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Article

Measurement and Dynamic Trend Research on the Development Level of Rural Industry Integration in China

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Abstract: China is a traditional agricultural country, and the integration of rural industries has become an essential policy direction for the current strategy of agricultural modernization in China. In recent years, the agricultural industrial chains across various regions of China have consistently expanded and extended. The multifunctionality of agriculture is continuously unearthed, and the principal entities managing agriculture have become increasingly diversified and have grown significantly. New industries and forms in agriculture emerge incessantly. Accurately and profoundly understanding the inherent features of the integration of industries in rural China, establishing a scientific and rational measurement index system in line with the current status and development goals of rural China, and employing appropriate measurement methods to assess its development level and process, is instrumental in comprehending the level of integrated development in various regions. This aids in identifying challenges in the developmental process and proposing targeted developmental strategies. Hence, this paper, rooted in the integration of rural industries, cross-industry, industry extension, industry agglomeration, and industry penetration, sets up an measurement index system. Using provincial panel data from 2011 to 2020, the paper measures the level of integrated development in rural industries across China and its 31 provinces. Based on the measurement results, further techniques such as kernel density estimation and Gini coefficient decomposition have been used to analyze the spatial distribution characteristics and dynamic trends of the integrated development of rural industries in China. Research indicates that during the sample period, the overall level of integrated development in rural industries in various provinces in China has shown an upward trend. Development among the eastern, central, and western regions is highly uneven, but this disparity has been gradually narrowing in recent years. Furthermore, the levels of integrated development in different provinces exhibit significant spatial agglomeration effects. The development level of neighboring regions significantly impacts the province's development status. In the process of integrated development of rural industries in China, there's a trend where "it's easier to downgrade than to upgrade," with very few regions achieving leapfrog development.

Keywords: integration of rural industries; development level measurement; regional disparities; dynamic trend

1. Introduction

China is a traditional agricultural powerhouse. According to the 2020 Statistical Bulletin on National Economic and Social Development, approximately 560 million people reside in China's rural areas. The issues related to agriculture, rural areas, and farmers (often referred to as the "Three Rural" issues) concern the fundamental interests of the vast majority of the people. Over the past decade, the government has successively issued a series of policy documents to guide and encourage localities to delve deeper into the multi-functionality of agriculture, continuously expand the agricultural industry value chain, enhance the comprehensive competitiveness of agriculture, and promote farmers' income growth.

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From a theoretical perspective, many scholars have conducted in-depth research on the connotations, driving mechanisms, developmental pathways, drivers, domestic and international experiences, existing challenges, and countermeasures related to the integration of rural industries. A consensus has gradually emerged regarding the core of rural industrial integration. Specifically, such integration is not just the vertical extension of the agricultural industry chain but also its horizontal expansion, representing a multiplicative development model of the industry chain. Regarding the methods to evaluate the level of rural industrial integration and the analysis of the measurement results, some scholars have also made beneficial explorations. For example, Shi Xiuyi (2023) emphasized the importance of evaluating rural industrial integration based on extending agriculture, industries interacting with agriculture, and expanding agricultural functions. Ge Jihong, Wang Meng, and others (2022) proposed that the additive effect of rural industrial integration is manifested as the vertical extension of the agricultural industry chain, and the multiplicative effect manifests as the horizontal derivation of new business formats.

In terms of practical experiences, China's rural industrial integration has flourished in recent years with constant expansion and diversification of the agricultural industry chain, emergence of new agricultural industries, and more. Specifically: Accelerated Integration within the Agricultural Industry: Many regions in China have integrated planting, breeding, and animal husbandry, evolving into new industry models such as ecological, circular, and precision agriculture. Rapid Transformation and Upgrading of Agricultural Product Processing: In 2020, over 2.24 million farmer cooperatives were established in China. Continuous Innovation in Agricultural Product Marketing Models: Relying on internet information technology, new rural e-commerce and culturally integrated marketing models have achieved rapid development. Thriving Leisure Agriculture and Rural Tourism: By the end of 2019, there were more than 300,000 leisure agricultural entities in China. Deep Integration and Agglomeration of the Agricultural Industry: Various regions of China are actively exploring new models of industrial organization.

