Performance Evaluation of Chinese Listed port companies under the "Belt and Road Initiative"

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Abstract： With the proposed national strategy of "New Silk Road Economic Belt" and "21st Century Maritime Silk Road" ("Belt and Road Initiative"), China's ports usher in new opportunities for development. In this paper, PCA method is used to extract the principal components index, and DEA method is used to analyze the performance of 16 listed port companies in China. We shows that enterprises in the Bohai Rim region are not stable in technological change and scale efficiency, and enterprises in the Yellow Sea develop more slowly, meanwhile companies in the East China Sea are relatively stable and technologies are relatively scarce; and enterprises in the coastal regions of the Yangtze River have technological advances and scale efficiency has been effectively improved. At last, We find that enterprises in the Pearl River Delta region developed well. The comparison of the efficiency before and after the implementation of the Belt and Road Initiative shows that the efficiency of listed port companies has been greatly improved after the strategy was put forward.

1. INTRODUCTION

Port plays an increasingly important role in China's economic development and opening up. The development level of the port has become an important indicator of the economic strength of a country or region. With the development of economic globalization and the regional strategy along the "Belt and Road Initiative", we will further carry out international economic cooperation and the healthy development of port companies will be of great importance to our national economy.

There are many methods to evaluate the performance of port enterprises, such as analytic hierarchy process, principal component analysis, fuzzy comprehensive evaluation, data envelopment analysis, BP neural network evaluation and factor analysis[1]. In this paper, PCA method is used to eliminate the correlation between the evaluation index, reduce the workload of the index selection, use its strong ability to extract the highest score on the principal component index, as the input and output of the DEA Malmquist Indicators, making the evaluation value more practical. Therefore, this article combines both PCA and DEA Malmquist to better evaluate the performance of the China’s listed port companies.

2. METHODOLOGY

Principal component analysis (PCA) is a statistical dimensionality reduction approach that transforms an associated orthonormal vector into an uncorrelated new random vector by using an orthogonal transform, which appears to be the covariance matrix algebra of the original random vector Transform into a diagonal matrix, transform the original geometric coordinates into a new orthogonal coordinate system, point it to the orthogonal direction of the sampling point P orthogonal to the most open p orthogonal direction, and then multi-dimensional variable system dimensions to make its high-precision system Into low-dimensional variables, and then through the construction of appropriate value function, make it into a one-dimensional system.

Data envelopment analysis is based on Farrell's concept of analyzing the UK's agricultural production process[2]. In 1978, data envelopment analysis (DEA) was proposed by Charnes, Cooper and Rhodes[3] and introduced DEA as a tool to measure the efficiency and productivity of

decision-making units. DEA is immediately recognized as a modern tool for measuring performance[4]. This method is an efficiency evaluation method formed by the intersection of mathematics, statistics, operations research and quantitative economics and other disciplines. It establishes a non-parametric interface of related data by means of linear programming and evaluates the efficiency through non-parametric interface. The data envelopment analysis is a multi-input and multi-output efficiency evaluation method, which is suitable for the comparison of the effectiveness of the same type of unit. In comparison, input and output indicators can have different sizes, which can be compared dimensionlessly, which is a typical non-parametric analysis method.

In 1953, Sten Malmqiust, a mathematician and statistician, put forward the Malmquist index method[5] in order to evaluate the changes in consumption efficiency when studying the changes in consumption. Taking the technique of period t as a reference value, the Malmquist index measures the change of total factor productivity from period t to t+1[6], and the change is also considered as the unit of comprehensive efficiency change. The Malmquist index constructs the distance function as The actual production point (x, y) to the ideal minimum point of compression ratio[7]. The Malmquist index refers to the ratio of two or more different distance functions over different periods.

In 1994, the establishment of the Malmquist productivity index by Rolf and Fare, etc., and factor growth was decomposed into the product of changes in technology and technological efficiency. The decomposition of the Malmquist index is as follows:

$$M\left(x^{t+1}, y^{t+1}, x^{t}, y^{t}\right)=\frac{D^{t}\left(x^{t}, y^{t}\right)}{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}\times\left[\frac{D^{t+1}\left(x^{t}, y^{t}\right)}{D^{t}\left(x^{t}, y^{t}\right)}\times\frac{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D^{t+1}\left(x^{t+1}, y^{t+1}\right)}\right]^{1/2}=EC\times TC \quad (1)$$

The average of the two ratios in parentheses in equation (1) represents the technical change (TC) from period t to period t+1. This effect is called the "frontal plane shift effect" and indicates a technological change. When TC is greater than 1 When, that technology advances, TC less than 1, said the technology backslide. equation (1) The part outside the parentheses indicates the distance between the existing inputs and the optimal inputs, ie, the relative technical efficiency is evaluated. This effect is called "catch-up effect"[8]. If EC is greater than 1, Closer to the production frontier, the overall efficiency has been improved; if EC is less than 1, then the overall efficiency decreased.

