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Dynamic Evolution and Trend Prediction of the Development Level of China's Agricultural and Rural Modernization

Wenjie Qian*

Anhui University of Finance and Economics, Bengbu 233040, China

*Corresponding Author

Abstract

Based on the three dimensions of agricultural, rural and farmers' modernization, the development level of agricultural and rural modernization of 30 provinces (excluding Tibet, Hong Kong, Macao and Taiwan) in China is measured from 2012 to 2021, and on this basis, the regional differences and dynamic evolution of the development level of agricultural and rural modernization in China are examined using Dagum's Gini Coefficient Decomposition, Kernel Density Estimation, and the Lan Index. The results show that the differences in the development level of agricultural and rural modernization in each region from 2012 to 2021 show a trend of gradual reduction, and there is a phenomenon of convergence. To a certain extent, it indicates that inter-regional differences are the key factors leading to the overall differences. According to the validation of kernel density estimation, the development level of China's agricultural and rural modernization basically remains stable from 2012 to 2021. The Moran index test can be obtained that the development level of China's agricultural and rural modernization shows a spatial positive correlation in geographic distance, and there is a spatial clustering phenomenon.

Keywords

Agricultural and Rural Modernization; Dynamic Evolution; Regional Differences; Evolutionary Trends.

1. Introduction

The report of the 20th CPC National Congress proposes to comprehensively promote rural revitalization, adhere to the priority development of agriculture and rural areas, and accelerate the construction of the country's agriculture, pointing out the direction for the work of the "three rural areas". The "three rural" issue is related to the country's wealth and strength, national rejuvenation, and people's happiness. 2023, the central "No. 1 document" fully demonstrates a distinctive theme - strong agriculture, rural beauty, rich farmers, the document also pointed out that we should make the "three rural" issue as the work of the whole party, and the "three rural" issue as the work of the whole party. The document also points out that we should make the "three rural issues" the top priority of the work of the whole party, take the road of socialist rural revitalization with Chinese characteristics, and accelerate the modernization of agriculture and rural areas. In the new era, in order to promote the process of agricultural and rural modernization, it is necessary to eliminate all kinds of obstacles hindering its development. To this end, on the basis of grasping the law of temporal and spatial dynamics of agricultural and rural modernization as well as the long-term trend, analyzing the reasons for the differences in the structure and level of agricultural and rural modernization in each province will help to understand the development law of agricultural and rural modernization in a more in-depth way, make up for the shortcomings, and realize the

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coordinated development of agricultural and rural modernization in each province. coordinated development of agricultural and rural modernization in all provinces.

In order to scientifically measure the modernization of agriculture and rural areas, scholars have carried out a series of related research, and have accumulated many scientific research achievements in the field of modernization of agriculture and rural areas, and the research on China's modernization of agriculture and rural areas is mainly divided into two aspects, one is about the measurement of the level of development of modernization of agriculture and rural areas, and the other is about the analysis of the characteristics of the spatial distribution of modernization of agriculture and rural areas in China. For the measurement of rural agricultural modernization, the level of development of agricultural and rural modernization is measured and analyzed by constructing an index system. Qin Cheng and Wang Bao [1], Li Gang [2], etc., by constructing the indicator system, all of them used the multi-indicator comprehensive measurement method to measure the development level of China's agricultural and rural modernization; while Liu Lu and Xin Ling [3], etc., on the basis of existing research, used three evaluation methods, including the multi-indicator comprehensive measurement method, the model method and the BP neural network method, to measure the development level of agricultural modernization in 30 provinces in 2020 . Xin Ling and Liu Heng [4], among others, used a combination of entropy coefficient and complex correlation coefficient assignment to empirically analyze the development level of agricultural and rural modernization in 31 provinces in China. In general, the measurement system of agricultural and rural modernization takes into account the five core requirements of rural revitalization while inheriting the indicators of agricultural modernization, but the assessment of agricultural structure, agricultural production and agricultural operation is slightly weak; the evaluation methods mainly cover the coefficient of variation method [5], the subjective-objective combination of the assignment method [6-8], the hierarchical analysis method [9] and the entropy value method [10]. Therefore, the study of agricultural and rural modernization still needs to expand the direction of the assessment as well as to improve the precision of the indicator weights. Regarding the research on the spatial distribution of the development level of China's agricultural and rural modernization, around the exploration of different geographic regions and comparing the spatial and temporal characteristics of the development level of agricultural and rural modernization, Chang Yanhua [11] and others, Liu Chuanming and Ning Anning [12] and others, and Xie Huijiang and Wang Han [13] analyzed the spatial distribution of the development level of agricultural and rural modernization through the methods of kernel density estimation, Dagum Gini coefficient decomposition, and spatial correlation analysis. They analyzed the spatial distribution of the development level of agricultural and rural modernization through the methods of kernel density estimation, Dagum Gini coefficient decomposition and spatial correlation analysis, and found that although the development level of China's agricultural and rural modernization is on an upward trend, there are characteristics of unbalanced development in various regions.