In summary, although significant achievements have been made in both the theoretical research and practical experiences of rural industrial integration in recent years, there remain key issues to be addressed due to regional differences. Against this backdrop, this paper aims to grasp the essence of rural industrial integration in China, establish a scientifically sound measurement index system, and use it to evaluate the development level and progress of rural industrial integration across 31 provinces. The ultimate goal is to offer feasible suggestions and countermeasures to promote the high-quality development of modern agriculture in China and achieve the modernization of agriculture and rural areas.

2. Materials and Methods

2.1. Measurement Method

Given that the measurement object is each province in China, and considering the numerous measurement indicators involved, the measurement process should not be overly complicated. Hence, this paper refers to the approaches of Xin Ling (2022) and Chen Shengwei (2020)，adopting a multi-indicator comprehensive measurement model to assess the level of integrated development of rural industries in China[21-22]. The specific process starts by determining the measurement indicator system based on the connotations of modern agricultural development and the objectives of integrated rural industrial development. The entropy method and expert scoring method are then combined to standardize the original measurement indicator data. Finally, the results of each region are formed and further analysis and discussion are carried out. The calculation formula for the multi-indicator comprehensive measurement model is:

$$Z_{is} = \sum^{j} w_j Y_{ij} \tag{1}$$

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$$\mathrm{RI}_i = \sum^{m} Z_{is} \tag{2}$$

Where $Z_{is}$is the index of integrated rural industrial development of the *i-th* province and the *s-th* subsystem; $W_j$is the weight of the *j-th* indicator, and Y_{ij} is the standardized value of the *j-th* indicator of the *i-th* province. RI_i represents the development index of rural industry integration of the *i-th* province, and m represents the number of subsystems of rural industry integration.

2.2. Gini Coefficient Decomposition Method

For a deeper analysis of spatial heterogeneity, the Gini coefficient decomposition method can be used. According to this method, the total difference *G* can be decomposed into the contribution of intra-regional differences G_w, inter-regional differences G_{nb}, and the contribution of transvariation density G_t. The transvariation density contribution is the impact difference on the total difference caused by the existence of crossover items when dividing the group. The specific formulas are:

$$G = G_w + G_{nb} + G_t \tag{3}$$

$$G = \frac{1}{2n^2\mu}\sum_{j=1}^{k}\sum_{h=1}^{k}\sum_{i=1}^{n_j}\sum_{r=1}^{n_h}\left|y_{jit} - y_{hrt}\right| \tag{4}$$

Where $y_{jit}(y_{hrt})$ represents the integrated development index of rural industries of the *i-th* (*r-th*) measurement object in the *j-th* (*h-th*) region in year *t*, with 31 provinces in total. μ represents the average value of all measurement objects, *n* is the number of measurement objects, *k* represents the number of regional divisions, and $n_j(n_h)$is the number of measurement objects in the *j-th* (*h-th*) region.

$$G_{jj} = \frac{\frac{1}{2\mu_j}\sum_{i=1}^{n_j}\sum_{r=1}^{n_j}|y_{ji}-y_{jr}|}{n_j^2} \tag{5}$$

$$G_w = \sum_{j=1}^{k} G_{jj}P_jS_j \tag{6}$$

$$G_{jh} = \frac{\sum_{i=1}^{n_j}\sum_{r=1}^{n_j}|y_{ji}-y_{jr}|}{n_jn_h(\mu_j+\mu_h)} \tag{7}$$

$$G_{nb} = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_js_h + p_hs_j)D_{jh} \tag{8}$$

WhereG_{jj}andG_w represent the Gini coefficient of region *j* and the intra-regional Gini coefficient, respectively. G_{jh} and G_{nb} represent the Gini coefficient between region *j* and region *h*, and the inter-regional Gini coefficient, respectively. D_{gh} represents the relative impact between region *j* and region *h* on the development level of rural industry integration.

$$G_t = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{hj}(p_j\,s_h + p_hs_j)(1 - D_{jh}) \tag{9}$$

$$D_{jh} = \frac{d_{jh}-p_{jh}}{d_{jh}+p_{jh}} \tag{10}$$

$$d_{jh} = \int_0^{\infty} dF_j(y)\int_0^{y}(y-x)dF_h(y) \tag{11}$$

$$p_{jh} = \int_0^{\infty} dF_h(y)\int_0^{y}(y-x)dF_j(y) \tag{12}$$

Where G_t represents the contribution of transvariation density, $1 - D_{jh}$ represents transvariation density, and $F_j(F_h)$ represents the distribution function of region *j (h)*.