3. DATA DESCRIPTION

The data is obtained from the CSMAR database and the annual report of the listed port companies. The period of the data is from January 2011 to December 2016.

We select data based on the following two standards:(1)Not including the companies whose data is not full. (2) Excluding the ST and *ST Inc. Finally we get the 16 Chinese Listed port companies.

In order to describe the development of various regions along the Belt and Road, 16 listed port companies are divided into five regions, as shown in Table 1.

Table1 Regional division table

Bohai Rim	Yellow Sea region	East China Sea region	Yangtze River region	Pan-Pearl River Delta region
Tianjin Port	Rizhao Port	Shanghai International Port	Nanjing Port	Zhuhai Port
Dalian Port PDA	Lianyungang Port	Xiamen Port	Chongqing Gangjiu	Yan Tian Port
Jinzhou Port		Ningbo Port		Shenzhen Chiwan
Yingkou Port				Beibuwan Port
Tangshan Port				

4. PERFORMANCE EVALUATION INDEXES SELECTION OF CHINESE LISTED PORT COMPANIES

There are many literatures about the comprehensive evaluation index system of port logistics in recent years at home and abroad. Lummus et al. not only proposed seven steps in developing a strategic supply chain plan, but also enumerated the four main assessment indicators of supply chain performance in four aspects: process management, supply, demand management, delivery and a total of 10 Basic Indicators[9]. Khalid Bichou and other measures of port performance indicators include such as financial indicators, throughput indicators, production efficiency indicators and economic impact indicators and many other aspects[10]. Yun Jun and other major port in China's coastal port logistics efficiency evaluation index, which contains the input indicators are classified as the terminal front depth, the number of container berths, the total number of mechanical units, the level of information eight indicators, the output indicators of container throughput and container throughput Volume growth rate[11]. Luo Dan and Xie Shouhong selected the input indicators based on both the selection criteria and the availability of data to evaluate the two aspects: the total number of berths, berths of 10,000 tons and above, the level of port information, port logistics main business costs, port road density, port fixed assets Total, length of quay shoreline, number of logistics personnel employed in port and shipping industry; output index: cargo loss rate and operating income of port logistics[12].

Based on the research of many scholars, this paper uses the following evaluation indicators, as shown in the following Table 2.

TABLE 2. Performance Evaluation Indexes of Listed port companies

First Indicators	Secondary Indicators	Formula
Size	Total assets	——
	Net assets	——
	Operating income	——
	Number of employees	——
	Earnings per share	——
capacity	Return on Assets	(Total profit / total assets)×100％
	Rate of Return on Common Stockholders' Equity	（Net profit after tax / net assets）×100％
	Per capita rate of return	（Net profit after tax / number of employees）×100％
Cost control ability	Operating income margin	（Operating profit / operating income）×100％
	Asset expense ratio	（Current total expenses / total assets）×100％
	Per capita fee rate	（Total cost of the current / total number of employees）×100％
Growth ability	Cost rate	（Period expenses / operating costs）×100％
	Annual revenue growth rate	（Revenue growth / total revenue for the previous year）×100％
	Net profit growth rate	（Net profit growth / net profit last year）×100％
	Net asset growth rate	((Closing net assets - Beginning net assets / Beginning net assets)×100％
	The total annual growth rate of assets	（Total assets growth this year / total assets at the beginning of the year）×100％

Calculated by the PCA analysis shows that the Return on Assets, Net assets, Per capita rate of return and Total assets in the first principal component of the load. The Number of employees and operating income in the second principal component of the higher load. The Net profit growth rate and The total annual growth rate of assets are higher in the third principal component. Per capita rate of return and Per capita fee rate accounted for the largest load on the fourth and fifth principal components respectively.