To sum up, most of the existing literature focuses on the analysis of theoretical connotation and the measurement of overall level, while there is a relative lack of in-depth research on the spatial imbalance and evolution of the development level of agricultural and rural modernization, the regional development level and the dimension of indicators. Based on this, this paper constructs an indicator system for the development level of agricultural and rural modernization by selecting corresponding indicators from the three dimensions of agricultural modernization, rural modernization and farmers' modernization, and uses the entropy weight method to measure the development level of agricultural and rural modernization of 30 provinces in China from 2012 to 2021. At the same time, based on the research results in the literature, Dagum's Gini coefficient decomposition method is used to examine the development level of China's agricultural and rural modernization and regional development differences, and

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kernel density estimation and Moran's index are used to study the dynamic evolution of China's agricultural and rural modernization development level from the perspective of time and space.

2. Research Design

2.1. Construction of the Indicator System

According to the principles of scientificity, objectivity, guidance, systematicity and operability, this paper includes the modernization level of agriculture, rural areas and farmers at the system level, and sets agricultural industry, agricultural production, agricultural operation, rural culture, rural governance, rural ecology, farmers' income and consumption, and farmers' life as the guideline level, and splits the above guideline level into 38 indicators to construct the evaluation system of modernization of agriculture and rural areas.

2.2. Data Sources

Based on data availability, continuity and applicability, this paper chooses 2012-2021 as the research interval, and takes 30 provinces (excluding Tibet, Hong Kong, Macao and Taiwan) in China as the research object. The relevant data mainly come from China Statistical Yearbook, China Agricultural Yearbook, China Rural Statistical Yearbook, China Agricultural Machinery Industry Yearbook, China Leisure Agriculture Statistical Yearbook, as well as provincial statistical yearbooks, the official website of the National Bureau of Statistics, and the EPS database, etc. Taking into account the completeness and comparability of the sample data, the linear interpolation method is chosen to make up for the missing data in some areas.

2.3. Research Methodology

2.3.1. Methodology for Measuring the Agricultural and Rural Modernization Index:

This paper adopts the entropy weighting model, which mainly utilizes the difference information, and assigns weights by measuring the degree of dispersion of the difference information. The greater the degree of dispersion of the indicator value, the greater the weight of the indicator corresponding to the larger amount of information provided by the indicator. The assignment and quantitative ranking of the indicator system are conducive to reducing subjective bias, enhancing the objectivity of the measurement results, and clearly expressing the correlation and importance of each indicator.

2.3.2. Dagum Gini Coefficient Decomposition

This paper applies the Dagum Gini coefficient decomposition method to study the regional differences in the level of development of agricultural and rural modernization, and divides the regional differences into three parts, namely intra-regional differences, inter-regional differences, and inter-regional hypervariable density differences, which are used to measure the regional differences.

2.3.3. Kernel Kernel Density Estimation

In this paper, Kernel density method is used to analyze the distributional dynamics of the development level of agricultural and rural modernization.

2.3.4. Spatial Autocorrelation Analysis

At present, the index to measure spatial autocorrelation is mainly Moran index, Moran index, by the first law of geography, when the research sample design multiple units, the spatial correlation between the samples can not be ignored. Therefore, this paper uses the Moran index to test the spatial autocorrelation of the development level of agricultural modernization. Generally speaking, the Moran index is divided into the global Moran index and the local Moran index, and the global Moran index measures the global spatial autocorrelation, which tells us whether or not the spatial clustering of the development level of China's agricultural

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modernization is occurring, but doesn't indicate exactly where; while the local Moran index measures local spatial correlation and tells us where the aggregation has occurred.

