Matching Analysis of Ship and Marine Engineering Equipment Industry Value in Jiangsu Province

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Abstract. Through the analysis of the correlation between R&D and production links, R&D links and sales links, R&D links and profit links in the overall industry, manufacturing industry and supporting industries of ship and ocean engineering equipment in Jiangsu Province, we get the synergy between R&D and other links. It reveals the dynamic characteristics of the synergy between R&D and other links, clarifies the key development industries and key development links, providing reference for the coordinated development in the different value chains of the ship and ocean engineering equipment industry in Jiangsu Province.

1. Introduction

As an important part of advanced equipment manufacturing industry, Marine engineering equipment industry plays an important role in promoting the transformation and upgrading of China's shipbuilding industry. During the 12th five-year plan period, the shipbuilding and Marine engineering equipment industry in Jiangsu province has achieved leapfrog development. However, although the research and development capacity of the shipbuilding industry in Jiangsu province is in the leading position, there are still some contradictions and problems such as low quality and unreasonable structure, and the research and development investment advantage has not been fully transformed into the productivity and development advantage of the shipbuilding industry.

At present, more and more scholars are studying the value chain of Marine engineering equipment industry. Chen Changjiang et al [1] explored different modes of value chain extension and development of Marine engineering equipment industry and ship industry. He Mengjiao et al [2] studied the influence of network capability on the co-creation capability of ship industry value chain. Gan Aiping et al [3] found that the income in the value chain effect of China's shipbuilding industry was greater than the investment through the calculation of investment multiplier. Zhang Guangming et al. compared the shipbuilding industry of Jiangsu province with that of the whole country through the method of location entropy analysis, and concluded that the development level of the shipbuilding supporting industry of Jiangsu province was higher than the whole country. Zhi Yuanyuan et al. [4] discussed the optimization strategies of the shipbuilding industry structure in Jiangsu province.

In this article, Ship and ocean engineering equipment industry value chain is divided into research and development, production, sales and earnings four link, the link of research and development and the dynamic characteristics of the coordinated development of other parts, ships and ocean engineering equipment industry in Jiangsu province in promoting scientific and technological innovation and industrial development, the depth of the fusion industry competitiveness is of great strategic significance.
2. Association model construction

The research object is Jiangsu provincial ship and Marine engineering equipment industry from 2012 to 2016, which is a small sample data. Due to the limitation of people's understanding of value chain combination in different stages of specific regions and industries, the obtained data information is uncertain to some extent, and the grey correlation analysis method makes up for the deficiency of mathematical statistics method, which is applicable to both the number of samples and the irregularity. According to the similarity or dissimilarity of sequence geometry, the degree of correlation between corresponding sequences was measured. In the process of development, if the change trend of two sequences is consistent, the degree of correlation between them will be higher; otherwise, it will be lower. The grey relational degree model of Ben & Deng is established as follows:

Set reference sequence

\[ X_0 = \{x_0(k), k = 1, 2, ..., n\} \]  

And compare sequences

\[ X_i = \{x_i(k), k = 1, 2, ..., n\}, (i = 1, 2, ..., m) \]  

The grey correlation degree of \( X_0 \) and \( X_0 \) is defined as:

\[ \gamma(X_0, X_i) = \frac{1}{n} \sum_{k=1}^{n} \gamma(x_0(k), x_i(k)) \]  

And:

\[ \gamma(x_0(k), x_i(k)) = \frac{\min\ min_k [x_0(k) - x_i(k)] + \rho \max_k [x_0(k) - x_i(k)]}{\max_k [x_0(k) - x_i(k)] + \rho \max_k [x_0(k) - x_i(k)]} \]  

Is Distinguish coefficient, and \( \rho \in [0, 1] \). The gray relational degree of each sequence was ranked in descending order to obtain the correlation order set and judge the correlation degree of \( X_i \) and \( X_0 \). According to existing research results, when correlation is greater than 0.6, correlation is significant.

