Study on the Spatial Agglomeration of China's Agricultural Product Processing Industry: Measurement and Regression Analysis

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Abstract

The large-scale and regional characteristics of the agricultural product processing industry are becoming more and more obvious, so the research on the spatial agglomeration and influencing factors of the industry has important significance. This paper uses Wind database, "China Statistical Yearbook" and other data, firstly uses industrial concentration and location entropy to measure the agglomeration level of China's agricultural product processing industry in 2016. And then based on theoretical foundations, this paper selects relevant influencing factors to establish econometric models for empirical research. Through regression analysis using Stata software, it is finally found that: there are many significant spatial agglomeration phenomena in China's agricultural product processing industry, and it is formed by a variety of factors, among which natural endowment, scale economy, foreign direct investment and local government intervention play a significant positive role in promoting the spatial agglomeration of China's agricultural product processing industry.

Keywords-*spatial agglomeration; location entropy; spatial measurement model*

1. INTRODUCTION

Industrial spatial agglomeration refers to the process in which the capital elements of a certain industry are continuously concentrated within a specific geographic area. The greater the degree of concentration, the more conducive to reducing costs and increasing economies of scale. In recent years, the role of industrial space agglomeration in the modern economy has become increasingly prominent. The "Made in China 2025" promulgated by the State Council of China is to promote the formation of industrial agglomeration in terms of policies. The agricultural product processing industry is a follow-up industry closely linked to agriculture. Its development will help promote the modernization of China's agriculture and improve the competitiveness of the agricultural market and operating efficiency. With the increasingly obvious characteristics of the scale, regionalization and specialization of the agricultural product processing industry, the spatial agglomeration phenomenon of the agricultural product processing industry has gradually attracted widespread attention from scholars. Compared with other industries in the manufacturing industry, the development of the agro-processing industry is relatively slow, so early scholars did not have enough research on it. Most of the previous studies focused on the investigation of China's industrial agglomeration or the classification of the agricultural product processing industry into the manufacturing industry, and the measurement methods of industrial agglomeration were not diverse. Therefore, it is necessary to understand the development stage of the agro-industrial clusters and to measure the level of the agro-industrial clusters.

In recent years, the main research objects of industrial spatial agglomeration have mostly been other industries in the manufacturing industry, and the research on the spatial agglomeration of agricultural products processing industry often only focuses on measuring its concentration without specific analysis of its influencing factors. The innovation of this article is mainly to use different indicators to qualitatively measure the spatial agglomeration level of the agricultural product processing industry, and to specifically analyze and discuss its influencing factors.

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2. Literature Review

In recent years, a large number of scholars have conducted a large number of in-depth studies based on the measurement methods of the spatial agglomeration level of various industries in China. Li, J.X. used the geographic concentration of industries to quantitatively measure and analyze the agglomeration level of China's food industry [1]. Zhang, D.M., Xie, J.M. and Zhu, Z.C. used two methods of EG index and spatial Gini coefficient to quantitatively calculate and analyze the industrial spatial agglomeration level of the agricultural product processing industry in Jilin Province [2].

The agricultural product processing industry is also of great significance for increasing the growth rate of the national economy. Burger, K., Kameo, D. and Sandee, H. took Indonesia as an example, studied the spatial agglomeration of small and medium-sized agro-processing industries, and found that one of the important factors affecting the spatial agglomeration of their enterprises is the target market demand [3]. Jafar, A. and Eshghi, TA used the relevant data of the olive industry in Northern Iran in 2007 and found that there are corporate capital disadvantages within the olive industry cluster in Northern Iran, and companies should pay more attention to active information exchange and communication cooperation, which will help the industry cluster development [4]. Zhang, K. Researched and verified the two-way influence mechanism of industrial agglomeration and regional innovation from the perspective of technological effect and scale effect [5]. Luo, F.M., based on the dynamic mechanism of the spatial agglomeration of the agricultural product processing industry, carried out a quantitative analysis of its related influencing factors from multiple angles [6].

The theory of industrial spatial agglomeration has only attracted the attention of a large number of scholars in the past two decades, and there is still much room for digging in this theory. On the basis of previous studies, this article will use industry concentration and location entropy to measure the agglomeration level of my country's agricultural product processing industry. Moreover, natural endowments, human capital endowments, economies of scale, technological externalities, infrastructure construction, foreign direct investment, and local government intervention are the basic factors that affect industrial agglomeration.

