He, Q., Zhang, J.B., Wang, L.J., Zeng, Y.M. (2020), "Impact of Agricultural Industry Agglomeration on Income Growth: Spatial Effects and Clustering Differences", *Transformations in Business & Economics*, Vol. 19, No 3C (51C), pp.486 -507.

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BUSINESS & ECONOMICS

IMPACT OF AGRICULTURAL INDUSTRY AGGLOMERATION ON INCOME GROWTH: SPATIAL EFFECTS AND CLUSTERING DIFFERENCES[1]

[1]Qing He
Affiliation 1:
Department of Economics and Management, Huazhong Agricultural University,
Wuhan, Hubei, 430070,
China

Affiliation 2:
Department of Mathematics and Economics,
Hubei University of Education,
Wuhan, Hubei, 430205
China
E-mail: wanzj@mail.hzau.edu.cn

[2]Junbiao Zhang
Department of Economics and Management,
Huazhong Agricultural University,
Wuhan, Hubei, 430070
China
E-mail: zhangjb513@126.com

[3]Lijun Wang
Department of Economics and Management,
Hubei University of Technology,
Wuhan, Hubei, 430068
China
E-mail: wanglj2019@126.com

[4]Yangmei Zeng
Department of Resource Economics and Environmental Sociology,
University of Alberta,
9007-116 St NW, Edmonton
Canada
E-mail: yangmei@ualberta.ca

[1]Qing He, PhD, is postdoctoral and currently studying in Department of Economics and Management, Huazhong Agricultural University, and working in Department of Mathematics and Economics, Hubei University of Education, China. She obtained her doctor's degree from Zhongnan University of Economics and Law, China. Her research interests focus on sustainable development economics.

[2]Junbiao Zhang (*corresponding author*), PhD, is professor and currently working in Department of Economics and Management, Huazhong Agricultural University, China. He obtained his doctor's degree from Huazhong Agricultural University, China. His research interests focus on sustainable development economics.

[1]**Acknowledgment**. This study was supported by the National Natural Science Foundation of China (Grant No. 71333006) & the China Postdoctoral Science Foundation (Grant No. 2018M632888).

[3]**Lijun Wang**, PhD, is postdoctoral and currently working in Hubei University of Technology, China. He obtained his doctor's degree from Wuhan University of Technology, China. His research interests focus on sustainable development economics.

[4]**Yangmei Zeng**, MSc, is PhD candidate at Huazhong Agricultural University. She is now studying as a visiting student in Department of Resource Economics and Environmental Sociology, University of Alberta, Canada. Her research interests focus on sustainable and environmental economics.

Received: January, 2020
1st Revision: May, 2020
2nd Revision: August, 2020
Accepted: December, 2020

ABSTRACT. ***Industrial agglomeration can increase income, but the income of farmers is uncertain under agricultural industry agglomeration. Agricultural industry agglomeration can not only increase farmers' income due to the scale effect, but it can also cause the loss of agricultural production resources and reduce farmers' income due to the siphon effect. To explore the spatial effects and the cluster differences in the impact of agricultural industrial agglomeration on the growth of farmers' income. On the basis of spatial economics, the Moran's I index of location entropy and spatial auto-correlation were used to analyze the correlation between China's agricultural industry agglomeration and farmers' income growth in 2003-2017. The spatial panel Durbin model under two different weight matrices was constructed to explore the impact and spatial interaction effects of China's agricultural agglomeration on farmers' income. Finally, a threshold model was used to analyze the cluster differences of the impact of agricultural industry agglomeration on income growth in three different degrees of agricultural agglomeration areas. Results demonstrate that a spatial correlation is found between the geographical agglomeration of agricultural industry and farmers' income in China. From the perspective of space, the externality of agricultural industry agglomeration significantly increases the income of local farmers. The siphon effect of agricultural industry agglomeration has a restraining effect on the income growth of farmers in surrounding areas, which may aggravate the unbalanced development of the rural economy. The groups with different aggregation degrees have obvious differences. In the high and moderate agricultural agglomeration areas, agricultural industry agglomeration has a significant effect on the increase of farmers' income, but in low agglomeration areas, the effect is not obvious. The conclusions provide theoretical references for the government in the layout and the structure optimization of the agricultural industry.***

KEYWORDS: agglomeration of agricultural industry, spatial Durbin model, direct effects, indirect effects, threshold model.

JEL classification: D31, Q12, Q18, L16, O18, C33.

Introduction

Fifty percent of the world's production activities are concentrated in 1.5% of the earth's land area. The prosperity of the global economy dominates the world economic map through the phenomenon of spatial agglomeration. From geographical discovery to industrial revolution, the history of human social development is a history of struggle that demonstrates the constantly opposing distance between autocracy and collective welfare. The World Bank puts forward that the core of income growth is to stimulate economic growth and to increase employment opportunities, so that the market can better benefit the poor, and the poor can have jobs to earn a living. Enterprise agglomeration provides effective income growth and employment channels for countries and regions (Strotmann *et al.,* 2019; Lu *et al.,* 2020). Studies claim that industrial agglomeration can improve income levels or labor productivity. Under the assumption of complete competition and constant returns to scale, neoclassical economic growth theory posits that the economic growth of various regions would eventually converge. However, neoclassical economic growth theory ignores geographical factors. As a result, related industries in another region could be gradually transferred out due to the outflow of production factors. Finally, the pattern of industrial agglomeration would be formed. Moreover, industrial agglomeration was claimed to promote the growth of economy and income through the role of externalities.

The problems of income growth and poverty reduction are wide concerns in government departments and academic circles (Lu *et al.,* 2019; Mion, Adaui*,* 2020). The poverty-stricken population mainly came from rural areas. Hence, the key to poverty reduction is to promote the growth of farmers' income (Ping, Wang*,* 2018). Regional economic growth is the most effective means of income growth because economic growth can increase total economic volume of the whole society, and welfare brought by economic prosperity can benefit every poor population, and finally achieve income growth (Allanson *et al.,* 2019; Ioannides*,* 2004). With the emergence of new economic geography, spatial agglomeration in economic activities has received growing attention from decision-makers. Industrial agglomeration is the trend of economic activities in a geographical location. Agricultural industry agglomeration is a type of agricultural industry cluster in rural areas based on their unique resource endowment. The cluster is formed to achieve competitive advantages from economies of scale and regional production, to reduce the transaction cost of enterprises, and to develop into a sustainable competitive agricultural industry cluster (Wu *et al.,* 2020; Chen *et al.,* 2018; Sekhon, Kathuria*,* 2019). With the rapid development of the agricultural industry, agricultural agglomeration has become an important force to promote sustainable development of rural economy and agricultural modernization (Picard, Zeng*,* 2005; Yu *et al.,* 2018). Industrial agglomeration improves the production efficiency of Indonesia's cocoa farms, which is conducive to the income growth of Indonesia's rural areas (Effendy *et al.,* 2019). Agricultural industry agglomeration significantly promotes the growth of China's rural economy and farmers' income (Lu, Zhou*,* 2011). Improving the income of rural residents is important to develop efficient and modern agriculture through agricultural industry agglomeration (Jiang, Jiang*,* 2018).