3. Correlation analysis of value links between ships and Marine engineering equipment industry

3.1. Analysis of correlation degree of different value links between equipment industry

Table 1 and figure 1 reflect the number of indicators of the overall industrial R&D, production, sales and profit of ship and Marine engineering equipment from 2012 to 2016. You can see that the ship and ocean engineering and equipment research and development of whole industry ring section of invention patent applications and sales link enterprise overall advocate business income rising, and production companies and earnings link on the rules of total corporate profits in a downward trend, especially enterprise profit, the drop is more obvious. The analysis shows that although the main business income is increasing, the total profit is decreasing.

Table 1. Index data of different value links in the overall industry from 2012 to 2016

| The whole industry indicators | 2012    | 2013    | 2014    | 2015    | 2016    |
|-----------------------------|---------|---------|---------|---------|---------|
| R&D link Number of application for invention patent (piece) | 169     | 136     | 392     | 273     | 290     |
| Production process Number of listed enterprises | 451     | 462     | 468     | 429     | 417     |
| Sales link Main business income (ten thousand yuan) | 25401659 | 24930090 | 23164332 | 26331972 | 25554935 |
| Earnings link Total profit (ten thousand yuan) | 32341728 | 2384926 | 1729511 | 1660467 | 1543616 |
Table 2 shows the correlation between ship and Marine engineering equipment's overall industrial R&D and production, R&D and sales, R&D and profit. From the numerical point of view, the matching degree of the three is not very different, between 0.6 and 0.65. It can be seen that the research and development link and the production link, the research and development link and the sales link, the research and development link and the profit link of the whole industry of ship and Marine engineering equipment have a significant correlation with each other. The correlation between R & D and sales is slightly higher than that between other links, with a value of 0.6358, while the correlation between R & D and production is the lowest, 0.6033.

### Table 2. Correlation degree of value links between ship and Marine engineering equipment industry.

| processes            | R&D - production | R&D - sales | R&D - profit |
|----------------------|------------------|-------------|--------------|
| correlation          | 0.6033           | 0.6358      | 0.6205       |

#### 3.2. Correlation analysis of different value links between manufacturing industry

Table 3 and figure 2 reflect the number of indicators in the R&D, production, sales and profit of the shipbuilding and Marine engineering equipment manufacturing industry from 2012 to 2016. In the manufacturing industry, the number of invention patent applications in the research and development link and the main business income in the sales link are on the rise as a whole, while the number of enterprises in the production link and the total profit in the profitable link are on the decline, especially the total profit of enterprises, which has decreased from 2822922 million yuan in 2012 to 902405 million yuan in 2016. Although the main business income is increasing, the total profit is decreasing, which is consistent with the overall situation of Marine engineering and shipping industry.

### Table 3. Index data of different value links in manufacturing industry from 2012 to 2016.

| manufacturing industry | indicators                              | 2012   | 2013   | 2014   | 2015   | 2016   |
|------------------------|------------------------------------------|--------|--------|--------|--------|--------|
| R&D link               | Number of application for invention patent (piece) | 86     | 79     | 187    | 104    | 136    |
| Production process     | Number of listed enterprises              | 164    | 158    | 161    | 144    | 137    |
| Sales link             | Main business income (ten thousand yuan)  | 25401659 | 24930090 | 23164332 | 26331972 | 25554935 |
| Earnings link          | Total profit (ten thousand yuan)          | 2822922 | 1902215 | 1234282 | 950844 | 902405 |
Table 4 shows the correlation between the research and development link and the production link, the research and development link and the sales link, and the research and development link and the profit link of the Marine engineering equipment manufacturing industry. From the perspective of numerical value, the matching degrees of the three are all between 0.6 and 0.72, with a relatively significant correlation. The matching degree between the research and development link and the sales link is slightly higher than other correlation degrees, with the value of 0.7102, while the correlation degree between the research and development link and the profit link is the lowest, 0.604.