3. The Spatial Agglomeration Status of China's Agricultural Product Processing Industry

3.1. Study Jects and Data Sources

Statistically, there are 12 industries related to the processing industry of agricultural products in China, including "Food Processing Industry", "Food Manufacturing", "Beverage Manufacturing", "Textile Industry", "Tobacco Processing Industry", "Clothing and Other Fiber Products Manufacturing", "Leather, Fur, Down and Its Products Industry", "Furniture Manufacturing", "Wood Processing and Bamboo, Rattan and Palm Grass Products Industry", "Papermaking and Paper Products Industry", "Reproduction of recording media in the printing industry" and "Rubber Products Industry".

Due to the lack of data for the agricultural product processing industry by province and industry, the data of the research objects in this article are all intercepted to 2016 in order to maintain the consistency of the research data of the article.

This section calculates the industry concentration and location entropy of each province based on the province and industry data of the agricultural product processing industry in 2016. The data comes from the China Statistical Yearbook (2017) and Wind official statistical database. Among them, the total output value of different provinces by industry is extracted from the official Wind statistical database, and the total industrial output value of each province is extracted from the "China Statistical Yearbook" (2017).

3.2. Measurement Indexes

3.2.1. Industrial Concentration

Industrial concentration refers to the index used to measure the degree of industrial agglomeration by using the relevant values of the largest regions in a certain industry to account for the country's share. The regional division level in this article is province, and the relevant values adopted are drafted as output value. The formula for calculating industry concentration is as follows:

$$CR_{\mathrm{n}} = \sum_{i=1}^{n} X_i / \sum_{i=1}^{N} X_i \qquad (1)$$

In (1), CR_n represents the industrial concentration of industry X, n represents the top provinces of the scale. CR_n reflects the degree of agglomeration of the X industry in the previous province, and its value is between 0 and 1. The larger the value, the more concentrated the industry in the first n provinces.

3.2.2. Location entropy

Location entropy refers to the ratio between the proportion of the output value of a specific department in the total industrial output value of the region and the proportion of the output value of the specific department in the country's total industrial output value. The calculation formula of location entropy is as follows:

$$Y = \left(\frac{S_{ij}}{\sum_{j=1}^{n} S_{ij}}\right) / \left(\frac{\sum_{i=1}^{m} S_{ij}}{\sum_{i=1}^{m}\sum_{j=1}^{n} S_{ij}}\right) \quad (2)$$

In (2), Y represents location entropy, and S_{ij} represents the output value of industry j in area i. The larger the value of Y, the higher the level of specialization. When its value is greater than 1, it can be judged that the industry belongs to the specialized department of its specific area.

3.3. Measurement and Analysis of the Indexes

3.3.1. Industrial Concentration

In this paper, the relevant indicator data of each industry of agricultural products in 2016 are used. Due to the lack of data from Hong Kong, Macao and Taiwan, they are not calculated. Based on n being 5, the industry concentration of each industry in China's 31 provinces is calculated. The specific calculation results are shown in Table 1.

TABLE 1. CR_5 OF DIFFERENT INDUSTRIES IN AGRICULTURAL PRODUCTS PROCESSING INDUSTRY IN 2016

Industry	*Top 5 provinces by size*	*CR_5*
Food Processing Industry	Jiangsu, Shandong, Henan, Hubei, Guangdong	0.477
Food Manufacturing	Tianjin, Fujian, Shandong, Henan, Guangdong	0.454
Beverage Manufacturing	Jiangsu, Shandong, Henan, Hubei, Sichuan	0.481
Textile Industry	Shanghai, Zhejiang, Hubei, Hunan, Yunnan	0.498
Tobacco Processing Industry	Jiangsu, Zhejiang, Shandong, Henan, Guangdong	0.677
Clothing and Other Fiber Products Manufacturing	Jiangsu, Zhejiang, Fujian, Shandong, Guangdong	0.671
Leather, Fur, Down and Its Products Industry	Hebei, Zhejiang, Fujian, Henan, Guangdong	0.670
Furniture Manufacturing	Jiangsu, Fujian, Shandong, Henan, Guangxi	0.556
Wood Processing and Bamboo, Rattan and Palm Grass Products Industry	Zhejiang, Shandong, Henan, Guangdong, Sichuan	0.592
Papermaking and Paper Products Industry	Jiangsu, Zhejiang, Shandong, Henan, Guangdong	0.582
Reproduction of recording media in the printing industry	Jiangsu, Anhui, Shandong, Henan, Guangdong	0.535
Rubber Products Industry	Jiangsu, Zhejiang, Shandong, Henan, Guangdong	0.598