2.3. Construction of measurement Index System

In the process of evaluating the level of rural industrial integration, establishing the measurement index system is the most crucial step[23]. The design of the measurement index system

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hierarchy should comprehensively cover all dimensions of rural industrial development and its integration level. The construction should follow four principles:

Guidance: It should represent the objectives and requirements of rural industrial integration development and should align with international conventions and public perceptions.

Systematic: One must fully consider the profound connotations of rural industrial integration and the strategic goals of China's rural revitalization.

Scientific: The selected indicators should have both a theoretical foundation and policy basis. They should also take into account differences in regional resource endowments, development levels, and other real-world situations.

Operability: The selected indicators should be highly representative, targeted, and continuous. There should be connections and mutual validation among the indicators, but each should be independent, avoiding overlaps, to ensure the measurement is straightforward, feasible, and effective[24-25].

Considering the above, combined with the main modes of rural industrial integration development in China, this study has identified five system-level indicators: agricultural industry development, agricultural chain extension, agricultural industry crossover, agricultural industry agglomeration, and advanced technology penetration. Specifically:

Agricultural Industry Development: This primarily examines whether the foundational status of agriculture is solid, thoroughly measuring the production cost of agriculture and the quality of agricultural products.

Agricultural Chain Extension: It mainly examines the degree of connection between "cultivation + breeding" in agriculture and related industries such as processing, sales, and research.

Agricultural Industry Crossover: This mainly examines the level of coordinated development between other industries closely related to agriculture or those providing services to it.

Agricultural Industry Agglomeration: This mainly examines the excellence of the agricultural industrialization organizational model and whether it has the capability for sustainable integrated development.

Advanced Technology Penetration: This primarily investigates the degree of integration and penetration of new information technologies in various stages of agricultural production, processing, and marketing.

Based on the definition of the system level for measurement indicators, 18 specific indicators are set at the indicator level, as shown in Table 1.

Table 1. Evaluation Index System of Rural Industry Integration Development Level.

System Level	Indicator Level	Calculation Method	Weight
Agricultural Industry Development	(A1) Total agricultural output (in 10,000 yuan)	-	0.038
	(A2) Agricultural labor productivity (in 10,000 yuan/person)	Added value of agriculture/Number of employed in agriculture	0.044
	(A3) Land yield rate (in 10,000 yuan/hectare)	Added value of agriculture/Rural land area	0.050
	(A4) Rural fertilizer and pesticide reduction intensity (tons/thousand hectares)	Reduced fertilizer and pesticide usage/Total crop planting area	0.063
Agricultural Industry Extension	(A5) Proportion of livestock industry output (%)	(Livestock + Fisheries output)/Total agricultural output	0.062
	(A6) Proportion of agricultural product processing industry output (%)	Agricultural product processing output/Total agricultural output	0.055

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	(A7) Proportion of agro-forestry-fishery services output (%)	Agro-forestry-fishery services output/Total agricultural output	0.087
	(A8) Scale of agricultural social services (units/100 households)	Number of specialized agricultural machinery service institutions/Number of households in the region	0.069
Industrial Crossover Integration	(A9) E-commerce transaction amount of agricultural products (in 10,000 yuan)	-	0.052
	(A10) Ratio of recreational agriculture and rural tourism total output (%)	Recreational agriculture and rural tourism total output/Total agricultural output	0.077
	(A11) Rural logistics penetration rate (km)	Total length of rural delivery routes/Total number of households in the rural area	0.054
Industry Element Aggregation	(A12) Agricultural loan amount (in 10,000 yuan)	-	0.069
	(A13) Ratio of urban to rural residents' income (%)	Average disposable income of urban residents/Average disposable income of rural residents	0.046
	(A14) Non-agricultural employment capability of farmers	Number of non-agricultural employed in rural areas/Working-age population in rural areas	0.054
	(A15) Urbanization rate (%)	Number of permanent urban residents/Total permanent residents in the region	0.023
Industrial Technology Penetration	(A16) Comprehensive mechanization rate of crop cultivation and harvesting (%)	Ploughing rate × 40% + Planting rate × 30% + Harvesting rate × 30%	0.066
	(A17) Agricultural disaster prevention rate (%)	1 - (Area of crops affected by disaster/Area of crop planting)	0.051
	(A18) Rural informatization rate (units/100 households)	Number of computers owned by rural households/Number of households in the region	0.039