However, the impact of agricultural industry agglomeration on farmers' income is uncertain. Although agricultural industry agglomeration increases farmers' income due to the scale effect, it may also cause loss of agricultural production resources and reduce farmers' income due to the siphon effect. Therefore, the impact of agricultural industry agglomeration on farmers' income growth needs to be examined. Besides, with the improvement of traffic conditions and gradual elimination of institutional barriers, regional ties have become increasingly intense, and neighboring economies may interact with one another. The development of a region not only depends on its conditions, but also makes full use of the favorable factors of surrounding areas, and it is affected by the surrounding environment (Fang *et al.,* 2019). Therefore, the existence of this spatial interaction should be considered when studying the relationship between economic variables. When studying the mechanism of agricultural industrial agglomeration on farmers' income, the spatial effect must be considered.

The rest of this study is arranged as follows. Section 2 combs the literature on the effect of agricultural industry agglomeration on income growth. Section 3 introduces the main variables and the application processes of the Durbin model and the threshold model. Section 4 calculates the Moran's I index and the agglomeration coefficient, and analyses the influence effect and spatial interaction effect of agricultural agglomeration on farmers' income. Moreover, the cluster differences of the impact in three different degrees of agricultural agglomeration areas are analyzed. Section 5 discusses the analysis results. The conclusions obtained from this study are drawn in Section 6.

1. Literature Review

As an important form of rural economic development, agricultural industry agglomeration can gather farmers, agricultural enterprises, intermediary organizations, agricultural scientific research institutions, and the government into an organic whole in space. The convergence could promote the development of rural economy and the growth of farmers' income through specialized production around advantageous industries guided by the market (Krugman*,* 1991; Wardhana *et al.,* 2020). The agglomeration of sugarcane industry improved agricultural productivity. A diversified system of sugarcane production could reduce planting costs, improve the efficiency of processing plants, and help farmers receive higher remuneration (Singh *et al.,* 2019). The aggregation degree of more than 20 types of crops in China was measured and most crops presented significant spatial correlation, but the spatial correlation of different crops varied (He*,* Li, 2016). The spatial and temporal characteristics and evolution trends of the geographical agglomeration of China's planting industry from two aspects of the region and the industry were analyzed, and Central China was the main geographical agglomeration area of the planting industry (Xiao*,* 2012).

The impact of industrial agglomeration on economic growth and income has yielded several research results. Generally, industrial agglomeration can form economies of scale and reduce transaction costs (Samanta *et al.,* 2019; Baldwin*,* 1999). In the past, China's farmers have generally decentralized: a large number of people had little land, and their force was weak. Hence, they could not form economies of scale. Most of them entered the market in their ways. They faced high transaction costs, such as planting expenses, selling expenses, quality inspection fees, defaults or fraud losses. Moreover, farmers did not understand market demand, which led to blind planting of agricultural products and market winds. As a result, farmers' income was low (Jiang, Jiang*,* 2018). After the formation of agricultural industry agglomeration, many farmers were linked together to form agricultural scale economy. Moreover, leading enterprises could effectively reduce production and marketing costs, reduce market risks, and increase farmers' income by taking leading enterprises as the intermediary for market transactions, market-leading enterprises and leading enterprises connecting farmers, which could effectively reduce production and marketing costs, and reduce market risks and increase farmers' income (Qin *et al.,* 2019). Among them, scale economies and external economy formed by industrial agglomeration were important driving forces that promoted economic growth (Zhou *et al.,* 2019; Siegel*,* 1999; Henderson*,* 2003; Gao, Zhang*,* 2018). The geographic agglomeration index of China's planting industry was calculated, and industries presented characteristics of continuous agglomeration, and geographic agglomeration significantly promoted the agricultural industry and farmers' income (Deng *et al.,* 2013).

Many scholars believed that industrial agglomeration could promote technological innovation (Billings, Johnson*,* 2016; Audretsch, Feldman*,* 1996; Berliant *et al.,* 2006). Agricultural technology innovation was not only the driving force of agricultural economic growth, but also the fundamental means for farmers to achieve income growth. However, education level of Chinese farmers was not high, and they were not receptive to new knowledge and new technology. Therefore, China's agricultural innovation ability was relatively weak. Giving full play to the role of scientific research institutions, enterprises, and the government was necessary to build a lasting and efficient innovation system of agricultural technology. The "cluster effect" of agricultural industrial agglomeration helped strengthen the cooperation between scientific research institutions and enterprises (Gabe*,* 2005; Robert*,* 2006), and improved utilization rate of land resources and productivity of agricultural labor. Through spatial spillover effect of innovative knowledge in the agglomeration area, scientific and technological content of agricultural products in the region would increase (Martinus *et al.,* 2020; Votinov *et al.,* 2020), and value of agricultural products would be improved, which would inevitably increase the income of farmers.

Scholars believed that industrial agglomeration could produce brand effects and enhance value of agricultural products (Eduardo *et al.,* 2020; Miguel *et al.,* 2020). According to the theory of demand price elasticity, agricultural products were inelastic commodities. Even during bumper harvest, farmers' income was not even increased, but it was decreased, which demonstrates "the cheap grain hurts farmers" phenomenon in economics (Henderson*,* 2003). Therefore, the market demand of consumers had a great impact on farmers' income. If structural change of consumer demand was not well understood, then such lack in knowledge might lead to agricultural production increase, but farmers' income would not increase (Deng *et al.,* 2013). Agricultural industry agglomeration could form brand effects of agricultural products, and well-known agricultural brands could create amazing market value, such as the corn industry in the United States, the bread industry in France, the apple industry in Chile, the Shouguang vegetable industry in Shandong, the cotton industry in Xinjiang, and the flower industry in Yunnan (He, Li*,* 2016). Brand effect symbolized the success of agricultural industry aggregation, which could ensure stable market prices and sales income of agricultural products, thus increasing the income of farmers. Spatial agglomeration of tea production was conducive to reducing planting costs, improving product quality, creating tea brands, and promoting the transformation and upgrading of China's tea industry (Han *et al.,* 2018).

Scholars have analyzed income and economic growth effects of industrial agglomeration from different perspectives, which provided valuable insights for this study. However, previous literature had deficiencies. Existing studies on the impact of agricultural industrial agglomeration on farmers' income was not representative and took only a certain industry in a certain province as an example. In addition, the effect of industrial agglomeration has differences in various degrees of agglomeration areas.

Therefore, this study discusses the following topics. Firstly, combined with the new economic geography and spatial econometric theory, an index of agricultural industry agglomeration was constructed to measure the degree of China's agricultural industry agglomeration. Provincial panel data were used to describe the basic characteristics and spatial trends of agricultural industry agglomeration. Secondly, a spatial econometric model was constructed for empirical analysis of spatial spillover effect of agricultural industry agglomeration on rural residents' income. Thirdly, threshold model was used to analyze the group differences of agricultural industry agglomeration on the income growth in three different degrees of agricultural agglomeration areas.