It can be seen from Table I that the value of the 12 sub-sectors of the agricultural product processing industry is between 0.4 and 0.7, and there is a clear phenomenon of industrial agglomeration. In 2016, these 12 industries gathered more frequently in the five provinces of Jiangsu, Zhejiang, Shandong, Henan, and Guangdong, indicating that these areas belong to the main clusters of agricultural products processing industries. The industrial agglomeration areas of these agricultural products processing industries show the characteristics of being highly concentrated in the eastern part of China. The possible reason is that the eastern part of China is relatively ahead of the central and western parts of China in terms of urbanization development. It

also has greater advantages in technology, talents, capital, infrastructure and other endowments. Therefore, it can be used in the processing of agricultural products in these areas. To a certain extent, it can carry out coordinated development and drive each other.

3.3.2. Location Entropy

In this paper, the relevant index data of each industry of agricultural products in 2016 is used to calculate the location entropy of 31 provinces in the country (excluding Hong Kong, Macao and Taiwan regions). Among them, the data of the rubber products industry is missing, so it is not calculated. The calculation results of the food processing industry are shown in Table 2.

TABLE 2. LOCATION ENTROPY OF FOOD PROCESSING INDUSTRY BY INDUSTRY IN 2016

Province	*Y*	*Province*	*Y*	*Province*	*Y*
Beijing	0.363	Anhui	1.256	Sichuan	1.230
Tianjin	0.602	Fujian	1.132	Guizhou	0.546
Hebei	0.801	Jiangxi	1.103	Yunnan	1.188
Shanxi	0.449	Shandong	1.453	Tibet	0.353
Inner Mongolia	1.460	Henan	1.394	Shaanxi	0.932
Liaoning	1.228	Hubei	1.784	Gansu	1.067
Jilin	2.261	Hunan	1.391	Qinghai	0.638
Heilongjiang	4.125	Guangdong	0.418	Ningxia	0.555
Shanghai	0.167	Guangxi	1.586	Xinjiang	1.114
Jiangsu	0.549	Hainan	1.113		
Zhejiang	0.263	Chongqing	0.752		

It can be seen from the research that there are provinces with location entropy greater than 1 in all types of agricultural product processing industries. Each industry has corresponding specialized regions. For example, the food processing industry belongs to specialized departments in 17 provinces. A relatively obvious industrial agglomeration has formed, which shows that the overall agglomeration level of the agricultural product processing industry is relatively high.

4. ANALYSIS ON INFLUENCING FACTORS

From the third section, it can be inferred that China's agricultural product processing industry currently has obvious spatial agglomeration. This section will further analyze and discuss which factors determine industrial agglomeration.

4.1. Variables Selection and Description

4.1.1. Independent Variable

Location entropy is widely used in the research of regional dominant industries. This article refers to existing research and will use location entropy as an indicator to measure the industrial agglomeration level of China's agricultural product processing industry [7].

4.1.2. Dependent Variables

Based on the literature of domestic and foreign scholars on the formation mechanism of industrial agglomeration, this paper divides the factors affecting the formation of spatial agglomeration of China's agricultural products processing industry into seven aspects: natural endowment, human capital endowment, economies of scale, technological externality, infrastructure construction, foreign direct investment and local government intervention. This paper uses the data of total agricultural output value(X_1), average labor cost(X_2), the proportion of the number of agricultural products processing enterprises in the whole country(X_3), the turnover of technology market(X_4), the proportion of fixed assets investment in GDP(X_5), the total foreign direct investment(X_6) and the proportion of fiscal expenditure in GDP(X_7).

4.2. Data Sources

This section uses the data of Chinese provinces from 2007 to 2016 to calculate relevant indicators. The data are from wind official statistical database, China Statistical Yearbook (2008-2017), China Industrial Statistical

Yearbook (2013-2017) and China Industrial Economic Statistical Yearbook (2008-2012).

4.3. Construction of Spatial Measurement Model

Based on the selection of variables in this article, the spatial measurement model is established as follows:

$$Y_{it} = \alpha + \beta_1 \ln X_{1_{it}} + \beta_2 \ln X_{2_{it}} + \beta_3 X_{3_{it}} + \beta_4 \ln X_{4_{it}} + \beta_5 X_{5_{it}} + \beta_6 \ln X_{6_{it}} + \beta_7 X_{7_{it}} + \mu_{it} \quad (3)$$

In (3), Y_{it} represents the industrial cluster level of province i during period t.