3. Analysis of Regional Differences in the Level of Development of Agricultural and Rural Modernization

3.1. Overall Differences

Table 1 shows the sources of overall differences in the level of development of agricultural and rural modernization in the country and their contribution in 2012-2021. According to Table 2, the annual average value of the overall Gini coefficient of the development level of agricultural and rural modernization in the country was 0.133 in 2012-2021, and from the time dimension, this value generally showed a decreasing trend in 2012-2021, however, it increased from 2013 to 2019, while decreasing year by year in other years. As a whole, in 2012-2021, the differences in the development level of agricultural and rural modernization in each region gradually narrowed, and there was a phenomenon of convergence. In terms of the size of the contribution rate, in 2012-2021, the contribution rate of the overall Gini coefficient is ranked from the highest to the lowest, which are inter-regional differences, intra-regional differences and hypervariable density, which indicates to a certain extent that the inter-regional differences are the main factors contributing to the overall differences. From the perspective of the evolution process, from 2012 to 2021, the change in the contribution rate of intra-regional differences remains stable without any obvious fluctuation trend, basically stabilizing at about 22%, with an average annual contribution rate of 22.40%, and the contribution rate of inter-regional differences gradually increases in the period from 2012 to 2017, reaching 61.66% and then decreasing, and then turning from decreasing to increasing, with its average annual contribution rate reached 58.73%. The contribution rate of hypervariance density showed a gradual decline from 2012 to 2017, but began to show an increase after falling to 16.63%. Therefore, there is a fluctuating relationship between the contribution rate of interregional differences and the contribution rate of hypervariable density.

Table 1. Sources of overall differences in the level of development of China's agricultural and rural modernization and their contribution rates

Year	Overall Gini coefficient	Intra-regional variations		Interregional differences		hypervariable density	
		Source	Contribution (%)	Source	Contribution (%)	Source	Contribution (%)
2012	0.150	0.0332	22.09	0.0900	59.83	0.0272	18.08
2013	0.152	0.0334	22.00	0.0879	57.88	0.0306	20.12
2014	0.142	0.0313	20.05	0.0840	59.24	0.0265	18.71
2015	0.136	0.0307	22.47	0.0794	58.15	0.0264	19.38
2016	0.127	0.0283	22.28	0.0737	58.07	0.0249	19.65
2017	0.128	0.0278	21.71	0.0790	61.66	0.0213	16.63
2018	0.127	0.0287	22.68	0.0748	58.99	0.0232	18.33
2019	0.133	0.0308	23.14	0.0797	59.76	0.0228	17.10
2020	0.121	0.0300	24.75	0.0666	55.01	0.0245	20.24
2021	0.111	0.0254	22.81	0.0653	58.69	0.0206	18.50
Averages	0.133	0.0300	22.40	0.0780	58.73	0.0248	18.67

3.2. Intra-regional Variations

Table 2 shows the intra-regional Gini coefficients of the development level of agricultural and rural modernization in 2012-2021.The average values of the Gini coefficients of the

ISSN: 2710-0723

development level of agricultural and rural modernization in each region in 2012-2021 are, from smallest to largest, in the order of the West, the Central, the East, and the Northeast, but the Gini coefficients of the Northeast decrease year by year in 2012-2021, indicating that intra-regional disparities in the Eastern region decrease year by year, and the Gini coefficients of the Eastern region increase year by year in 2012-2021, indicating that regional disparities in the Eastern region increase year by year. 2021 the Gini coefficient in the east increases year by year indicating that the regional differences in the eastern region increase year by year. Therefore, the western region has the smallest difference in the development level of agricultural and rural modernization among provinces, while the eastern region has the largest difference in the development level of agricultural and rural modernization among provinces. Sub-regionally, the Gini coefficient in the Northeast region in 2012 decreased year by year, indicating that the differences in the development level of agricultural and rural modernization among the provinces in the Northeast region after 2012 are getting smaller and smaller, and there is a trend of convergence. The mean values of the Gini coefficient in the central and western regions are 0.0939 and 0.0505 respectively, with relatively stable intra-regional differences and little fluctuation. In the eastern region, the intraregional Gini coefficient fell from 0.1075 in 2012 to 0.0840 in 2017, and has basically been on the rise since 2017, in a state of constant fluctuation.

Table 2. Intra-regional Gini coefficients for the level of development of agricultural and rural modernization in China.