2.4. Data

The data for this study originates from public data released by relevant statistical departments, such as the "China Statistical Yearbook," "China Rural Statistical Yearbook," and "Rural Business Management Statistical Annual Report." Considering accessibility, this paper utilizes panel data from 2011 to 2020, spanning ten years, of China and its 31 provinces (excluding the Hong Kong, Macau, and Taiwan) to evaluate and study the dynamic trends of rural industrial integration development level. To ensure the completeness and comparability of sample data, individual missing values have been filled using the mean method and interpolation.

3. Results

3.1. measurement Results of Rural Industrial Integration Development Level

Following the measurement index system and measurement method established earlier, the results of evaluating the level of rural industrial integration development in China's 31 provinces are shown in Figure 1. (For a direct comparison, only the measurement results for the years 2011, 2015,

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and 2020 are displayed.) Observing the overall trend, except for a few provinces (such as Inner Mongolia, Qinghai, etc.) that remain unchanged or slightly declined, the industrial integration development levels of China and its provinces consistently show an upward trend. From a regional perspective, provinces located in the eastern region (like Beijing, Zhejiang, Shandong, and Jiangsu) have markedly higher levels of industrial integration development than those in the western region (like Guizhou, Yunnan, Chongqing, and Tibet). While the central region's industrial integration level is slightly higher than that of the western region, it is generally lower than the Chinese average. This indicates a significant unevenness in the industrial integration development levels across China's provinces. The eastern region, due to its locational and economic development advantages, has taken a leading position in promoting rural industrial integration[26]. In contrast, the potentials of the central and western regions are yet to be fully exploited. The resource utilization efficiency is not high. However, the measurement results suggest that there's substantial potential for growth in industrial integration development.

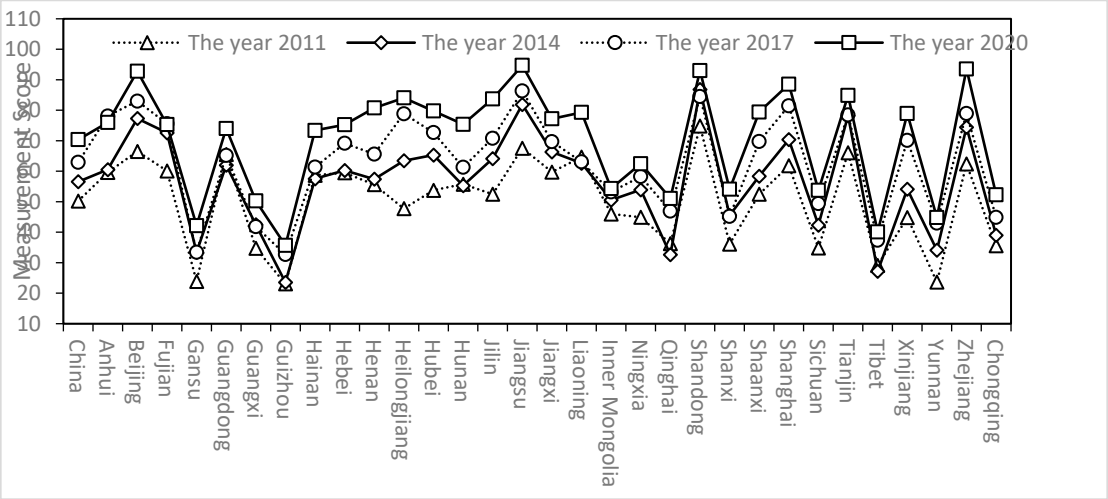

Figure 1. Evaluation Index System of Rural Industry Integration Development Level.