16 indicators in the extracted five principal components of the score, so select the highest score on each principal component of the value as the principal component of the naming, at the same

time which is as the DEA analysis of input and output indicators. The analysis shows that the Return on Assets, The Number of employees, Net asset growth rate, Rate of Return on Common Stockholders' Equity, Per capita fee rate respectively in the first principal component, the second principal component, the third principal component, the fourth principal component and the fifth principal component In the ranking of the first, so these five principal components are available for total return on assets, the total number of employees, the net asset growth rate, Rate of Return on Common Stockholders' Equity, Per capita fee rate. The Input indicators and output indicators are in Table 3.

TABLE 3. Input Indicator and Output Indicator

Input Indicator	Output Indicator
Number of employees	Rate of Return on Common Stockholders' Equity
Per capita fee rate	Net asset growth rate
	Earnings per share

At last，we use DEAP2.1 software to calculate the Malmquist indexs of the 16 Chinese Listed port companies

5. RESULT

According to the divided regions, we obtained the number of valid indicators of Malmquist indexs in the deap2.1. The results show that the number of valid indicators varies from region to region.

5.1 Analysis of the Number of Effective Indicators in Bohai Rim Region from 2011 to 2016

In the Bohai Rim region, the effective indicators for a total of 6 years from 2011 to 2016 varied continuously from high to low. Among them, the biggest change is the effective number of valid indicators in 2015 is only nine, of which the effective number of techch (technical change) and tfp (total factor productivity) is zero, and the effective number of pech (pure technical efficiency) is only one. The Huang Bohai region contains five listed port companies, that is, only one company in 2015 pech (pure technical efficiency) effective. 2011 and 2014 sech (scale efficiency) are invalid. The 2012 techch (technical change) is null and void, but 17 of the total valid indicators are the same as in 2016.

5.2 Analysis of the Number of Effective Indicators in Yellow Sea region from 2011 to 2016

The total number of valid indicators in the Yellow Sea region is much less than that in the Bohai Sea Rim. Except for the number of companies listed in the Yellow Sea region, which is less than the number of listed companies in the Bohai Rim region, the effective numbers of many indicators are all 0 A In 2012, 2013 and 2015, there are only two effective indicators for the three years. Among them, only sech (scale efficiency) is valid among the five indicators in 2013 and 2015, and the rest are null and void. In 2012, only techch (technical change) and sech (scale efficiency) were valid and both were only 1. The rest were totally null and void. The total effective indicators for 2011-2016 totaled 30. Looking at the Yellow Sea region, we found that many indicators except for the years of 2011 and 2016 showed no effect and were mainly ineffective in terms of technical efficiency, pure technical efficiency and total factor productivity.

5.3 Analysis of the Number of Effective Indicators in East China Sea region from 2011 to 2016

In the East China Sea region, the number of valid indicators in 2014 was the largest, while the number of other effective indicators in the other five years was relatively small. There were 0 invalid techchs in 2013 and 2015 and 0 invalid tfpch in 2013, 2015 and 2016 (total factor productivity changes). We can see that the overall trend is going downhill and the only one region showing a downward trend over time. Although the number of valid indicators in the East China Sea region is larger than that in the Yellow Sea region, the development trend is still going downhill.

It can be seen that the invalid indicators in the East China Sea region are mainly on the techch (technological change) and tfp (total factor productivity).

5.4 Analysis of the Number of Effective Indicators in Yangtze River region from 2011 to 2016

The number of valid indicators in the region along the Yangtze River region in 2013 is 0, which means that all five indicators are invalid. This is a very rare situation. There are only two listed companies in the Yangtze River region and Huanghai regions, so the effective numbers are not too much. The total effective number of the Yangtze River region is 32. The overall development trend was also a high and a low continuous ups and downs. In 2014, the number of valid indicators is the largest, with nine. Because there are only two listed companies in the region, the overall efficiency of the region in 2014 is generally close to ideal. However, in 2011, 2012 and 2015, there were some indicators that all showed no effect. It can be seen that there are invalid indicators in all the indicators along the Yangtze River region. Among them, all the indicators in 2013 show 0 invalid.