2. Methodology

2.1 Measurement of Moran's I index

Development of new economic geography promotes wide application of Moran's I index. The global Moran's I index can evaluate the spatial distribution pattern of variables, whereas the local Moran's I index can evaluate regional correlation and dependence of variables and show regional differences of variables. Moran's I index is between [−1, 1]. If Moran's I is greater than zero, a positive spatial correlation exists among variables. The larger the index value is, the stronger the spatial correlation between variables is, which is in high-high concentration or low-low concentration. If Moran's I is less than zero, a negative spatial correlation exists among variables. The larger the index value is, the greater the spatial difference is between variables. The closer the index is to −1, the greater the difference of farmers' income in adjacent areas is. A less concentrated distribution indicates that the area is in the state of low-high agglomeration or high-low agglomeration. If Moran's I is 0, no spatial correlation exists. Moran's I index is used to measure spatial correlation of farmers' income. The global Moran's I index reflects the overall distribution trend of farmers' income in geographical space, whereas the local Moran's I index reflects spatial correlation and difference of farmers' income among different regions.

The calculation formula of the regional Moran's I is as follows:

$$Moran's\ I=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\times C_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\times S^2} \tag{1}$$

In formula (1), $C_{ij}=(X_i-\bar{X})(X_j-\bar{X})$ is the similarity matrix, $S^2=\frac{1}{n}\sum_{i=1}^{n}(X_i-\bar{X})^2$, X_i and X_j are the spatial unit values, and W_{ij} is the spatial weight matrix.

The local Moran's I scatter map is used to describe the local differences of different regions intuitively. Calculation formula of the regional Moran's I index is as follows:

$$RMI_i=\frac{x_i-\bar{x}}{(\sum_{j=1, j\neq i}^{n} x_j^2)\Big/(n-1)-x^2}\sum_{j=1}^{n} w_{ij}(x_j-\bar{x}) \tag{2}$$

In formula (2), x_i is the target unit value, and x_j is the unit value beyond the research scope.

2.2 Spatial Weight Matrix

The spatial weight matrix reflects the degree of correlation between the geographic attribute values of different spatial elements. In this study, two types of spatial weight matrices are constructed.

0-1 adjacency weight matrix shows that the 0-1 weight matrix is set according to whether values are adjacent in space. Adjacent areas take 1, otherwise 0:

$$W_{ij} = \begin{cases} 1 & \text{(I is adjacent to j)} \\ 0 & \text{(I is not adjacent to j)} \end{cases} \tag{3}$$

Spatial distance weight matrix shows that the weight is set according to the reciprocal of the spatial distance between two regions. The shorter the distance is, the greater the weight is. The longer the distance is, the smaller the weight is. The weight matrix is defined as follows:

$$W = \begin{cases} \dfrac{1}{d_{ij}} & (i \neq j) \\ 0 & (i = j) \end{cases} \tag{4}$$

Where d_{ij} is the distance between two regions which is calculated using the longitude and the latitude.

2.3 Measurement of the Level of Agricultural Industry Agglomeration

Many methods can be used to measure industrial agglomeration. These methods are mainly based on economic activities, distance space, and spatial correlation. Among them, the indicators for measuring spatial agglomeration based on economic activities are often used, mainly including location entropy and spatial Gini coefficient. Location entropy is selected to measure the agglomeration degree of the agricultural industry.

Location entropy evaluates specialization level of a region by measuring the difference between industry structure of a region and national average level. It is often used to study the degree of specialization of industry in each region, and to investigate the leading industry of a region. One is usually taken as the dividing point. If the location entropy is exactly 1, an industry is in equilibrium in the region. If the location entropy is greater than 1, an industry occupies a comparative advantage in the region. Otherwise, it has a comparative disadvantage. The calculation formula is as follows:

$$LQ_{ij} = \frac{L_{ij} \Big/ \sum_{j=1}^{n} L_{ij}}{\sum_{i=1}^{m} L_{ij} \Big/ \sum_{i=1}^{m} \sum_{j=1}^{n} L_{ij}} \tag{5}$$

Where *j* is the agricultural industry, *i* is the region where the agricultural industry is located, L_{ij} represents the output value of industry *j* in region *i*. $\sum_{j=1}^{n} L_{ij}$ represents the total output value of agriculture in region *i*. $\sum_{i=1}^{m} L_{ij}$ is the total output value of industry *j* in the whole country. $\sum_{i=1}^{m}\sum_{j=1}^{n} L_{ij}$ is the total output value of agriculture in the whole country, and LQ_{ij} is the location entropy of industry *j* in region *i*. A larger value indicates a higher degree of agricultural industry agglomeration.

2.4 Models and Variables

The agglomeration of agricultural industry has a spillover effect on the income of farmers in surrounding areas, whereas agricultural agglomeration has a siphon effect on the income of local farmers. The spatial panel model is used to study the spatial interaction effect between agricultural agglomeration and farmers' income (Anselin, Moreno*,* 2003; Šljivarić *et al.,* 2019; Wu *et al.,* 2020). The spatial Durbin model (SDM) is as follows:

$$y = \rho W y + \beta X + \gamma W X + \varepsilon \tag{6}$$

W is the element in the spatial weight matrix, and γ is the spatial autoregressive coefficient. If γ is greater than zero, agricultural industry agglomeration has a spatial spillover effect on the surrounding areas. If it is less than zero, agricultural industry agglomeration has a siphon effect on surrounding areas. X is the degree of agglomeration, β is the regression coefficient of agricultural agglomeration, and ε is the error term.

In traditional regression model, regression coefficient represents influence degree of explanatory variable on explained variable. However, in spatial econometric model, the meaning of regression coefficient becomes richer, and influence of explained variable on explanatory variable is more complex. Hence, a specific explanation is necessary (Anselin, Moreno*,* 2003; Kelejian *et al.,* 2006; Siraphob, Jaruloj*,* 2019). Among them, a simple method is proposed to measure these spatial effects (Lesage, Pace*,* 2008).

$$y = \sum S(W)X + V(W)I\alpha + V(W)\varepsilon \tag{7}$$

$$S(W) = V(W)(I\beta + W\gamma) \tag{8}$$

$$V(W) = (I - \rho W)^{-1} \tag{9}$$

After the above-mentioned transformation of the formula, each row or column of the matrix W is added, mean value of the row i can be understood as the average total effect accepted by region i, and mean value of column j can be understood as the average total effect of region j. The total effect represents average impact of explanatory variables on all regions. Mean value of the diagonal elements of matrix W can be understood as average direct effect, which represents average impact of the explanatory variables on the region. Average indirect effect can be obtained by calculating difference between average total effect and average direct effect. The indirect effect shows average impact of explanatory variable on other regions.

Based on the model agglomeration effect of planting industry (Deng *et al.,* 2013; He, Li*,* 2016), the SDM of farmers' income growth is constructed. In the model, using the logarithmic form of data, it can eliminate the heteroscedasticity to a certain extent. The specific expression of it is as follows:

$$\ln y_{it} = \beta_0 + \beta_1 Lq_{it} + \delta_1 Huc_{it} + \delta_2 \ln Fc_{it} + \delta_3 Ur_{it} + \delta_4 Gov_{it} + \rho w_{it} \ln y_{it} + \gamma w_{it} Lq_{it}$$
$$+ w_{it}(\theta_1 Huc_{it} + \theta_2 \ln Fc_{it} + \theta_3 Ur_{it} + \theta_4 Gov_{it}) + \varepsilon_{it} \quad (10)$$

In this study, the per capita income of rural residents is chosen as the explanatory variable, and main explanatory variable is location entropy, which represents degree of agricultural industry agglomeration. Education level of rural residents and quantity of fixed capital, as well as the level of economic development in region and the government's preferential policies for agriculture, are important factors affecting farmers' income. Hence, human capital, material capital, urbanization level, and government are selected as control variables. According to calculation results of the degree of crop aggregation in China, the grain industry with obvious agglomeration characteristics is selected as the representative for empirical analysis (He, Li, 2016).