Year	Eastern	Central	Western	Northeastern
	Gini coefficient	Gini coefficient	Gini coefficient	Gini coefficient
2012	0.1075	0.1008	0.0482	0.1527
2013	0.1029	0.1012	0.0519	0.1529
2014	0.0909	0.0916	0.0500	0.1474
2015	0.0908	0.0919	0.0573	0.1379
2016	0.0888	0.0868	0.0425	0.1274
2017	0.0840	0.0983	0.0426	0.1104
2018	0.1110	0.0761	0.0768	0.0935
2019	0.1313	0.1040	0.0411	0.0951
2020	0.1403	0.0944	0.0494	0.0761
2021	0.1256	0.0939	0.0454	0.0572
Averages	0.1073	0.0939	0.0505	0.1151

3.3. Interregional Differences

Table 3 shows the Gini coefficient of the development level of agricultural and rural modernization between regions in 2012-2021, reflecting the differences in the development level of agricultural and rural modernization between regions. For example, the Gini coefficients of East-North East, Central-North East and other regions are more different from each other, and their average values are above 0.15. The Gini coefficients of East-Central, East-West, Central-West and Central-Northeast show upward and downward fluctuations until 2019, but the fluctuations are not large, and show a decreasing trend after 2019. East-Northeast and West-Northeast, the Gini coefficient between regions is in a decreasing trend in 2012-2021, and the differences between regions are decreasing, indicating the existence of convergence. As a whole, the differences in the development level of agricultural and rural modernization among regions are decreasing from 2012 to 2021, indicating the existence of a convergence phenomenon.

ISSN: 2710-0723

Table 3. Gini coefficients for the level of development of agricultural and rural modernization among regions of China

Year	East-Central	East-West	East-Northeast	Central-West	Central-Northeast	West-Northeast
	Gini coefficient	Gini coefficient	Gini coefficient	Gini coefficient	Gini coefficient	Gini coefficient
2012	0.1111	0.1545	0.2233	0.1334	0.2027	0.1303
2013	0.1079	0.1562	0.2243	0.1333	0.2052	0.1368
2014	0.1019	0.1521	0.2167	0.1180	0.1895	0.1310
2015	0.0989	0.1491	0.2029	0.1218	0.1786	0.1218
2016	0.0967	0.1364	0.1919	0.1078	0.1678	0.1143
2017	0.1016	0.1414	0.1855	0.1234	0.1744	0.0977
2018	0.1086	0.1282	0.1722	0.1138	0.1567	0.1041
2019	0.1282	0.1453	0.1783	0.1387	0.1636	0.0815
2020	0.1280	0.1423	0.1549	0.1250	0.1305	0.0676
2021	0.1197	0.1168	0.1486	0.1172	0.1401	0.0685

4. Trends in the Evolution of the Level of Development of Agricultural and Rural Modernization

4.1. Trends Over Time

In order to show the dynamic evolution law of the development level of China's agricultural and rural modernization in a more visual and intuitive way, therefore, this paper adopts the kernel density method to get the three-dimensional diagrams shown in Figures 1 to 5, which represent the dynamic evolution of the development level of agricultural and rural modernization of China as a whole, in the eastern part of the country, in the central part of the country, in the western part of the country and in the northeastern part of the country.

In 2012-2021, the development level of modernization of agriculture and rural areas in China showed a trend of shifting to the left, but overall maintained a stable change with little change. For these four regions, in terms of distribution location, the development level of agricultural and rural modernization in each year shows fluctuations around the mean value, especially in the eastern region, where the upward and downward trend is more obvious, which indicates that the differences in the development level of agricultural and rural modernization in the eastern region are getting bigger and bigger, showing the phenomenon of multi-polarization and spatial imbalance. The central and western regions show no obvious fluctuation trend; the northeastern region shows a trend of shifting to the right. In terms of the distribution pattern, the peak in the eastern region shows a process of change from falling to rising, while the width of the main peak first expands and then gradually narrows, indicating the difference in the development level of agricultural and rural modernization in the eastern region, which first expands year by year and then narrows year by year. In the central region, the peak shows a slight downward trend, while the width of the main peak does not fluctuate significantly, and remains basically stable on the whole. In the western region, the peak shows a gradual upward trend, while the width of the main peak also narrows year by year, indicating that the differences in the development level of agricultural and rural modernization in the western region are narrowing year by year. In the eastern region, however, the phenomenon of multiple peaks is observed, indicating that the development level of agricultural and rural modernization in the northeast is unstable and subject to frequent changes. In terms of distributional extensibility, there is no obvious trailing phenomenon in either the whole or the regions, suggesting that the level of development of agricultural and rural modernization in both the whole and the regions is relatively concentrated in all years.

