

# Research on the Agglomeration of Jiangsu Electromechanical Industry Based on the Method of Order Relation Analysis

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**Abstract**—Industrial agglomeration is considered by many scholars as a spatial organization that can achieve the highest economic benefits. This article combines the status quo of the export trade of mechanical and electrical products in Jiangsu Province, summarizes its export advantages and difficulties faced by exports, and analyzes the main influencing factors of the formation, development, maturity, and decline of Jiangsu's mechanical and electrical industry clustering from the perspective of the industrial cluster life cycle and the weight of each influencing factor, aiming to inject new vitality into the export of Jiangsu's electromechanical industry, bring better development opportunities, and walk away from emerging development bottlenecks.

## 1 INTRODUCTION

### 1.1 The export volume of mechanical and electrical products slows down in the post-financial crisis era

In recent years, Jiangsu's exports of mechanical and electrical products accounted for more than 55% of Jiangsu's total exports (as shown in Table 1). It has become a new force in promoting the rapid development of Jiangsu's foreign trade with a great contribution rate. The country ranks in the forefront.

From 2000 to 2008, the export value of mechanical and electrical products in Jiangsu Province increased from 9.69 billion US dollars to 136.48 billion US dollars. However, with the increase in comprehensive costs such as labor and

exchange rates, the traditional competitive advantages of mechanical and electrical products are gradually weakening. Coupled with the phenomenon of shrinking overseas markets after the global financial crisis in 2008, trade protectionism has risen, and the international industrial division of labor has also experienced profound changes. Changes, Jiangsu's export of mechanical and electrical products gradually slowed down from 2012 to 2015, and even experienced a second negative growth in 2016. As the current economic and trade scale of Jiangsu Province is already very large, it will be difficult for foreign trade to obtain breakthrough development momentum before the new round of technological revolution and the resulting transformation and upgrading generate new growth momentum. Low-speed growth will become the "new normal" of foreign trade.

**TABLE 1.** EXPORTS OF JIANGSU'S MECHANICAL AND ELECTRICAL PRODUCTS FROM 2008 TO 2018

years	Mechanical and electrical exports (One hundred million U.S. dollars)	Year-on-year growth	Total exports (100 million US dollars)	Year-on-year growth	The proportion of mechanical and electrical products in total exports
2008	1364.7960	14.4%	2380.3627	16.8%	57.3%
2009	1194.4616	-12.5%	1992.4278	-16.3%	60.0%
2010	1644.8028	37.7%	2705.5014	35.8%	60.8%
2011	1788.0782	8.7%	3126.2305	15.6%	57.2%
2012	1807.9423	1.1%	3244.4163	3.8%	55.7%
2013	1813.2848	0.3%	3246.5195	0.06%	55.9%
2014	1871.7293	3.2%	3377.4301	4.0%	55.4%
2015	1889.8514	1.0%	3336.5671	-1.2%	56.6%
2016	1739.6215	-7.9%	3129.1098	-6.2%	55.6%
2017	1981.1741	13.9%	3467.1500	10.8%	57.1%
2018	2216.3355	11.9%	3844.6034	10.9%	57.6%

(The data comes from the data compiled by the Jiangsu Provincial Department of Commerce)

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### 1.2 The export mode based on processing trade has a tendency to change

Since it is impossible to obtain the export value of processing trade in Jiangsu's mechanical and electrical product exports, the export value of all processing trade in Jiangsu indirectly reflects the export situation of mechanical and electrical product processing trade. Based on the analysis of the current situation of electromechanical products, it is concluded that although Jiangsu's export mode of electromechanical products based on processing trade has a trend of change, it is more dependent on processing trade. It can be seen that processing trade was the main form of export trade in Jiangsu from 2014 to 2018.

## 2 THE ADVANTAGES AND DIFFICULTIES OF JIANGSU'S ELECTROMECHANICAL INDUSTRY

In 2018, there were 3,348 foreign direct investment projects in Jiangsu Province, with a registered agreement of US\$60,522.16 million and actual use of US\$25.59.248 million. Among them, 733 were foreign direct investment projects in mechanical and electrical sectors, accounting for 21.9%.