It uses double-threshold model to investigate the clustering differences of the impact of agricultural industry agglomeration on income growth in three different degrees of agricultural agglomeration areas. The advantage of this model is that it can empirically test and estimate the corresponding threshold value and the threshold effect. The specific model is as follows:

$$\begin{cases} \ln y_{it} = \alpha_0 + \alpha_1 x_{it}.I(\eta_{it} \le \gamma_1) + \alpha_2 x_{it} \\ I(\gamma_2 \le \eta_{it} \le \gamma_1) + \alpha_3 x_{it}.I(\eta_{it} \ge \gamma_2) + u_{it} + \varepsilon_{it} \end{cases} \quad (11)$$

Where η_{it} is the threshold variable, γ is the threshold value. I is the indicator function, and x_{it} is the threshold interpretation variable.

3. Results Analysis

The variable data mainly come from the *China Statistical Yearbook* and *China Agricultural Statistical Yearbook*. This study takes 2003 as the base period and makes the price index adjustment for the data related to currency. *Table 1* shows the description and statistics of the variables.

Table 1. Descriptive Statistics of Variables

Variable	Index explanation	Mean	Minimum	Maximum
Farmers' income	Logarithm of per capita net income of rural residents	7.99	7.26	8.96
Industrial agglomeration	Location entropy of grain industry in different regions	0.96	0.48	1.40
Human capital	Years of education per capita	8.46	3.74	12.39
Material capital	Logarithm of rural fixed assets investment level	4.35	0.21	6.15
Urbanization	Proportion of non-agricultural population in total population	0.49	0.15	0.89
Government	Proportion of regional agricultural financial expenditure in GDP	0.03	0.01	0.21

Source: China Statistical Yearbook and China Rural Statistical Yearbook in 2003-2017.

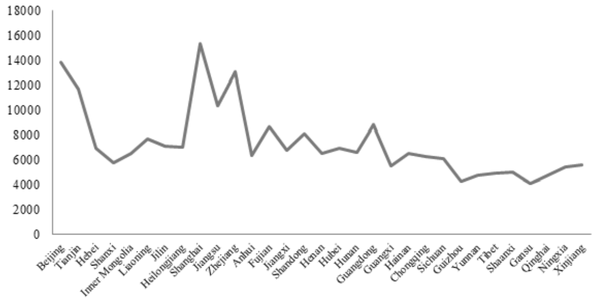
With the rapid development of China's economy, China's farmers' income continues to grow. The change in farmers' income is depicted from the time dimension.

Table 2. Farmers' income in different regions, 2003-2017

Province	2003	2006	2010	2014	2017
Beijing	5601.55	8275.47	13262.29	18867.3	24240.5
Tianjin	4566.01	6227.94	10074.86	17014.18	21753.7
Hebei	2853.38	3801.82	5957.98	10186.14	12880.9
Shanxi	2299.17	3180.92	4736.25	8809.437	10787.5
Inner Mongolia	2267.65	3341.88	5529.59	9976.301	12584.3
Liaoning	2934.44	4090.4	6907.93	11191.49	13746.8
Jilin	2530.41	3641.13	6237.44	10780.12	12950.4
Heilongjiang	2508.94	3552.43	6210.72	10453.2	12664.8
Shanghai	6653.92	9138.65	13977.96	21191.64	27825
Jiangsu	4239.26	5813.23	9118.24	14958.44	19158
Zhejiang	5389.04	7334.81	11302.55	19373.28	24955.8
Anhui	2127.48	2969.08	5285.17	9916.421	12758.2
Fujian	3733.89	4834.75	7426.86	12650.19	16334.8
Jiangxi	2457.53	3459.53	5788.56	10116.58	13241.8
Shandong	3150.49	4368.33	6990.28	11882.26	15117.5
Henan	2235.68	3261.03	5523.73	9966.072	12719.2
Hubei	2566.76	3419.35	5832.27	10849.06	13812.1
Hunan	2532.87	3389.62	5621.96	10060.17	12935.8
Guangdong	4054.58	5079.78	7890.25	12245.56	15779.7
Guangxi	2094.51	2770.48	4543.41	8683.182	11325.5
Hainan	2588.06	3255.53	5275.37	9912.569	12901.8
Chongqing	2214.55	2873.83	5276.66	9489.815	12637.9
Sichuan	2229.86	3002.38	5086.89	9347.741	12226.9
Guizhou	1564.66	1984.62	3471.93	6671.224	8869.1
Yunnan	1697.12	2250.46	3952.03	7456.127	9862.2
Tibet	1690.76	2435.02	4138.71	7359.195	10330.2
Shaanxi	1675.66	2260.19	4104.98	7932.207	10264.5
Gansu	1673.05	2134.05	3424.65	6276.592	8076.1
Qinghai	1794.13	2358.37	3862.68	7282.725	9462.3
Ningxia	2043.3	2760.14	4674.89	8410.016	10737.9
Xinjiang	2106.19	2737.28	4642.67	8723.829	11045.3

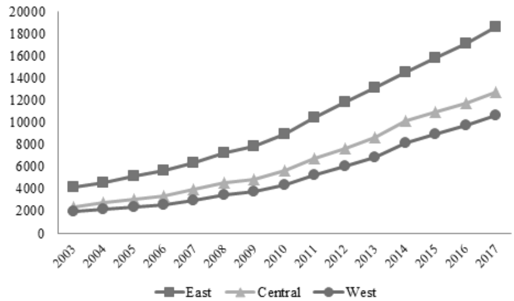
Source: China Statistical Yearbook in 2003-2017.

Table 2 shows that from 2003 to 2017, China's farmers' income continued to grow steadily. This trend reflects China's stable grain production, and the agricultural industry promotes development of rural economy and increase of farmers' income. However, significant differences are observed in farmers' income among provinces and regions, and the trend of regional income difference is increasing. In 2017, the annual income of farmers in Zhejiang was the highest, reaching 24,955.8 RMB, and the lowest was Gansu, which was only 8,076.1 RMB. The annual income of farmers in Zhejiang was approximately three times of Gansu.



Source: created by the authors.

Figure 1. **Average Income of Farmers in Different Provinces and Cities, 2003-2017**



Source: created by the authors.

Figure 2. **Farmers' Income in Eastern, Central and Western Regions, 2003-2017**

Figure 1 reports the average value of farmers' income in China's provinces and cities from 2003 to 2017. The highest average income was Shanghai, which was 15,356.48 RMB, and the lowest was Gansu. The income gap among provinces and cities is obvious. *Figure 2* shows the average income of eastern, central, and western regions from 2003 to 2017, which indicates that the average income of farmers in each region has continued to grow. In the eastern region, the average income of farmers had increased from 4,160.42 RMB to 18,608.59 RMB from 2003 to 2017. In the central region, the average income was 2,407.36 RMB in 2003 and 12,733.73 RMB in 2017. The income in the western region was 1,920.53 RMB in 2003 and gradually increased to 10,618.52 RMB in 2017. The income gap between the eastern region and the central-western region continues to expand.