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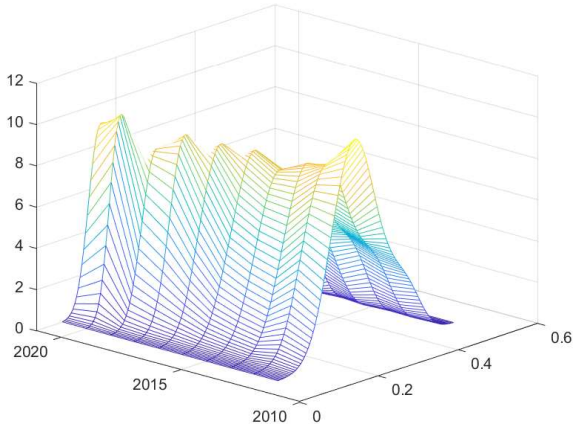

Figure 1. Dynamic evolution of the level of development of China's overall agricultural and rural modernization

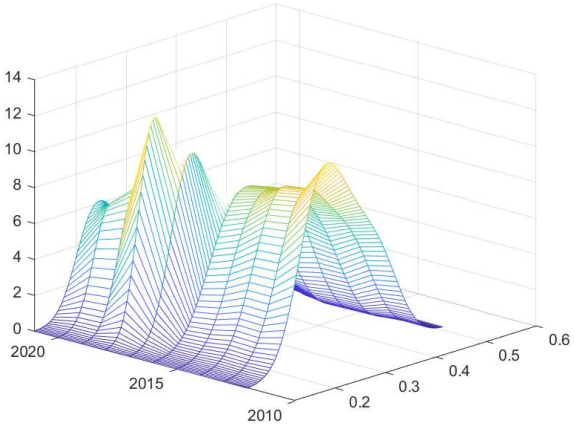

Figure 2. Dynamic evolution of the level of development of agricultural and rural modernization in the eastern region

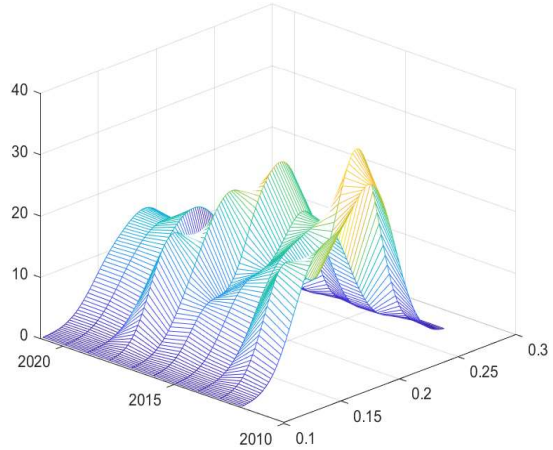

Figure 3. Dynamic evolution of the level of development of agricultural and rural modernization in the central region

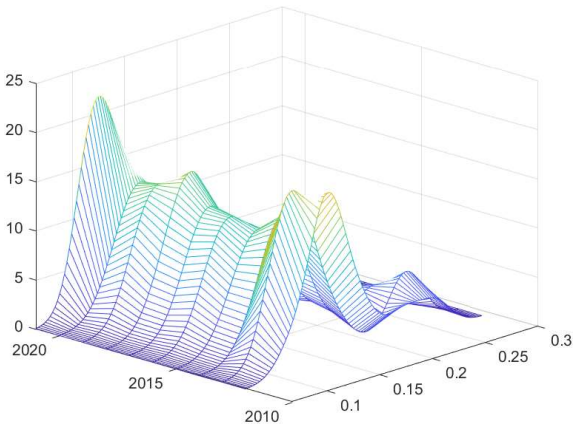

Figure 4. Dynamic evolution of the level of development of agricultural and rural modernization in the western region