Foxconn, Taiwan Glass, Darfon and other large-scale leading and base projects have settled in northern Jiangsu, which has strongly promoted industrial transformation and upgrading in northern Jiangsu. The establishment of R&D centers by foreign capital is accelerating. A large number of world-renowned multinational companies, including Bosch, Ford, Samsung, etc., have invested in Jiangsu and established more than 100 independent legal person foreign R&D centers, mainly involving biomedicine, electronic information, machinery, automobiles and Parts, new energy, new materials and other fields.

However, most electromechanical enterprises in Jiangsu Province currently lack the ability to independently research and develop new products. The exported electromechanical products rarely have core technologies and independent intellectual property rights, and the proportion of exports of independent brands is less than

20%. The lack of high-tech talents, low investment in research and development, and lack of awareness of innovation have led to the low technical content of the products exported by electromechanical products, backward processes, and low levels of the industrial chain. The scale of production is expanded to increase benefits. The vast majority of exports of mechanical and electrical products are based on OEM orders. This simple volume expansion model is not conducive to sustainable economic growth and the improvement of international competitiveness.

In addition, with the aging of our country's population, the advantage of the labor force has gradually disappeared. The labor cost in Cambodia, Myanmar, and Bangladesh is far lower than that in our country. The electromechanical industry is a labor-intensive industry, which causes foreign-funded enterprises to choose lower labor costs in Cambodia, Myanmar, India and other countries to invest and set up factories to produce electromechanical products. Even electromechanical enterprises in our province are also facing pressure from the cost of raw materials and labor.

## 3 FACTORS INFLUENCING THE CLUSTERING OF JIANGSU'S ELECTROMECHANICAL INDUSTRY

Based on the main influencing factors of general industry clustering in the whole life cycle, combined with the main problems faced in the process of clustering transformation of Jiangsu electromechanical industry, this paper proposes 11 main influencing factors of Jiangsu electromechanical industry clustering. Specifically include: the degree of specialized division of labor and social collaboration within the industry, open market conditions, diversified export trade methods, flexible cost control strategies, government policy support, a common cultural environment, sufficient social capital, Diversified product export markets, innovative technology support, significant innovation advantages and the creation of independent cluster brands. Table 2 shows the corresponding relationship between the influencing factors and the stages of the industrial cluster life cycle.

**TABLE 2.** THE MAIN INFLUENCING FACTORS OF JIANGSU'S ELECTROMECHANICAL INDUSTRY CLUSTERING IN THE LIFE CYCLE PROCESS

Industrial cluster life cycle	Main factors affecting general industrial clustering	The main problems of Jiangsu's electromechanical industry clustering	The main influencing factors of Jiangsu's electromechanical industry cluster
Formation stage	Degree of professional division of labor and collaboration Open market conditions	—	Degree of professional division of labor and collaboration Open market conditions
Progression stage	Common cultural environment Government policy support	The cost of production factors is higher Single export trade method	Diversified export trade methods Flexible cost control strategy Government policy support Common cultural environment

Mature stage	Sufficient social capital Innovative technology support	Excessive concentration of export markets	Sufficient social capital Diverse product export markets Innovative technology support
Recession phase	Significant innovation advantage Creation of independent cluster brand	——	Significant innovation advantage Creation of independent cluster brand

## 4 WEIGHT ANALYSIS OF FACTORS AFFECTING JIANGSU'S MECHANICAL AND ELECTRICAL INDUSTRY CLUSTER

### 4.1 Order relation method

The order relationship analysis method, also known as the G1 method, is proposed for the inconsistency defect of the judgment matrix construction in the analytic hierarchy process. This method is a method of determining the weight of factors without the need for consistency testing. In addition, the order relation method has no limit on the number of schemes, and can fully express the preference of the judgment expert, and its results are highly reliable. Therefore, this paper adopts the method of order relation to determine the weight of the influencing factors of Jiangsu's electromechanical industry clustering.

