reporting period of the final results of industrial production activities, is one of the economic accounting basic indicators, fixed assets investment activities of construction and purchase of fixed assets in monetary terms of work, it is to reflect the scale of investment in fixed assets, speed, the direction of the proportional relationship and use comprehensive index. The number of employees can reflect the size of a city. The more employees there are, the bigger the city will be, the faster the urbanization will be, and the faster the urban economy will grow. Therefore, the number of urban employees can affect the development of urban economy. Therefore, the number of urban employees is selected as the main index of the city.

### 4. Introduction to data envelopment analysis

Data Envelopment Analysis (DEA) is a new interdisciplinary field of operations research, management science and mathematical economics. It is a quantitative analysis method to evaluate the relative effectiveness of comparable units of the same type by means of linear programming according to multiple input indexes and multiple output indexes. DEA method and its model since 1978 by the famous American operations research home A.C harnes and W.W.C ooper proposed since, has been widely used in different industries and departments, and in dealing with multiple

indicators input and output index, reflects its unique advantages, the CCR model is by the famous mathematician Charnes, operational research, cooper and economic management at Rhodes on the basis of the concept of "relative efficiency evaluation", used for DMU technology validity of decision making units, relative effectiveness, and evaluate the scale efficiency. The most famous CCR model is as follows: There are  $n$  decision making units  $DMU_j(j=1,2,\dots,n)$ , the input and output vectors of  $DMU_j$  are, respectively

$$X_j = (x_{1j}, x_{2j}, \dots, x_{mj})^T > 0, j = 1, 2, \dots, n$$

$$Y_j = (y_{1j}, y_{2j}, \dots, y_{sj})^T > 0, j = 1, 2, \dots, n$$

Variable weight input and output vectors are introduced respectively as and to synthesize input and output. For each decision unit  $DMU_j$ , there is a corresponding efficiency evaluation index:

$$h_j = \frac{\sum_{k=1}^s u_k y_{kj}}{\sum_{i=1}^m v_i x_{ij}} = \frac{u^T y_j}{v^T x_j}, j = 1, 2, \dots, n$$

the optimization model formed is the CCR model:

$$\begin{cases} \max h_{j_0} = \frac{\sum_{k=1}^s u_k y_{kj_0}}{\sum_{i=1}^m v_i x_{ij_0}} \\ \text{s.t.} \frac{\sum_{k=1}^s u_k y_{kj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, j = 1, 2, \dots, n \\ u \geq 0, v \geq 0 \end{cases}$$

The model is transformed into the following linear programming:

$$\begin{cases} \max h_{j_0} = \mu^T y_{j_0} \\ \text{s.t.} \omega^T x_j - \mu^T y_j \geq 0, j = 1, 2, \dots, n \\ \omega^T x_{j_0} = 1 \\ \omega \geq 0, \mu \geq 0 \end{cases}$$

According to the dual theory, the dual programming model of the above formula can be obtained, as shown below:

$$\begin{cases} \min \theta \\ \text{s.t.} \sum_{j=1}^n \lambda_j x_j \leq \theta x_{j_0} \\ \sum_{j=1}^n \lambda_j y_j \geq y_{j_0} \\ \lambda_j \geq 0, \theta \text{无约束} \end{cases}$$

According to the ABOVE DEA CCR model, this paper will select various index data of Suzhou city and Suzhou Port to conduct efficiency value evaluation in the following part.

### 5. Case Analysis

This paper collects various indicators of Suzhou from 2010 to 2019 as shown in Table 5-1. These data are selected because since the 21st century, the port logistics function of Suzhou Port has been continuously expanded and the port industry has entered the stage of rapid development, which is of substantial help to the study of this paper.

The program prepared by Lingo software was used to solve the DEA model of Suzhou Port and city effectiveness, and the constraint conditions of variables, definition of variable set, initial data of variables and definition of variable set were input into Lingo software for operation. According to the

operation of Lingo software, the evaluation results of port and city effectiveness were shown in Table 5-2

Table 5-1 Efficiency evaluation index of Suzhou Port for Suzhou City

Year	Wharf berths (one)	Cargo throughput (tons)	Container throughput (tons)	Gross Regional Product (\$100 million)	Gross industrial output value(one hundred million yuan)
2010	97	32877	364.4	9366.47	5035.1
2011	107	38006	450	10885.92	5700.95
2012	116	42801	586	12207.81	6225.26
2013	122	45435	530.52	13191.33	6462.84
2014	126	47792	445	13994.42	6563.23
2015	127	53990	510.19	14761.36	6715.07
2016	128	57937	547.92	15748.58	6894.16
2017	129	60456	587.52	17319.51	7606.45
2018	130	53227	635.51	18263.48	8167.59
2019	130	52275	626.74	19235.8	8316.49

Table 5-2 Shows the efficiency of Suzhou Port for Suzhou city

Year	Efficiency value	The validity of
2010	1	effective
2011	0.9486958	invalid
2012	0.9142344	invalid
2013	0.9057876	invalid
2014	1	invalid
2015	0.9253026	invalid
2016	0.9219752	invalid
2017	0.9416305	invalid
2018	0.9665103	invalid
2019	1	effective