3.1 Moran's I Correlation Analysis of Farmers' Income

Spatial evolution and development of the agricultural industry promote spatial effect of industrial geographical aggregation and farmers' income growth. According to standardized statistic formula of global Moran's I, the global spatial autocorrelation coefficients of crop production over the years were calculated using the software Stata 15. *Table 3* reports the Moran's I index of rural per capita net income. The results in *Table 3* show that the Moran's I index of rural per capita net income in 2003-2017 was significantly positive (0.5-0.6), indicating that the spatial correlation of rural residents' income in China is strong. The Moran's I index under the spatial distance weight matrix is lower, which indicates that the spatial impact of farmers' income in adjacent areas is stronger, and the spatial correlation of farmers' income gradually weakens with the increase of distance.

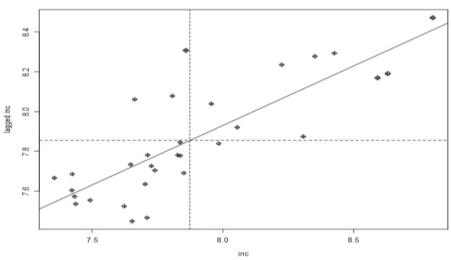
Table 3. Moran's I Index of Rural Residents' Income, 2003-2017

Year	0-1 adjacency weight matrix			Spatial distance weight matrix		
	Moran's I	P-value	Z value	Moran's I	P-value	Z value
2003	0.55***	0.00	5.11	0.15***	0.00	5.62
2004	0.57***	0.00	5.20	0.16***	0.00	5.86
2005	0.54***	0.00	5.04	0.15***	0.00	5.74
2006	0.55***	0.00	5.20	0.16***	0.00	5.87
2007	0.54***	0.00	5.03	0.16***	0.00	5.95
2008	0.53***	0.00	4.97	0.16***	0.00	5.96
2009	0.53***	0.00	4.94	0.16***	0.00	5.89
2010	0.53***	0.00	4.93	0.16***	0.00	5.96
2011	0.55***	0.00	5.05	0.17***	0.00	6.13
2012	0.55***	0.00	5.07	0.17***	0.00	6.17
2013	0.56***	0.00	5.08	0.17***	0.00	6.21
2014	0.57***	0.00	5.25	0.18***	0.00	6.47
2015	0.57***	0.00	5.25	0.18***	0.00	6.39
2016	0.57***	0.00	5.24	0.18***	0.00	6.31
2017	0.57***	0.00	5.25	0.18***	0.00	6.46

Notes: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, * indicates significance at the 0.10 level (bilateral test).

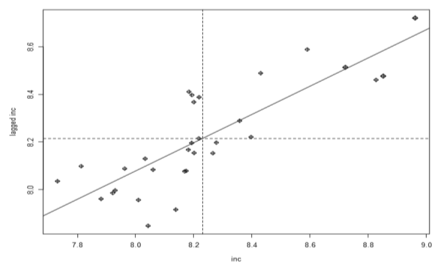
Source: own calculations.

Moran's I scatter plot describes the attribute values of each region and the "spatial lag" attribute values with a two-dimensional matrix, in which the horizontal axis corresponds to the attribute variable values of each region, and the vertical axis corresponds to the spatial lag value. The Moran's I scatter diagram falls into four quadrants. The area in the first quadrant indicates that the region and its adjacent areas are high-level areas, and that it is "high–high agglomeration". The area in the third quadrant indicates that the region and its adjacent areas are low-level areas, which is "low-low agglomeration", whereas the areas in the second and fourth quadrants correspond to "low-high agglomeration" and "high-low agglomeration". Whether these agglomeration characteristics are statistically significant depends on the significance level of the local Moran's I value.



Source: created by the authors.

Figure 3. **Scatter Plot, 2003**



Source: created by the authors.

Figure 4. **Scatter Plot, 2017**

An analysis of Moran's I index shows that farmers' income presents an obvious phenomenon of high-high agglomeration or low–low agglomeration. *Figure 3* and *Figure 4* report the evolution of farmers' income aggregation in space in 2003 and 2017, respectively. The trend of farmers' income over time is relatively stable, basically showing high-high aggregation and low-low aggregation.

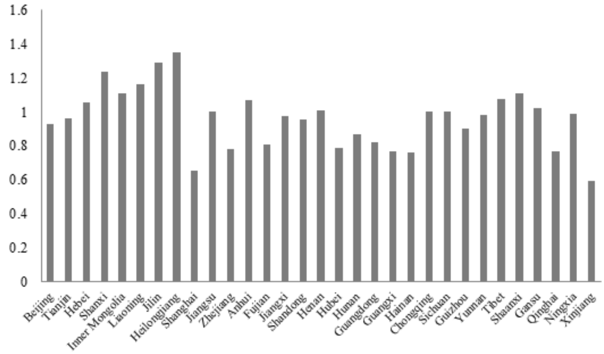
3.2 Location Entropy Analysis of Agricultural Industry Aggregation Index

According to the calculation method of location entropy index, agricultural industry aggregation indexes of China's provinces and cities from 2003 to 2017 were calculated. *Table 4* and *Figure 5* show the results.

Table 4. Location Entropy of Provinces and Cities, 2003-2017

Province	2003	2006	2010	2014	2017	Average
Beijing	0.7017	0.9916	1.0300	0.8994	0.8506	0.9301
Tianjin	0.7891	0.8552	0.9927	1.0596	1.0992	0.9614
Hebei	1.0550	1.0513	1.0537	1.0666	1.0702	1.0538
Shanxi	1.1717	1.2156	1.2585	1.2749	1.2844	1.2379
Inner Mongolia	1.0798	1.0547	1.1483	1.1275	1.0766	1.1082
Liaoning	1.1309	1.2473	1.1412	1.1403	1.1723	1.1651
Jilin	1.3047	1.2917	1.2581	1.3071	1.3043	1.2915
Heilongjiang	1.2692	1.2832	1.3779	1.4042	1.4006	1.3492
Shanghai	0.5425	0.6136	0.6531	0.6778	0.7007	0.6519
Jiangsu	0.9300	0.9752	1.0138	1.0276	1.0433	1.0036
Zhejiang	0.7723	0.7970	0.7509	0.8176	0.8138	0.7793
Anhui	1.0346	1.0569	1.0687	1.0876	1.1015	1.0688
Fujian	0.8954	0.8534	0.7936	0.7626	0.7455	0.8059
Jiangxi	0.9361	0.9811	0.9751	0.9742	0.9773	0.9742
Shandong	0.9036	0.9431	0.9577	0.9893	1.0092	0.9543
Henan	0.9998	0.9762	0.9996	1.0422	1.0479	1.0083
Hubei	0.7642	0.8236	0.7439	0.7907	0.8340	0.7885
Hunan	0.8983	0.8863	0.8559	0.8332	0.8200	0.8665
Guangdong	0.8703	0.8513	0.8183	0.7755	0.7658	0.8196
Guangxi	0.8473	0.7675	0.7591	0.7593	0.7254	0.7688
Hainan	0.9161	0.8058	0.7669	0.6727	0.6454	0.7617
Chongqing	1.1247	1.0654	0.9768	0.9297	0.9213	1.0000
Sichuan	1.0435	1.0139	0.9877	0.9818	0.9781	1.0004
Guizhou	0.9996	0.9531	0.9091	0.8350	0.8201	0.9025
Yunnan	1.0837	1.0343	0.9710	0.9197	0.9222	0.9806
Tibet	1.2199	1.0965	1.0359	1.0317	1.0458	1.0753
Shaanxi	1.1805	1.1546	1.1039	1.0594	1.0578	1.1062
Gansu	1.0583	1.0334	1.0248	0.9939	0.9753	1.0189
Qinghai	0.8146	0.7910	0.7340	0.7425	0.7382	0.7667
Ningxia	1.0932	1.0506	0.9891	0.9034	0.8998	0.9891
Xinjiang	0.5973	0.5833	0.6234	0.6001	0.6033	0.5905

Source: China Statistical Yearbook and China Rural Statistical Yearbook in 2003-2017.