### 4.2 Weight determination

According to the processing steps of the order relationship method on the factor weight coefficient problem, this paper comprehensively selects 15 experts from 11 companies in the Jiangsu electromechanical industry chain, and collects the importance ranking information of the 11 influencing factors of Jiangsu electromechanical industry clustering through questionnaire surveys. The ratio information of the

relative importance of adjacent factors in the sum-order relationship. A total of 40 questionnaires were distributed and 35 valid questionnaires were returned. In order to facilitate the statistics of the survey results, this article simplifies the 11 influencing factors in turn, namely { the degree of specialized division of labor and social collaboration within the industry, open market conditions, diversified export trade methods, flexible cost control strategies, government policy support, a common cultural environment, sufficient social capital, diversified product export markets, innovative technology support, significant innovation advantages and the creation of independent cluster

brands. }= $\{C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}\}$ . The analysis of the survey results of the importance ranking of influencing factors is based on the principle of "the minority obeys the majority", and the number of voters of each influencing factor under each importance ranking number is compared, and the order relationship of the influencing factors of Jiangsu's electromechanical industry clustering is finally determined. According to the ranking results of importance, with reference to the relative importance degree assignment standard, the ratio of the relative importance degree of 15 experts to adjacent influencing factors  $r_k$  was calculated. After calculating the sum and average, the final value is obtained. The statistics of the two questionnaire surveys are shown in Table 3 and Table 4.

**TABLE 3.** RANKING RESULTS OF THE IMPORTANCE OF INFLUENCING FACTORS OF JIANGSU'S ELECTROMECHANICAL INDUSTRY CLUSTERING

	$x_1^*$	$x_2^*$	$x_3^*$	$x_4^*$	$x_5^*$	$x_6^*$	$x_7^*$	$x_8^*$	$x_9^*$	$x_{10}^*$	$x_{11}^*$
C <sub>1</sub>	6	5	4	—	—	—	—	—	—	—	—
C <sub>2</sub>	5	5	3	1	1	—	—	—	—	—	—
C <sub>3</sub>	—	1	2	3	4	1	—	—	—	4	—
C <sub>4</sub>	—	2	3	3	3	1	—	—	3	—	—
C <sub>5</sub>	1	1	3	5	5	—	—	—	—	—	—
C <sub>6</sub>	—	—	2	2	2	—	3	—	2	1	3
C <sub>7</sub>	—	—	—	1	4	—	2	1	1	2	4
C <sub>8</sub>	—	—	—	—	2	5	3	1	2	2	—
C <sub>9</sub>	—	—	5	3	2	—	—	2	2	1	—
C <sub>10</sub>	2	2	3	7	1	—	—	—	—	—	—
C <sub>11</sub>	2	1	6	4	1	1	—	—	—	—	—
Order relation	$C_1 \geq C_2 \geq C_{11} \geq C_{10} \geq C_5 \geq C_7 \geq C_6 \geq C_8 \geq C_4 \geq C_3 \geq C_9$										

The statistics of the order relationship of the influencing factors are carried out in the order of  $x_1^* > x_2^* > \dots > x_m^*$ . When the ordering encounters conflicts, first consider whether any of the conflicting factors has already appeared in the ordering relationship, if any, remove the ordered factors, and then the number of votes according to the factors How much is sorted. If none of the conflicting factors appear in the sorting result, refer to the number of

voters under other sorting sequence number  $x_m^*$ , and the priority sorting with more votes. The statistical analysis and the average results of the relative importance of adjacent influencing factors in the sequence relationship  $C1 \geq C2 \geq C11 \geq C10 \geq C5 \geq C7 \geq C6 \geq C8 \geq C4 \geq C3 \geq C9$  are shown in Table 4. This questionnaire survey issued 15 questionnaires and 14 valid questionnaires were returned. Therefore, the author only counted 14 Comprehensive value of expert opinions.