According to table 5-2 in Suzhou port results show the effectiveness of the evaluation, the city in 2010 to 2019, this decade, 2010, 2014 and 2019, the efficiency of the value is 1, that Suzhou port for the economic development of Suzhou, Suzhou port construction and development to promote trade between Suzhou and the establishment of bilateral economic and trade cooperation relations, the input and output of high efficiency. In the other 7 years, the efficiency value of Suzhou port to its city is less than 1, and the efficiency value of Suzhou's development to Suzhou's economic development is low. However, the analysis results of the effectiveness of the port to the city in these years are between 0.9 and 1, indicating that the port has been in a benign state of development. Although the development of Suzhou Port lags behind that of Suzhou City, with the increase of investment in Suzhou Port and the continuous improvement of port handling capacity, the economic development of Suzhou city will be promoted.

The program prepared by Lingo software was used to solve the DEA model of Suzhou's effectiveness for Suzhou Port, and the definition of variable constraint variable set, initial data of variable and definition of variable set were input into Lingo software for operation. According to the operation of Lingo software, the effectiveness evaluation results of the port and its city were shown in the following table

Table 5-3 Effective evaluation data indicators of Suzhou Port

Year	Number of employees on duty at the end of the year (10,000)	Fixed Asset Investment (100 million YUAN)	Total merchandise imports and exports (US \$100 million)	Container throughput (tons)
2010	126.97	2617.82	2740.76	364.4
2011	129.83	4502.02	3008.63	450
2012	130.40	5266.49	3056.92	586
2013	131.78	6001.94	3093.48	530.52
2014	285.47	6230.67	3113.06	445
2015	307.21	6124.43	3053.5	510.19
2016	295.79	5648.49	2737.58	547.92
2017	279.90	5629.59	3160.79	587.52
2018	282.52	4555.70	3541.14	635.51
2019	280.60	1933.1	3190.86	626.74

Table 5-4 Shows the efficiency of Suzhou city for Suzhou Port

Year	Efficiency value	The validity of
2010	1	effective
2011	0.9497916	invalid
2012	1	invalid
2013	1	invalid
2014	0.7859828	effective
2015	0.8663776	invalid
2016	1	invalid
2017	1	invalid
2018	0.9157870	invalid
2019	1	effective

According to table 5-4 suzhou on their port development effectiveness of the evaluation results, in 2010 to 2019, this decade, except in 2011, 2014, 2014, and 2018, this 4 years, six years of the rest of the town of port efficiency value is 1, the economic development of suzhou during the six years in the development of the port are effective, with the rapid development of urban economy, the port cargo throughput and container throughput has significant improvement, input and output of high efficiency. And the above referred to in the four years, although the development of urban economy evaluation results on the development of their ports as invalid, removed in 2014 and 2015 did not reach 0.9, 2011 and 2018, the efficiency value is greater than 0.9 shows that the economic development of suzhou port throughput of suzhou's influence is not significant relative to the rest of the effective date, but it can still reflect the suzhou city in the process of economic development of suzhou port role into the benign development stage. According to the above table of interaction effects, we can get the mutual efficiency values between cities and ports as shown in Table 5-5 below

Table 5-5 Statistics of efficiency values of mutual influence between port and city

Year	City to port efficiency value	Port to city efficiency value
2010	1	1
2011	0.9486958	0.9497916
2012	0.9142344	1
2013	0.9057876	1
2014	1	0.7859828
2015	0.9253026	0.8663776
2016	0.9219752	1
2017	0.9416305	1
2018	0.9665103	0.9157870
2019	1	1

According to table 5-5 between suzhou port and port city comprehensive effectiveness evaluation result shows, in the 10 years from 2010 to 2019, the economic development of port and city is effective in 2010, and in 2019, the efficiency values are 1, 2 years indicates that the development of suzhou port and Qingdao economic development presents the trend of the development of effective, in addition, in 2011, 2015 and 2018, the impact of the three years between port and city suzhou are invalid, from the data can reflect the port and city development not balanced, In the remaining 5 years, one of the two efficiency values of port and city interaction is effective.

## 6. Conclusion

It Can be seen from the above empirical analysis, for nearly 10 years in suzhou port affect the economic efficiency in suzhou, and suzhou on the efficiency of the port impact studies can be concluded that suzhou port promoted the economic development in suzhou city, suzhou city's GDP is so high also cannot leave the contribution of port, this is in line with the suzhou city as a "big brother" of the development of the module in the south of jiangsu, but we can also see suzhou city in 2014 and 2015 for port efficiency value is lower than 0.9 can reflect the influence of these two years efficiency relationship is not very big, the rest of the year the bidirectional efficiency were greater than 0.9 research significance. At the same time, Suzhou municipal government should also vigorously support the port construction, make full use of the natural conditions of the existing ports, develop the port scientifically and rationally, clarify the functional positioning of each port area, accelerate the pace of information port construction, so as to improve the economy of Suzhou to a higher level.

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