Source: created by the authors.

Figure 5. **Average Location Entropy of Provinces and Cities, 2003-2017**

According to *Table 4* and *Figure 5*, aggregation of the grain industry in China demonstrates the following characteristics. On the whole, aggregation degree of grain crops was between 0.5 and 1.5 from 2003 to 2017, which indicates that most provinces and regions in China are in moderate concentration level. Fourteen provinces and cities (Heilongjiang, Jilin, Shanxi, Liaoning, Inner Mongolia, Shaanxi, Tibet, Anhui, Hebei, Gansu, Henan, Jiangsu, Sichuan, and Chongqing) had location entropy higher than 1. This trend indicates that the pattern of agricultural agglomeration in China has been initially formed, but regional differences exist, which is consistent with the conclusion of existing literature that China presents an obvious agricultural geographical agglomeration pattern. Except for Guangdong, Guangxi, Hainan, and Yunnan, location entropy of other provinces showed an average downward trend. Average agglomeration rate is gradually increasing, and degree of geographical agglomeration is constantly becoming strong.

3.3 Estimation and Result Analysis of the SDM

Hausman test can be used to judge whether a fixed effect model or a random effect model is appropriate. Hausman test statistic of the OLS panel model is 34.71 (P=0.00), and the Hausman test passes the 5% significance level. Hence, the fixed-effect model is adopted. *Table 5* shows the estimation results of the OLS panel model.

Results show that estimated spatial lag coefficient rho of the OLS panel model is 0.67, which indicates a positive spatial spillover effect on rural residents' income. Spatial spillover effect based on the fixed effect panel model is good, which indicates that income growth of rural residents in a certain area can drive an increase in income of farmers in neighboring areas. Therefore, in the analysis of rural residents' income growth, the effect of spatial spillover cannot be ignored. Given that the OLS estimation is prone to bias, the estimation results and the SDM contain the lag term of the interpreted variables. The SDM is selected for regression estimation in this study, and the estimation results are shown in *Table 6*.

Table 5. Estimation Results of the OLS Panel Model

Variable	Mixed regression	Individual fixed effects	Time fixed effects	Double fixed effects
Industrial agglomeration	0.34*** (0.00)	0.13 (0.57)	0.31*** (0.00)	0.15*** (0.00)
Human capital	0.17*** (0.00)	0.18*** (0.00)	0.04*** (0.00)	-0.003*** (0.00)
Material capital	0.02* (0.06)	0.03 (0.25)	0.03*** (0.00)	0.05*** (0.00)
Urbanization	0.39*** (0.00)	0.33** (0.00)	0.59*** (0.00)	0.09*** (0.00)
Government	1.40*** (0.00)	1.51*** (0.00)	1.14*** (0.00)	0.19*** (0.00)
R^2	0.74	0.72	0.91	0.92
rho	0.67	0.89	0.88	0.98
Hausman	34.71(0.00)			

Notes: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, * indicates significance at the 0.10 level (bilateral test).

Source: own calculations.

Table 6. Estimation Results of the SDM

Variable	0-1 weight matrix			Spatial distance weight matrix		
	Individual	Time	Double fixation	Individual	Time	Double fixation
Industrial agglomeration	0.20*** (0.00)	-0.16*** (0.01)	0.21*** (0.00)	0.22*** (0.00)	-0.15*** (0.00)	0.20*** (0.01)
Human capital	0.00 (0.83)	-0.02 (0.16)	0.00 (0.75)	0.00 (0.84)	-0.01 (0.28)	0.00 (0.82)
Material capital	0.01* (0.07)	0.10*** (0.00)	0.03*** (0.00)	0.03*** (0.00)	0.06*** (0.00)	0.04*** (0.00)
Urbanization	0.30*** (0.00)	1.96*** (0.00)	0.32*** (0.00)	0.37*** (0.00)	1.69*** (0.00)	0.37*** (0.00)
Government	0.76 (0.00)	1.61*** (0.00)	0.85*** (0.00)	0.95*** (0.00)	1.30*** (0.00)	0.96*** (0.00)
Weight matrix × Industrial agglomeration	0.69*** (0.00)	0.46*** (0.00)	0.51*** (0.00)	2.30*** (0.00)	0.50 (0.32)	2.44*** (0.00)
Weight matrix × Human capital	0.06*** (0.00)	-0.05** (0.03)	0.03 (0.23)	0.04** (0.01)	-0.14 (0.12)	0.11 (0.20)
Weight matrix × Material capital	-0.15*** (0.00)	0.06*** (0.00)	-0.08 (0.11)	0.531*** (0.00)	0.183 (0.23)	-0.701*** (0.00)
Weight matrix × Urbanization	-0.30*** (0.00)	0.23* (0.08)	-0.19 (0.15)	-0.315*** (0.00)	2.108*** (0.00)	-0.109 (0.79)
Weight matrix × Government	-0.72*** (0.007)	0.53 (0.32)	0.34 (0.27)	-1.414** (0.03)	-13.268*** (0.00)	1.466 (0.45)
Rho	0.78*** (0.00)	0.43*** (0.00)	0.44*** (0.00)	0.868*** (0.00)	0.405*** (0.00)	0.419*** (0.00)
R^2	0.79	0.50	0.67	0.80	0.63	0.78
Log-L	769.70	344.87	815.76	780.74	371.10	801.75
Hausman	85.27 (0.00)			18.46 (0.01)		

Notes: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, * indicates significance at the 0.10 level (bilateral test).

Source: own calculations.

Estimation results of the SDM show that underweight of 0-1 distance and weight of spatial distance. Spatial auto-correlation coefficient is greater than 0 and passes the 1% significance level. Results show that growth of rural residents' income is affected by industrial development of surrounding areas with obvious spatial correlation. Agricultural industry agglomeration has a positive effect on the income of rural residents, and a higher degree of agglomeration has a more obvious effect on the income growth of farmers. Scale economy has a positive Schumpeter effect, which promotes income growth of rural residents and creates a significant spillover effect in agricultural industry agglomeration.

Effects of each control variable on rural residents' income show significant differences. Fixed capital has a significant positive effect on rural residents' income. Accumulation of fixed capital helps improve rural residents' income, but the effect is small, which may indicate influence of distance factors and spatial limitations. The development of urbanization has a significant positive effect on promoting regional economic development and improving the income level of farmers. Government support has a significant positive effect on the income of rural residents, and its coefficient is the largest among the control variables, which shows that government support has the greatest impact on the income of rural residents. Therefore, the government's policy of supporting agriculture helps improve income level of farmers.