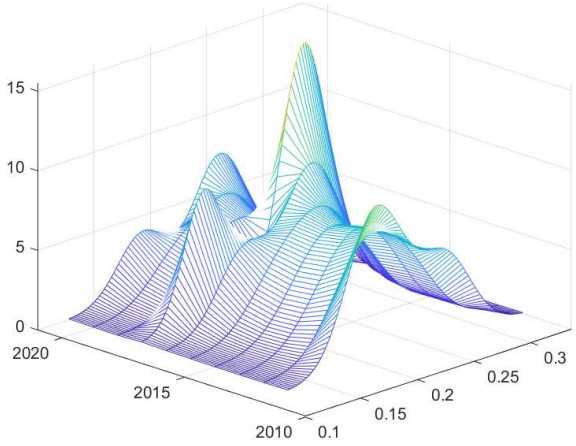

Figure 5. Dynamic evolution of the level of development of agricultural and rural modernization in the Northeast region

4.2. Trends in Spatial Evolution;

In this paper, based on the index of agricultural and rural modernization development level of China's provinces in previous years, the spatial autocorrelation test of China's agricultural and rural modernization development level was carried out by calculating the global Moran index, and the results of the calculations are shown in Table 4. 2012-2021, from Table 5, it can be obtained that based on the geographic weight matrix of China's agricultural and rural

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modernization development level of the various provinces of the global Moran index are all positive values and the Z value is greater than the critical value at the confidence level, which shows that the development level of agricultural and rural modernization in China's provinces shows a positive spatial correlation in geographic distance, and there is a phenomenon of spatial aggregation, from which it can be concluded that the provinces with a high level of development of China's agricultural and rural modernization tend to be strongly aggregated, and the provinces with a low level of development of China's agricultural and rural modernization tend to be weakly aggregated. As a whole, the global Moran index of China's agricultural and rural modernization development level shows a gradually decreasing trend, but there are slight fluctuations. From a specific point of view, the Moran index increased steadily year by year from 2012 to 2016, but after 2017 the Moran index decreased steadily year by year, which indicates that the spatial positive correlation of the level of development of agricultural and rural modernization in each province is gradually weakening in the trend, and this spatial correlation exists steadily for a long time. The reason for this is that China's agricultural industrial structure is undergoing continuous adjustment, agricultural reform is in progress, and policies that prioritize the development of agriculture and rural areas are being implemented. This has led to an increase in the level of development of agricultural modernization in the eastern, central and western regions, and has also narrowed the differences in the level of development of agricultural modernization among regions, thus further optimizing the imbalance in the level of development of agricultural modernization among regions.

Table 4. Spatial autocorrelation test of the development level of China's agricultural and rural modernization

Year	Moran's I	Z-Value	P-Value
2012	0.148	5.048	0.000
2013	0.161	5.371	0.000
2014	0.169	5.582	0.000
2015	0.170	5.604	0.000
2016	0.170	5.604	0.000
2017	0.140	4.874	0.000
2018	0.103	4.019	0.000
2019	0.101	4.127	0.000
2020	0.081	3.866	0.000
2021	0.100	4.119	0.000

5. Conclusion

The paper constructed the evaluation index system of the development level of agricultural and rural modernization through the three dimensions of agricultural modernization, rural modernization and farmers' modernization level, and measured the index of the development level of China's agricultural and rural modernization from 2012 to 2021, and decomposed the differences in the development level of agricultural and rural modernization among the eastern, central, western and northeastern regions of China by using the Dagum base. Based on this, and then from the two dimensions of time and space, kernel density estimation and Moran index were used to study the spatial distribution characteristics of the development level of agricultural and rural modernization in China's provinces as well as the dynamic evolution law, and finally, the traditional Markov chain transfer probability matrix was used to calculate the

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transfer probability between different states of China's agricultural and rural modernization development level. The conclusions are as follows: (1) According to the validation of the kernel density estimation, the development level of China's agricultural and rural modernization basically remains stable from 2012 to 2021. From a sub-regional perspective, the eastern region has the highest development level of agricultural and rural modernization, followed closely by the central region, the western region, and the northeastern region. (2) From an overall perspective, the differences in the development level of agricultural and rural modernization in each region from 2012 to 2021 show a trend of gradual reduction, and there is a phenomenon of convergence. To a certain extent, it shows that inter-regional differences are the key factor leading to the overall differences. The order of differences in the development level of agricultural and rural modernization within regions is from small to large: the western region, the central region, the northeastern region and the eastern region, and the size of the differences between regions is decreasing. (3) It can be obtained through the Moran index test that China's agricultural and rural modernization development level shows a spatial positive correlation in geographic distance, and there is a spatial clustering phenomenon.

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