

Research on the Measurement of Manufacturing Industry Integration Level of Shandong Capital City Cluster

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Abstract: This paper analyzes the integration level of regional manufacturing industry by measuring the similarity coefficient of manufacturing industry structure and regional division index between Jinan, the capital city of Shandong province, and other cities in the region from 2012 to 2017. From 2012 to 2017, the similarity coefficient of industrial structure of Shandong capital city cluster is declining; the regional division index is rising; and the industrial transformation of Jinan in the region has made remarkable progress, which is conducive to the continuous improvement of regional integration level.

1 INTRODUCTION

The level of industrial integration is an important indicator to measure the level of regional integration. According to economic theory, regional division of labor is a spatial form of social division of labor, while industrial division is an organizational form of regional division of labor. Regional division of labor according to their own resource endowments can improve production efficiency. Shandong capital city cluster includes Jinan, Zibo, Dezhou, Liaocheng, Tai'an, Laiwu, and Zouping, six prefecture-level cities and one county-level city, with a total population of 30.91 million by 2017 and an area of 43000 square kilometers. Taking Jinan as the center, the provincial capital city cluster is a typical "center-periphery" spatial mode. Since the implementation of the model, regional coordination and integration has made remarkable progress, but there are still some areas leave much to be desired in the process of development. This paper attempts to analyze the regional integration progress of the capital city cluster in Shandong province from the perspective of industrial integration.

2 THE SETTING OF INDUSTRIAL INTEGRATION INDEX

In this paper, similarity coefficient of industrial structure and index of regional division of labor are used to measure the industrial integration level of the cities in the capital city cluster of Shandong province.

A. Similarity Coefficient of Industrial Structure

The similarity coefficient of industrial structure is used to measure the similarities and differences of industrial structure between regions. If the similarity of industrial structure between regions is very high, the industrial competition between regions must be very

fierce, which will lead to regional protection between regions. On the other hand, if the similarity coefficient of industrial structure between regions is too low, the industrial synergy between regions must be poor, and the industrial connection between regions will not be strong[1]. The calculation formula of industrial structure similarity coefficient is as follows:

$$S_{ij} = \frac{\sum_{k=1}^n X_{ik}X_{jk}}{\sqrt{(\sum_{k=1}^n X_{ik}^2)(\sum_{k=1}^n X_{jk}^2)}} \quad (1)$$

In this Formula, S_{ij} is the similarity coefficient of industrial structure of two regions in the area, X_{ik} , X_{jk} , respectively, are the ratio of k industry in the industrial structure of region i and the ratio of k industry in the industrial structure of region j. The value range of S_{ij} is generally 0 ~ 1. The smaller the value of S_{ij} is, the more different the industrial structure is between the two regions. The closer S_{ij} is to 1, the higher the industrial structure similarity is between the two regions.

B. Regional Division of Labor Index

Since Paul R. Krugman put forward the index of regional division of labor, the index of regional division of labor has become an important index to measure regional integration. The calculation formula of regional division index is as follows[2][3]:

$$S_{jk} = \sum_{i=1}^n \left| \frac{q_{ik}}{q_k} - \frac{q_{ij}}{q_j} \right| \quad (2)$$

In the formula, S_{jk} is the regional division index of region j and region k; q_k and q_j are the total industrial output value of the two regions respectively, and q_{ik} and q_{ij} are the output value of industry i of the two regions respectively. S_{jk} value ranges from 0 to 2. If the industrial structures of the two regions are identical, the index is 0; if the industrial structures of the two regions are completely different, the index is 2.

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3 THE MEASUREMENT OF INDUSTRIAL INTEGRATION LEVEL OF THE CAPITAL CITY CLUSTER IN SHANDONG PROVINCE

The data of this paper comes from the statistical yearbook of each city in the capital city cluster of Shandong province. Because Zouping is a county-level city, the scale of its manufacturing industry is too small compared with other prefecture-level cities, it is not considered in the comparison. According to the industry classification standard set by China National Bureau of Statistics,

China's manufacturing industry is divided into 31 categories. The manufacturing output value of each city in the capital city cluster of Shandong province is mainly concentrated in the top 29 categories. Due to the changes of industry classification standard over the years, this paper adjusts the classifications of some manufacturing industry to ensure the consistency of the industry statistics data over the years. After the adjustment, the manufacturing industries in the capital city cluster of Shandong province are divided into 26 categories, which are as follows:

TABLE I. CATEGORIES OF MANUFACTURING INDUSTRIES IN THE CAPITAL CITY CLUSTER OF SHANDONG PROVINCE

Industry category	Industry category	Industry category	Industry category
Agricultural and sideline food processing industry	textile industry	Furniture manufacturing	Petroleum processing, coking, and nuclear fuel processing industry
Food manufacturing	Textile clothing, clothing industry, chemical fiber manufacturing industry	Paper making and paper manufacturing	Chemical raw materials and chemical products manufacturing industry
Wine, beverage, and refined tea manufacturing	Leather, fur, feather and their products, and footwear industry	Printing and recording media reproduction industry	Pharmaceutical manufacturing
Tobacco products industry	Wood processing and wood, bamboo, rattan, palm, and grass products industry	Culture and education, industry and beauty, sports and entertainment products manufacturing industry	Rubber and plastic products industry
Nonmetallic mineral products industry	General equipment manufacturing	Nonferrous metal smelting and rolling industry	Transportation equipment manufacturing industry
Ferrous metal smelting and rolling industry	Special equipment manufacturing industry	Metal products industry	Manufacturing of computer, communication and other electronic equipment
Electrical machinery and equipment manufacturing industry	Instrument manufacturing industry		

A. Calculation of Similarity Coefficient of Industrial Structure

This paper measures the industrial structure similarity coefficient of the manufacturing industries of Jinan city cluster from 2012 to 2017. The provincial capital city cluster is a regional spatial structure with Jinan as the center and other cities as the periphery. Therefore, the similarity coefficient of industrial structure is mainly used to calculate the industrial structure similarity between Jinan and the peripheral cities. The results are as follows:

TABLE II. INDUSTRIAL STRUCTURE SIMILARITY

	2012	2013	2014	2015	2016	2017
Zibo	0.65	0.61	0.62	0.64	0.59	0.48
Tai'an	0.80	0.80	0.81	0.89	0.85	0.66
Dezhou	0.63	0.68	0.71	0.91	0.86	0.69
Liaocheng	0.57	0.59	0.60	0.83	0.80	0.63
Laiwu	0.43	0.43	0.47	0.42	0.39	0.26

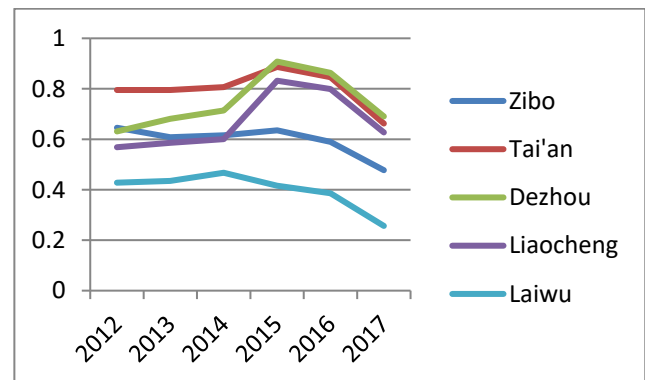


Figure 1. industrial structure similarity

As shown in the figure1 above, the similarity coefficient of manufacturing industrial structure between Jinan, the center, and the surrounding cities shows a trend of rising first and then declining. Before 2015, Tai'an had the highest similarity with Jinan's manufacturing industrial structure, and Laiwu had the lowest similarity. After 2015, the similarity coefficient of manufacturing industrial structure between Jinan and Dezhou was the highest, and 2015 was a turning point. The manufacturing industrial structure of Jinan and the surrounding cities shows an obvious downward trend.