4.4. Empirical Analysis

4.4.1. Cointegration Test of Panel Data

The cointegration test of panel data can explore whether there is a stable long-term cointegration relationship between variables. Since the sequence of each variable in this paper satisfies the cointegration test condition, that is, it belongs to the same order single integer sequence, so the cointegration test can be performed. In this paper, the Pedroni test method is used for cointegration test, and the test results are shown in Table 3.

TABLE 3. RESULTS OF PEDRONI TEST

Statistic type	*Statistic-value*	*P-value*
Modified Phillips-Perron t	10.4030***	0.0000
Phillips-Perron t	-10.6887***	0.0000
Augmented Dickey-Fuller t	-9.2260***	0.0000

a. *** means that it has passed the significance test at the 1% level.

According to Table 3, the three statistics are all 0.0000. This means that the three statistics of the Pedroni test reject the null hypothesis at a confidence level of 1%, and there is a long-term cointegration relationship between each variable.

4.4.2. Regression Analysis

In this paper, the Hausman test method is adopted to determine whether the model is a fixed effect or a random effect. The test results are shown in Table 4.

TABLE 4. RESULTS OF HAUSMAN TEST

Statistic type	*Statistic-value*	*P-value*
Chi-Sq.Statistic	8.87	0.2623

The result of Hausman test showed that Prob>chi2=0.2623, the fixed-effect model was rejected and the random-effect model was selected. Therefore, a random effects model was established, and Stata software was used to perform random effects regression. The regression results are shown in Table 5.

TABLE 5. REGRESSION RESULTS OF RANDOM EFFECT MODEL

Variable	*Coefficient*	*Statistic-value*
$\ln X_1$	0.43412	4.96***
$\ln X_2$	-0.1770455	-0.82
X_3	0.1366353	0.20
$\ln X_4$	-0.0783123	-1.40
X_5	-0.6780662	-3.74***
$\ln X_6$	0.1491616	3.90***
X_7	3.337651	4.41***
Constant	-1.13866	-0.54
Term	*Value*	
R^2	0.1203	
Wald chi2(7)	35.61	
Prob > chi2	0.0000	
Type of Model	RE	

a. *** means that it has passed the significance test at the 1% level.

It can be seen from Table 5 that each variable can better explain the formation of the spatial agglomeration of the agricultural product processing industry. On the other hand, this also shows that ignoring any one of the factors in the formation of the spatial agglomeration of the agricultural product processing industry may reduce the credibility of the empirical results.

According to the regression results, natural endowment, foreign direct investment and local government intervention have a very significant positive effect on the spatial agglomeration of the agricultural product processing industry, while the positive effect of economies of scale is not significant, but it is consistent with economic facts. Human capital endowments and technological externalities have an inverse relationship with the aggregating level of the agricultural product processing industry. This may be because the special nature of the agricultural product processing industry does not have excessive requirements on the level of labor and technical factors. Infrastructure construction has a significant negative impact on the agglomeration level of the agricultural product processing industry, which is inconsistent with theory. Generally speaking, good infrastructure construction conditions can positively promote industrial development by improving industrial production efficiency. This can be explained as

the fact that when infrastructure construction does not reach a certain scale, this factor cannot exert its own influence.

5. Conclusions and Recommendations

At present, there are a large number of significant spatial agglomeration phenomena in China's agricultural product processing industry. Based on the results of industrial concentration and location entropy in 2016, the various sub-sectors of the agricultural product processing industry tend to be concentrated in eastern China, the overall level of industrial agglomeration of China's agricultural product processing industry is relatively high, and it has begun to show specialization characteristics on a large scale.

Through research, this paper finds that the spatial agglomeration of the agricultural product processing industry is affected by a variety of factors, among which the positive influence factors are natural endowment, economies of scale, foreign direct investment and local government intervention; the negative influence factors are human capital endowment, technological externalities, infrastructure construction.

In order to promote the spatial agglomeration development of China's agricultural product processing industry, combined with the research conclusions, this article puts forward the following recommendations. Continuously promote the standardization of agricultural production. Reasonably plan the industrial layout and use economies of scale to improve economic benefits. Attract foreign investment and open up the international market. Promote the development of local government policy support for the agricultural product processing industry.

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