**TABLE 4.** THE RATIO OF RELATIVE IMPORTANCE OF ADJACENT FACTORS IN THE SEQUENCE OF CLUSTERING INFLUENCING FACTORS

Expert	$r_2$	$r_3$	$r_4$	$r_5$	$r_6$	$r_7$	$r_8$	$r_9$	$r_{10}$	$r_{11}$
1	1.4	1.4	1.6	1.6	1.2	1.4	1.4	1.4	1.6	1.4
2	1.2	1.6	1.4	1.4	1.4	1.2	1.3	1.6	1.4	1.2
3	1.4	1.6	1.6	1.4	1.8	1.6	1.6	1	1.7	1.6
4	1.3	1.4	1.3	1.2	1.6	1.6	1.8	1.2	1.4	1.4
5	1.2	1.4	1.2	1.8	1.3	1.6	1.6	1.6	1.6	1.2
6	1.4	1.6	1.4	1.4	1.8	1.4	1.7	1.2	1.6	1.4
7	1.4	1.7	1.6	1.2	1.6	1.3	1.6	1.3	1.6	1.6
8	1.4	1.6	1.6	1.7	1.6	1.8	1.4	1.7	1.4	1.8
9	1.2	1.6	1.7	1.6	1.2	1.4	1.4	1.6	1.3	1.3
10	1.2	1.4	1.4	1.3	1.4	1.6	1.2	1.6	1.2	1.7
11	1.4	1.8	1.4	1.6	1.4	1.7	1.4	1.4	1.4	1.6
12	1.3	1.4	1.6	1.8	1.8	1.6	1.2	1.4	1.8	1.4
13	1.4	1.3	1.8	1.4	1.6	1.4	1.6	1.2	1.6	1.4
14	1.2	1.4	1.4	1.6	1.4	1.4	1.4	1.8	1.4	1.6
<b>Comprehensive value</b>	1.31	1.51	1.50	1.50	1.51	1.50	1.47	1.43	1.50	1.47

The order relationship can be transformed,

$$w_{11}^* = \left( 1 + \frac{w_{10}^*}{w_{11}^*} + \frac{w_9^*}{w_{11}^*} + \frac{w_8^*}{w_{11}^*} + \frac{w_7^*}{w_{11}^*} + \frac{w_6^*}{w_{11}^*} + \frac{w_5^*}{w_{11}^*} + \frac{w_4^*}{w_{11}^*} + \frac{w_3^*}{w_{11}^*} + \frac{w_2^*}{w_{11}^*} + \frac{w_1^*}{w_{11}^*} \right)^{-1}$$

$$= \left( 1 + r_{11} + r_{11}r_{10} + r_{11}r_{10}r_9 + r_{11}r_{10}r_9r_8 + r_{11}r_{10}r_9r_8r_7 + r_{11}r_{10}r_9r_8r_7r_6 + r_{11}r_{10}r_9r_8r_7r_6r_5 + r_{11}r_{10}r_9r_8r_7r_6r_5r_4 + r_{11}r_{10}r_9r_8r_7r_6r_5r_4r_3 + r_{11}r_{10}r_9r_8r_7r_6r_5r_4r_3r_2 \right)^{-1} \quad (1)$$

Substitute the data in Table 4, we can get

$w_{11}^* = (1 + 49.8256)^{-1} = 0.020$  , After formula calculation,

$$w_{10}^* = w_{11}^*r_{11} = 0.028, w_9^* = w_{10}^*r_{10} = 0.035, w_8^* = w_9^*r_9 = 0.043$$

$$w_7^* = w_8^*r_8 = 0.054, w_6^* = w_7^*r_7 = 0.069, w_5^* = w_6^*r_6 = 0.089$$

$$w_4^* = w_5^*r_5 = 0.135, w_3^* = w_4^*r_4 = 0.157, w_2^* = w_3^*r_3 = 0.168$$

$$w_1^* = w_2^*r_2 = 0.223 \quad (2)$$

Table 5 shows the weight coefficients of the influencing factors of Jiangsu's electromechanical industry clustering.

**TABLE 5.** INFLUENCING FACTORS AND WEIGHT COEFFICIENTS OF JIANGSU'S ELECTROMECHANICAL INDUSTRY CLUSTER

Influencing factors	Weight coefficient
Degree of professional division of labor and collaboration	0.223
Significant innovation advantage	0.168
Creation of independent cluster brand	0.157
Open market conditions	0.135
Government policy support	0.089
Diverse product export markets	0.069
Innovative technology support	0.054
Common cultural environment	0.043
Flexible cost control strategy	0.035
Diversified export trade methods	0.028
Sufficient social capital	0.020

## 5 CONCLUSION

Combined with the main problems in the process of clustering of Jiangsu's electromechanical industry, the main influencing factors of Jiangsu's electromechanical industry clustering during the four stages of formation, development, maturity and decline are analyzed from the perspective of the life cycle of the industrial cluster. Among them, among the 11 main influencing factors of the clustering of Jiangsu's electromechanical industry, the degree of professional division of labor and collaboration, significant innovation advantage, and the establishment of independent cluster brands have the largest weight.

To further promote the agglomeration and development of Jiangsu's electromechanical industry, it is necessary to enhance the competitiveness of the industry from several aspects such as the government's leading role in industrial development, the main role of enterprises in industrial development, and the coordination role of industry associations in industrial development.

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