B. Calculation of the Regional Division of Labor Index

The index of regional division of labor between Jinan, the center of the capital city cluster of Shandong province, and the surrounding cities is calculated. The results are as follows:

TABLE III. INDEX OF REGIONAL DIVISION

	2012	2013	2014	2015	2016	2017
Zibo	0.82	0.85	0.84	0.87	0.88	0.97
Tai'an	0.65	0.66	0.66	0.62	0.63	0.75
Dezhou	0.83	0.78	0.75	0.68	0.68	0.70
Liaocheng	0.88	0.84	0.79	0.76	0.76	0.89
Laiwu	1.28	1.15	1.04	1.03	1.10	1.37

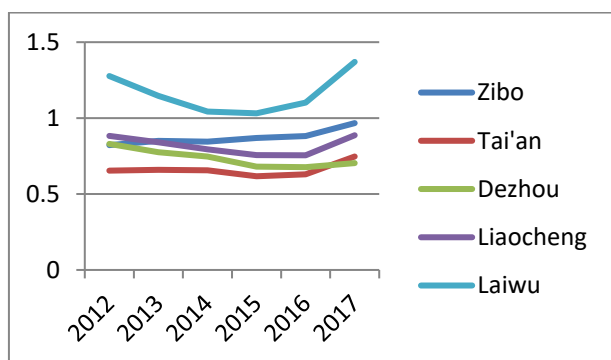


Figure 2. index of regional division

As shown in the figure2 above, according to the calculation of regional division of labor index, before 2015, Laiwu had the largest difference in industrial structure from Jinan and other cities in the provincial capital city cluster, and Tai'an had the smallest difference. Besides, the difference remained stable before 2015. However, since 2016, the difference in industrial structure between cities has increased, which is more obvious in Laiwu.

4 ANALYSIS ON THE DIFFERENCE OF MANUFACTURING INDUSTRIAL STRUCTURE IN THE CAPITAL CITY CLUSTER OF SHANDONG PROVINCE

The industrial structures of each city in the capital city cluster of Shandong province are very different. The industrial structure of Jinan is relatively balanced, with 26 manufacturing industries involved in the structure. In 2012, the industry with the largest output value is transportation equipment manufacturing, accounting for 15.49% of the total. In 2017, its output value increased to 21.88%, while the proportion of other industries is less than 10%[4].

Zibo's manufacturing industry was very concentrated, with chemical raw materials and chemical products manufacturing industry accounting for 27%, petroleum processing, coking and nuclear fuel processing industry accounting for 14.38%, and non-metallic mineral products industry accounting for 15.96% in 2012. These three industries totally accounted for 57.34%. In 2017, the share of the three industries hardly changed.

As for Tai'an, it has no manufacturing industry with special advantage, only some industries, such as chemical raw materials and chemical products manufacturing, general equipment manufacturing, and non-metallic mineral products industry, accounted for slightly 10% of the output value.

Dezhou's dominant manufacturing industries are agricultural and sideline food processing industry, and chemical raw materials and chemical products manufacturing industry, with the output value accounting for 13.64% and 11.5% respectively in 2012. In 2017, the advantages of agricultural and sideline food processing industry were more obvious, with the output value accounting for 13.46%, while the output value of other industries accounting for less than 10%.

Liaocheng's dominant manufacturing industries are textile industry, non-ferrous metal smelting and rolling processing industry. In 2012, the output value of these two industries accounted for 10.41% and 17.3%. In 2017, the proportion of textile industry, non-ferrous metal smelting industry and rolling processing industry decreased slightly, accounting for 10.84% and 15.49% respectively; and the proportion of general equipment manufacturing industry increased slightly, accounting for 11.88%.

In the capital city cluster of Shandong province, Laiwu has the simplest industrial structure of manufacturing industry, and almost all its output value of manufacturing industry is concentrated in ferrous metal smelting and rolling processing industry. In 2012, ferrous metal smelting and calendaring industry accounted for 69% of Laiwu's manufacturing output value; in 2017, it accounted for 68%; many other industries' output value in Laiwu was 0, only agricultural and sideline food processing industry accounted for slightly more than 5%.

The following table shows the top three industries in manufacturing output value of Shandong capital city cluster in 2012 and 2017:

TABLE IV. TOP THREE MANUFACTURING INDUSTRIES IN 2012

Top three manufacturing industries in 2012											
Jinan		Zibo		Tai'an		Dezhou		Liaocheng		Laiwu	
industry	Ratio	industry	Ratio	industry	Ratio	industry	Ratio	industry	Ratio	industry	Ratio
Transportation equipment manufacturing industry	15.49	Chemical raw materials and chemical products manufacturing industry	20	Chemical raw materials and chemical products manufacturing industry	11.68	Agricultural and sideline food processing industry	13.6	Non ferrous metal smelting and rolling industry	17.3	Ferrous metal smelting and rolling industry	69
Ferrous metal smelting and rolling industry	9.4	Nonmetallic mineral products industry	15.9	General equipment manufacturing	11.17	Chemical raw materials and chemical products manufacturing industry	11.5	textile industry	10.4	Chemical raw materials and chemical products manufacturing industry	4.26
Petroleum processing, coking and nuclear fuel processing industry	8.95	Petroleum processing, coking and nuclear fuel processing industry	14.38	Nonmetallic mineral products industry	9.45	Nonmetallic mineral products industry	9.46	Transportation equipment manufacturing industry	9.18	Metal products industry	3.9