3.4 Direct and Indirect Effects

To understand the direct and indirect effects of growth factors clearly, specific analysis was carried out. The direct effect, which refers to the influence of provincial growth factors on their farmers' income, can be exerted in two ways. On the one hand, growth factors of each region have a direct impact on farmers' income in their province. On the other hand, growth factors of each region have a spatial feedback effect on farmers' income in other provinces. Indirect effect shows influence of growth factors on farmers' income in other provinces. Indirect effect can also be demonstrated in various ways. A simple example is the change of growth factors in other areas outside the province has an impact on farmers' income in the province. Another example is through the interaction of farmers' income among the provinces. Interaction affects local farmers' income, and it affects other provinces. To further analyze spatial spillover effect of agricultural industry agglomeration, this study estimates the direct and indirect effects. *Table 7* shows the results.

Firstly, agricultural industry agglomeration has direct and indirect effects. Under the 0-1 weight matrix, the direct effect coefficient of agricultural industry agglomeration on the income of farmers is 0.01 in the region. Estimated coefficient is significant at the 5% level, thus reflecting the effect of agricultural industry agglomeration on farmers' income. Under the spatial distance weight matrix, direct effect coefficient of agricultural industry agglomeration on farmers' income is negative, but it is not significant. The results show that effect of agricultural industry agglomeration on farmers' income is weakened with increase of spatial distance. Under the 0-1 adjacency weight and spatial distance weight, indirect effect of agricultural industry agglomeration is negative, which shows that agricultural industry agglomeration hinders growth of farmers' income in surrounding areas.

Table 7. Direct and Indirect Effects of the SDM

Effect	Variable	0-1 weight matrix		Spatial distance weight matrix	
		Coefficient	Z statistics	Coefficient	Z statistics
Direct effect	Industrial agglomeration	0.01**	2.03	-0.29	-0.80
	Human capital	0.02**	2.54	0.01	0.52
	Material capital	0.02	0.92	0.04**	2.47
	Urbanization	0.27**	2.26	0.38**	2.18
	Government	0.71**	2.48	0.80**	2.44
Indirect effect	Industrial agglomeration	-2.29**	-2.17	-16.21**	-2.32
	Human capital	0.25***	5.41	0.27***	2.62
	Material capital	0.04	0.88	0.19**	2.26
	Urbanization	-0.29	-1.03	-0.06	0.11
	Government	-0.63	-0.44	-5.30	-0.96
Total effect	Industrial agglomeration	-2.28	-1.19	-16.50**	-2.26
	Human capital	0.27***	5.13	0.28***	2.59
	Material capital	0.06	0.90	0.23**	2.32
	Urbanization	-0.02	-0.07	0.43	0.81
	Government	0.08	0.05	-4.50	-0.80

Notes: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, * indicates significance at the 0.10 level (bilateral test).

Source: own calculations.

Secondly, control variables have direct and indirect effects. Under different spatial weights, estimation coefficients of direct effect of human capital and material capital are all positive. Human capital and material capital are important factors that affect people's income levels. Accumulation of capital is conducive to increasing farmers' income. Under the 0-1 adjacency weight and spatial distance weight, indirect spillover effect of human capital is also positive. Direct effect of urbanization and government support on farmers' income is significantly positive, which shows that urbanization and government support significantly promote economic growth and increase of farmers' income in the region. However, indirect effect is negative, because scale effect of agricultural industry agglomeration attracts human capital and knowledge from surrounding backward regions to developed regions. This negative spillover hinders development of agriculture and growth of farmers' income in surrounding areas.

3.5 Threshold Effect and Clustering Estimation Results

Impact of agricultural industry agglomeration on farmers' income may have different degrees of group differences, due to different levels of agricultural industry agglomeration. A threshold model is used, and different degrees of aggregation interval is divided by bootstrap, which can further refine impact effect and cluster difference of agricultural industry agglomeration on farmers' income. Using bootstrap method to determine the threshold number, *Table 8* shows the specific test results.

Table 8. Test Results of Threshold Effect

Threshold variable	Test type	F value	P-value	Bootstrap times	1%	5%	10%
Agricultural aggregation	Single threshold	24.291**	0.032	500	31.193	22.752	16.117
	Double threshold	18.801***	0.002	500	10.872	6.145	3.628

Notes: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, * indicates significance at the 0.10 level (bilateral test).

Source: own calculations.

It can be seen from *Table 8* that both single threshold and double threshold have passed the 5% significance test. Taking agricultural aggregation as the threshold variable and farmers' income as the threshold explanatory variable, estimation results of the double threshold model are shown in *Table 9* and *Table* 10.

Table 9. Threshold Estimation Results and Confidence Interval

Model	Threshold value	95% confidence interval
The first threshold	0.932	[0.631, 0.934]
The Second threshold	1.293	[0.932, 1.405]

Source: created by the authors.

Table 10. Threshold Model Estimation Results

Variable	Coefficient	Standard error	P value
lq>1.293	2.296***	0.655	0.000
0.932<lq <1.293	0.013***	0.502	0.000
lq<0.932	-0.609	0.372	0.102

Notes: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, * indicates significance at the 0.10 level (bilateral test).

Source: own calculations.

Taking agricultural industry cluster as the threshold variable, agricultural industry agglomeration can be divided into three categories: low concentration area (lq<0.932), medium concentration area (0.932<lq<1.293), and high concentration area (lq>1.293). Significant group differences exist in impact of industrial agglomeration on income growth in different degrees of agglomeration areas. When lq>1.293, the estimated coefficient is 2.296, which is significant at the 1% level. When 0.932<lq<1.293, the coefficient is 0.013, which passes the significance test of 1%. When lq<0.932, the estimated coefficient is negative but fails to pass the 5% significance test.

4. Discussions

The results analysis reveals a strong spatial correlation between agricultural industry agglomeration and farmers' income growth. Owing to the "diffusion effect," agricultural agglomeration has a significant role in promoting growth of farmers' income in this region. However, due to the "siphon effect," agricultural agglomeration has an inhibitory effect on farmers' income in surrounding areas. In the high and middle agricultural agglomeration areas, effect of agricultural industry agglomeration on the growth of farmers' income is significant. But in the low agricultural agglomeration area, the effect of industrial agglomeration on income growth is not obvious. Government support could promote agricultural industry agglomeration to produce greater external diffusion effect. Thus, the important guiding role of the government in formation and improvement of agricultural industry agglomeration areas should be emphasized.

Firstly, according to the results in *Table 3*, *Figure 1,* and *Figure 2*, rural residents' income has a spatial correlation and with high agglomeration or low agglomeration in China. The income of Chinese farmers varies greatly among regions, but a spatial correlation exists, which is consistent with the conclusion of previous studies (Jiang, Jiang*,* 2018). Given that most Chinese farmers have little access to education, their income is low. Through intensive development, agricultural industry cluster reaches a new joint production and management mode of "sharing interests and sharing risks" with farmers. This approach can provide technical training and support for farmers, solve the problems of agricultural planting and production technology, and improve the degree of organization and specialization, thereby leading farmers on the road to prosperity. Therefore, in the development plan for agricultural industry, China should reasonably arrange agricultural industry according to the characteristics of various regions, promote the production of agricultural industry to gather in advantageous production areas, strengthen leading enterprises in the agricultural industry cluster, realize the optimization and upgrading of the industrial chain, guide the development direction and the level of local agricultural industry, and provide financial and technical support.