3.3 Analysis of correlation degree of different value links between supporting industry
Table 5 and figure 3 reflect the number of indicators in the R&D, production, sales and profit of the Marine engineering equipment supporting industry from 2012 to 2016. It can be seen that in the supporting industry, the number of invention patent applications in the research and development link and the total profit in the profit link are on the rise as a whole, which is different from the whole industry and manufacturing industry. However, the number of enterprises above the designated level in production and the main business income in sales are in a slight decline.

Table 5. Index data of different value links in supporting industry from 2012 to 2016.

| supporting industry | indicators                                      | 2012  | 2013  | 2014  | 2015  | 2016  |
|---------------------|------------------------------------------------|-------|-------|-------|-------|-------|
| R&D link            | Number of application for invention patent (piece) | 83    | 57    | 175   | 169   | 153   |
| Production process  | Number of listed enterprises                    | 280   | 271   | 273   | 248   | 236   |
| Sales link          | Main business income (ten thousand yuan)        | 19610925 | 18048914 | 15650794 | 16586502 | 16587124 |
| Earnings link       | Total profit (ten thousand yuan)                | 358909 | 348446 | 376677 | 478851 | 390777 |
Table 6 shows the correlation between the research and development link and the production link, the research and development link and the sales link, and the research and development link and the profit link of the Marine engineering equipment supporting industry. The correlation degree of the three is between 0.54 and 0.57, which is obviously lower than that of the whole industry and manufacturing industry. The matching degree between the research and development link and the profit link is the highest, with a value of 0.5653. The correlation degree between the research and development link and the production link is the lowest, with a value of 0.5414. It is necessary to enhance the correlation between the research and development links of supporting industries and the links of production, sales and profit.

Table 6. Correlation degree of different value links between supporting industry

| processes          | R&D - production | R&D - sales | R&D - profit |
|--------------------|------------------|-------------|--------------|
| correlation        | 0.5414           | 0.5658      | 0.5653       |

4. The value chain matching analysis results of ship and Marine engineering equipment industry

(1) The overall industry research and development link of ship and Marine engineering equipment in Jiangsu province is significantly correlated with other links. The overall industrial research and development links are significantly related to production, sales and profitability. The number of invention patent applications and the main business income of the enterprise in the overall industry research and development of ship and Marine engineering equipment are on the rise, while the number of enterprises in the production process and the total profit of the enterprise in the profit process are on the decline, especially the total profit of the enterprise.

(2) The correlation between the research and development of the ship building and Marine engineering equipment manufacturing industry in Jiangsu province and other links is better than that of the supporting industries. The research and development link of manufacturing industry is more related to production, sales and profit than the supporting industry. Although the total profit of different value links in the supporting industry is on the rise, the correlation between the research and development link and the production link, the research and development link and the sales link, and the research and development link and the profit link is small, indicating that the development trend consistency among the research and development, production and sales of the supporting industry is poor.

5. Suggestions

This paper puts forward the following Suggestions from the matching analysis:

(1) Strengthen the linkage effect of R&D, production, sales and profit in the value chain of ship and Marine engineering equipment industry. We will strengthen the integration of resources, make full use of the research and development capabilities of research institutions, promote the transformation of research results, and promote the application, production and sale of new technology products.

(2) The correlation between each link of the value chain of Marine engineering equipment manufacturing industry and ship maintenance industry has been steadily improved, so as to give full play to its role in promoting the overall industry of Marine engineering equipment and ship
maintenance industry. By promoting the close cooperation between ship enterprises, the strategic alliance of key products or related technologies is established to promote the sustainable development of ship and Marine engineering equipment manufacturing industry.

(3) Improve the coordination and linkage between each link of the value chain of the Marine engineering equipment supporting industry and realize its joint development with the Marine engineering equipment manufacturing industry. We can strengthen independent innovation, improve the level of research and development and design of Marine auxiliary equipment, and enhance the overall competitiveness of the auxiliary industry.

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