TABLE V. TOP THREE MANUFACTURING INDUSTRIES IN 2017

Top three manufacturing industries in 2017											
Jinan		Zibo		Tai'an		Dezhou		Liaocheng		Laiwu	
industry	Ratio	industry	Ratio	industry	Ratio	industry	Ratio	industry	Ratio	industry	Ratio
Transportation equipment manufacturing industry	21.88	Chemical raw materials and chemical products manufacturing industry	28.24	General equipment manufacturing	10.97	Agricultural and sideline food processing industry	13.45	Non ferrous metal smelting and rolling industry	15.49	Ferrous metal smelting and rolling industry	68.55
Manufacturing of computer, communication and other electronic equipment	10.05	Petroleum processing, coking and nuclear fuel processing industry	16.62	Nonmetallic mineral products industry	10.7	Chemical raw materials and chemical products manufacturing industry	9.85	General equipment manufacturing	11.88	Agricultural and sideline food processing industry	5.43
General equipment manufacturing	9.08	Nonmetallic mineral products industry	12.5	Chemical raw materials and chemical products manufacturing industry	10	General equipment manufacturing	8.85	textile industry	10.84	Chemical raw materials and chemical products manufacturing industry	3.53

5 ANALYSIS ON THE TENDENCY OF CHANGE

If we use the median 0.5 of the similarity coefficient of industrial structure to distinguish, Jinan, the center of provincial capital city cluster, has a high similarity in

industrial structure with other cities except Laiwu. The high similarity of industrial structure means that there is a competitive relationship in industrial structure among Jinan, the center of the region, and the surrounding cities. The similarity coefficient of manufacturing industrial structure between Jinan, Dezhou and Tai'an reached 90%

in 2015, which means that there is a strong competitive relationship among the three cities[5].

From the perspective of regional integration, the optimal mode of industrial structure for central city and peripheral cities should realize reasonable regional division of labor and cooperation according to their respective resource endowments, so as to realize the most effective use of regional resources. When there is no trade barrier in a region and the transportation cost is very low, industries tend to gather in one area. The industrial similarity between Jinan and Laiwu is very low, which shows that the merger of Jinan and Laiwu is a correct decision. The lower manufacturing industry similarity means that Jinan and Laiwu have less competition in manufacturing industries and they can compensate for each other, which is conducive to the further development of regional integration.

Since 2015, the similarity of industrial structure between Jinan and other cities in the region has been decreasing, and the regional division index has been improving. The reason behind this is that the industrial transformation of Jinan is accelerating. From table 4 and table 5, it can be found that in 2012, the top three manufacturing industries in Jinan are transportation equipment manufacturing, ferrous metal smelting and rolling processing, petroleum processing, coking and nuclear fuel processing. However, by 2017, the top three industries have become transportation equipment manufacturing, computer, communication and other electronic equipment manufacturing, and general equipment manufacturing, which shows the industrial upgrading of Jinan has started. However, that of other cities in the region is not obvious. Generally speaking, the improvement of regional division of labor is conducive to the development of regional integration.

REFERENCES

1. Griffith E. Testing the von Thunen theory in Uruguay[J]. *Geographical Review*, 1973, 63: 500-516.
2. Krugman P. *Geography and Trade* [M]. Leuven University Press, 1991.
3. Krugman P. Increasing Returns and Economic Geography[J]. *Journal of Political Economy*, 1991(99): 483-499.
4. Fujita, M and Thisse, J.F. *Economics of Agglomeration: Cities, Industrial Location and Regional Growth* [M]. Cambridge: Cambridge University press, 2002.
5. Noughton, Barry. *How Much Can Regional Integration Do to Unify China's Market*, University of California at San Diego Mimeo, 1999.