5.5 Analysis of the Number of Effective Indicators in Pan-Pearl River Delta region from 2011 to 2016

The overall development of the Pan-Pearl River Delta region is still relatively good, second only to the development of the Bohai Rim region. Techch (technical change) and tfp (total factor productivity change) are shown to be ineffective in 2015, Techch (technical change) is invalid in 2012. As a whole, the number of effective indicators in the Pearl River Delta region in 2011-2016 is more balanced and the ups and downs are not particularly large. The most effective indicators in the Pan-Pearl River Delta region with a total of 15 in 2013 and 2016.

5.6 Analysis of the Number of Effective Indicators in Five Regions in 2011-2016

In this paper, the effective indicators for each region divided by the sum of the effective indicators for each region are given as a percentage of the effective indicators for each region. Regionally, we can see directly that the better developed regions are the Bohai Rim region and the Pan-Pearl River Delta region, accounting for 30.23% and 27.90% respectively. The effective indicators in the Yellow Sea region and the Yangtze River region are slightly lower, accounting for 11.62% and 12.40% respectively. It can also find that all the valid indicators in the Bohai Rim region and the Pan-Pearl River Delta region are higher than those in the Yellow Sea region and the Yangtze River region. The main reason for this is that the number of listed companies in different regions is also different. For example, there are five listed port companies in the Yellow Sea region and Bohai Sea region, while there are only two listed companies in the Hohai Sea region. Therefore, the progress of regional development is also different. However, as a whole, the development of all regions in the latter part of the year is relatively good and is on the rise.

5.7 Analysis of the Number of Effective Indicators before and after the Belt and Road Initiative

In order to compare and analyze the changes in the performance of listed companies along the way brought forward by President Xi Jinping in September 2013, this paper regards the empirical results of 2011-2013 as the efficiency before the proposal of the Belt and Road initiative. For the period after 2014-2016 effectiveness.

The total number of effective indicators for effch (technical efficiency change), techch (technical change), pech (pure technical change) and tfpch (total factor productivity change) over the three years from 2014 to 2016 was higher than in 2011-2013, and only sech (scale efficiency) is lower than before the Belt and Road was proposed. Listed companies have improved the technology, pure technical efficiency than ever before. The improvement of technical efficiency is due to the improvement of technology and the improvement of pure technical efficiency. However, the improvement of total factor productivity is small compared with the first three indexes, on the one hand, the reduction of scale efficiency and on the other hand, the improvement of technical efficiency Therefore, TFP in general has improved compared with that of the Belt and Road Initiative.

6. CONCLUSION AND FURTHER DISCUSSION

6.1 Conclusion

The companies in the Bohai Rim region are experiencing extreme changes in terms of technological change and economies of scale over time. For example, technological advances in 2011, 2014 and 2016 have all been effectively improved. The listed companies in the Bohai Sea region progress has been made but there are zero effective indicators for both 2012 and 2015. The five listed companies included in the Bohai Rim region in 2012, 2013 and 2015 are also all effective in scale efficiency, but they also show no effect in 2011 and 2014. Only one company in 2016 is valid. Therefore, it can be seen that the development of the Bohai Rim region in terms of technological change and scale efficiency is not stable. However, from the overall number of valid indicators, the Yellow Sea region and the Bohai Sea region are the best developed in the five regions.

The decrease of technical efficiency caused by the decrease of pure technical efficiency in the listed enterprises in the Yellow Sea region resulted in a decrease in the effective index of technical efficiency due to the small number of effective indicators of pure technical efficiency. The total effective rate of total factor productivity is also relatively small, the development of the Yellow Sea region is relatively slow, and is lack of technology.

The technological change and total factor productivity of listed companies in the East China Sea region are all 0 in 2013 and 2015. Except these two years, the development of the East China Sea region is still relatively stable. It Shows the lack of technology in the East China Sea region.

The effective number of each indicator of listed companies in the coastal regions of the Yangtze River region in 2013 is 0. The number of valid indicators for technical efficiency and economies of scale in 2011 was 0. However, the effective number of these two indicators increased in 2016, indicating that technological progress and economies of scale in the regions along the Yangtze River region have been effectively improved.

The listed companies in the Pan-Pearl River Delta region, except for the number of effective indicators for technology change indicators in 2012 and 2015, have more effective ones and the Pan-Pearl River Delta region have enjoyed better growth. The comparison of the efficiency before and after the implementation of the Belt and Road Initiative shows that the efficiency of listed port companies has greatly improved and improved after the strategy was put forward. It proves that the construction of the Belt and Road Initiative not only brings opportunities and challenges to the port, but also drives the economic development of listed port companies.