Secondly, *Table 7* shows the direct and indirect effects of agricultural industry agglomeration. Impact of agricultural agglomeration on farmers' income is positive in one region yet negative in surrounding areas, which verifies the conclusions of previous scholars (Effendy *et al.,* 2019; Kulshreshtha, Thompson*,* 2005). Murdar's "diffusion effect" and "backflow effect" can fully explain the formation of this phenomenon. Diffusion effect refers to the spillover of technical knowledge in developed areas, which can drive economic development of surrounding backward areas and indicates positive spillover effect of industrial agglomeration. The back flow effect refers to agglomeration of a large number of agricultural enterprises in developed areas, which attract the inflow of human capital and material capital from surrounding backward areas. As a result, economic development of backward areas is inhibited and a negative spillover effect occurs. The negative return effect is greater than the positive diffusion effect, which leads agricultural industry agglomeration to have a negative effect on the income of farmers in surrounding areas.

Thirdly, the threshold model estimation results show significant cluster differences in impact of industrial agglomeration on income growth in three different degrees of agricultural agglomeration areas. When agricultural industry cluster is greater than 1.293, estimated coefficient is 2.296, which is significant at the 1% level. This result indicates that agricultural industry agglomeration has a significant effect on the increase of farmers' income in the high concentration area. When agricultural industry cluster is between 0.932 and 1.293, the coefficient is 0.013, which indicates that agricultural industry has a positive role in promoting farmers' income in the middle cluster area. When agricultural agglomeration is less than 0.932, the coefficient is 0.013. The estimated coefficient is negative, but it fails to pass the significance test of 5%, which reflects that effect of industrial agglomeration on farmers' income is not obvious in low agricultural agglomeration areas. Therefore, the government should focus on cluster areas with strong competitiveness and wide radiation range, make industries in advantageous gathering areas bigger and stronger, and form local characteristic brands (Han *et al.,* 2018). Brand effects can increase added value of agricultural products, and make local agricultural products produce the largest economic benefits, thus increasing income of farmers.

Finally, *Table 5* and *Table 6* show the impact of industrial agglomeration and other factors on farmers' income. Among them, government support has the greatest impact on the income growth of rural residents. At present, development of agricultural agglomeration in most regions of China is not mature. Therefore, the government should give full play to the guiding role in formation and improvement according to characteristics of agglomeration area, formulate and implement feasible development plans for agricultural industry agglomeration, induce agricultural industry agglomeration to produce greater external spillover effects, and promote sustainable development of rural economy and regional economy.

Conclusions

The spatial effects and cluster differences of agricultural industry agglomeration on farmers' income growth were explored by using the panel data of 31 provinces in China from 2003 to 2017 in this study. The conclusions are drawn as follows: (1) the income of Chinese farmers has characteristics of high-high aggregation and low-low aggregation, with distribution characteristics of high in the east and low in the west showing a strong spatial correlation. China's agriculture shows strong spatial clustering characteristics. Most of China's areas are in moderate aggregation, whereas the rest are in high aggregation and low aggregation. Impact of agricultural industry agglomeration has obvious clustering differences. (2) A spatial correlation exists between agricultural industry agglomeration and farmers' income. Agricultural agglomeration can significantly improve farmers' income, which shows an obvious spatial effect. (3) From the spatial perspective, external formed by agricultural industrial agglomeration has a significant effect on local farmers' income. The siphon effect produced by agricultural industrial agglomeration may inhibit income growth of farmers in surrounding areas. (4) Differences are observed among the groups under different aggregation degrees. In high and moderate agricultural industry agglomeration areas, agricultural industry agglomeration has a significant effect on the increase in farmers' income. However, in low agglomeration areas, the effect is not obvious.

This study extends the latest progress of new economic geography to the field of agriculture, and proves the contribution of agricultural industry agglomeration to farmers' income growth. However, because China began the planning of the industrial belt in 2002, time span of this study is not long, which cannot fully reflect the changes in farmers' income and evolution of agricultural geographical agglomeration in China. Further research is needed for follow-up. In addition, the selection of spatial units in this study is based on provincial level, which cannot be analyzed from a detailed geographical scale of cities and counties. Agglomeration economic effect is different in different geographical scales. Due to limitations in data availability, studying the geographical scale of city and county is difficult. In the future, agricultural data of cities may be collected to clarify effect of agricultural industrial agglomeration on income growth in different geographical scales.

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ŽEMĖS ŪKIO GAMYBOS AGLOMERACIJOS POVEIKIS PAJAMŲ AUGIMUI: ERDVĖS POVEIKIS IR GRUPIŲ SKIRTUMAI

Qing He, Junbiao Zhang, Lijun Wang, Yangmei Zeng

SANTRAUKA

Pramoninė aglomeracija gali padidinti pajamas, tačiau žemės ūkio gamybos aglomeracijos ūkininkų pajamos nėra aiškios. Žemės ūkio gamybos aglomeracija gali ne tik padidinti ūkininkų pajamas dėl masto poveikio, bet taip pat dėl sifono efekto galima prarasti žemės ūkio gamybos išteklius, o ūkininkų pajamos gali sumažėti. Tad siekta ištirti erdvės poveikio ir klasterio skirtumus ūkininkų pajamų augimui žemės ūkio gamybos aglomeracijoje. Remiantis erdvine ekonomika, analizuojant koreliaciją tarp Kinijos žemės ūkio gamybos aglomeracijos ir ūkininkų pajamų augimo 2003–2017 m., buvo pasitelktas Morano pirmasis entropijos ir erdvės autokoreliacijos indeksas. Siekiant ištirti Kinijos žemės ūkio aglomeracijos poveikį ir erdvės sąveikos poveikį ūkininkų pajamoms, buvo sukurtas Durbin erdvės duomenų modelis pagal dvi skirtingas svorio matricas. Galiausiai buvo pasitelktas ribinis modelis, analizuojant žemės ūkio gamybos aglomeracijos pajamų augimo poveikį klasterio skirtumams trijuose skirtinguose žemės ūkio aglomeracijos srityse. Buvo nustatyta geografinės žemės ūkio gamybos aglomeracijos ir ūkininkų pajamų Kinijoje koreliacija. Žvelgiant iš erdvės perspektyvos, žemės ūkio gamybos aglomeracijos išoriškumas žymiai padidina vietos ūkininkų pajamas. Sifoninė žemės ūkio gamybos aglomeracija veikia per aplinkinių vietovių ūkininkų pajamų augimo ribojimą, tai gali trukdyti vystytis nesubalansuotai kaimo ekonomikai. Skirtingo agregacijos laipsnio grupėms būdingi akivaizdūs skirtumai. Aukšto ir vidutinio sunkumo žemės ūkio aglomeracijos srityse žemės ūkio gamybos aglomeracija itin veikia ūkininkų pajamų padidėjimą, tačiau žemos aglomeracijos vietovėse poveikis nėra akivaizdus. Išvadose pateikiamos teorinės vyriausybės nuorodos žemės ūkio gamybos plano ir struktūros optimizavimo srityje.

REIKŠMINIAI ŽODŽIAI: žemės ūkio gamybos aglomeracija, Durbin erdvės modelis, tiesioginis poveikis, netiesioginis poveikis, ribinis modelis.