6.2 Further Discussion

After the conclusion drawn from the above empirical analysis, the objective and fair reflection of the status quo of the basic situation of China's listed port companies is sufficient and a clear understanding of the advantages and disadvantages of various companies and regional development. In general, listed companies have not reached their maximum output at the state of the art. For listed companies to avoid technical inefficiencies in the countermeasure is to reduce costs. In the scale of efficiency, but also need to make the necessary improvements. First of all, to predict the market capacity needs, in order to reduce the scale of the listed companies is not economical phenomenon. Second, to increase the utilization of some equipment to reduce unreasonable losses. The following is how to improve the performance of China's listed port companies put forward suggestions and policies for improvement:

6.2.1 To strengthen the infrastructure construction of listed companies to improve the competitiveness of the company

The listed port companies further improved infrastructure construction, increased investment in infrastructure construction, strengthened infrastructure construction, tried hard to meet the market throughput demand, planned to increase the berths of professional container terminals, enhance the professionalization of enterprises and increase the business volume of the Company. Enhancing the overall overall efficiency

6.2.2 Deepen the reform and organizational restructuring plan

We should continue to reform the form of loading and unloading labor services, and change the form of labor from looseness to compactness. Optimize the structure of labor organizations and truly achieve full competition in all positions. In accordance with the principle of excellence and the principle of adapting to market competition, and establish a scientific management level.

6.2.3 Technology development and innovation

Enterprises should independently research and develop or purchase the necessary equipment and technologies necessary for the introduction and constantly improve or improve the existing technology, process equipment and management capabilities, improve their own level, promote new productivity, and enhance the efficiency of enterprises and market competitiveness.

6.2.4 Focus on enhancing the strategic cooperation of enterprises, mutual benefit and win-win situation

We should continue to cooperate with the industry to communicate and maintain a good strategic partnership to learn from the management experience, and further improve their management level, to achieve resource integration, complement each other and achieve mutual benefit and win-win.

6.2.5 The government should strengthen the macro-control of port companies and actively guide the policy

On the one hand, we should pay due attention to the development of the port. We should formulate a development policy specifically for the port enterprises. On the other hand, we must have targeted and practicable measures and industrial policies, including the formulation of preferential policies and increased support, and so on. For each resource integration among port enterprises, we should provide special financial subsidies, tax incentives and other form, in order to achieve economies of scale

REFERENCE

[1] Guo xiaoqing. Evaluation on Competitiveness of Xiamen Port And Kaohsiung Port And Study on Strategies of Their Cooperation Development. JiMei university.(2015)

[2] Farrel M.J. The Measurement of productive Efficiency. Journal of the Royal Statistical Society, 120,125-281. (1957)

[3] Charnes a Cooper-WW-Rhodes-E. Measuring the Efficiency of Decision Making Units. European Journal of Operational Research,2,429-444, (1978).

[4] Fr Forsund. Economic interpretations of DEA. Socio-Economic Planning Sciences, 61,9-15. (2018)

[5] Guo Yan. Evaluation of the Efficiency of Agricultural Product Based on DEA Malmquist Index. Bulletin of Science and Technology, 3,31-34, 60,(2014).

[6] Timothy J.Coelli,George E.Battese. An Introduction to Efficiency and Productivity Analysis (China Renmin University press, Beijing, 2008) ,pp. 297-299.

[7] Chen Yi. Empirical Study on China's Agricultural Production Growth Under the Binding of Environment.Chongqing university,(2011).

[8] Yang xinpu. R&D Efficiency Evaluation Based on DEA and Malmquist Index. Harbin Institute of Technology,(2009).

[9] Lummus rr Vokurka,RJ Alber KL. Strategic supply chain planning. Production and Inventory Management Journal, 39,49-58. (1998)

[10] Bichou K Gray-R. A logistics and supply chain management approach to port performance measurement. Maritime Policy & Management, 31,47-67. (2004)

[11] YunJun,Zhang Fan.Port Logistics Efficiency Evaluation Based on DEA Model. Statistics & Decision, 19,39-40.(2006)

[12] Luo Dan,Xie shouhong. A Supply Chain Perspective on Port Logistics Performance Evaluation:Based on Super Efficiency Three-stage DEA Model. Logistics Technology, 3,152-157. (2017)