To further clarify the development status of each province, this study classifies them according to quartile points based on the results of the industrial integration development level measurement. Specifically, those exceeding 75% of the sample measurement scores are categorized as "High Level," those between 75% and 50% are classified as "Upper-Medium Level," those between 50% and 25% are categorized as "Lower-Medium Level," and those below 25% of the sample measurement scores are designated as "Low Level." The organized results are presented in Table 2.

Table 2. Level of Rural Industrial Integration Development in Various Provinces by Region and Year.

Year/Region	Low Level	Medium-Low Level	Medium-High Level	High Level
		The year 2011		
Eastern	-	-	Fujian, Hebei, Hainan	Shandong, Jiangsu, Beijing, Tianjin, Guangdong, Liaoning, Zhejiang, Shanghai
Central	Shanxi	Jilin, Heilongjiang	Jiangxi, Anhui, Hunan, Henan, Hubei	-

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Western	Chongqing, Sichuan, Guangxi, Tibet, Gansu, Yunnan, Guizhou	Shaanxi, Inner Mongolia, Ningxia, Xinjiang, Qinghai	-	-
		The year 2014		
Eastern	-	Hainan	Liaoning, Guangdong, Hebei	Shandong, Jiangsu, Tianjin, Beijing, Zhejiang, Fujian, Shanghai
Central	-	Henan, Hunan, Shanxi	Hubei, Jilin, Heilongjiang, Anhui	Jiangxi
Western	Sichuan, Chongqing, Yunnan, Gansu, Qinghai, Tibet, Guizhou	Xinjiang, Ningxia, Inner Mongolia, Guangxi	Shaanxi	-
		The year 2017		
Eastern	-	Guangdong, Liaoning, Hainan	Fujian, Hebei	Jiangsu, Shandong, Beijing, Shanghai, Zhejiang, Tianjin
Central	Shanxi	Hunan	Hubei, Jilin, Jiangxi, Henan	Heilongjiang, Anhui
Western	Chongqing, Yunnan, Guangxi, Tibet, Gansu, Guizhou	Ningxia, Inner Mongolia, Sichuan, Qinghai	Shaanxi, Xinjiang	-
		The year 2020		
Eastern	-	Fujian, Hebei, Guangdong, Hainan	Liaoning	Jiangsu, Zhejiang, Shandong, Beijing, Shanghai, Tianjin
Central	-	Shanxi	Henan, Hubei, Jiangxi, Anhui, Hunan	Heilongjiang, Jilin
Western	Chongqing, Qinghai, Guangxi, Yunnan, Gansu, Tibet, Guizhou	Ningxia, Inner Mongolia, Sichuan	Shaanxi, Xinjiang	-

From Table 2, it is evident that in the eastern region, the provinces that are relatively lagging in development include Hainan, Guangdong, Liaoning, Hebei, and Fujian. Other provinces such as Beijing, Shanghai, Jiangsu, and Zhejiang consistently rank at a high level of integrated development. In the western region, most provinces are at a lower-medium development level. Still, leading provinces like Shaanxi and Xinjiang have taken advantage of national policy benefits and their resources to gradually fill their development gaps, joining the ranks of upper-medium level development. In the central region, leading provinces include Jiangxi, Heilongjiang, and Jilin. These provinces have a robust foundation in agricultural industry development and possess a comparative advantage in promoting rural industrial integration. Overall, the level of rural industrial integration in China shows a clear gradient from northeast (high) to southwest (low), with evident regional disparities.

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3.2. Spatial Distribution and Dynamic Trend of Rural Industrial Integration Development

3.2.1. Dynamic Change Trend of Rural Industrial Integration Development

Based on the Gaussian kernel density function, the dynamic distribution of rural industrial integration levels in China and its various regions was analyzed, with results shown in Figure 2. In general, the eastern, central, and western regions have all seen significant improvements in their levels of rural industrial integration. Specifically, in the eastern region, the peak height of the distribution curve in 2011 was relatively high and narrow. Between 2014-2020, there was a noticeable shift towards a lower peak and a broader curve. In the central region from 2011-2020, the peak height of the distribution curve initially decreased before slightly rising. In contrast, in the western region, the width of the peak remained relatively stable from 2011-2020, but the peak height slightly decreased.

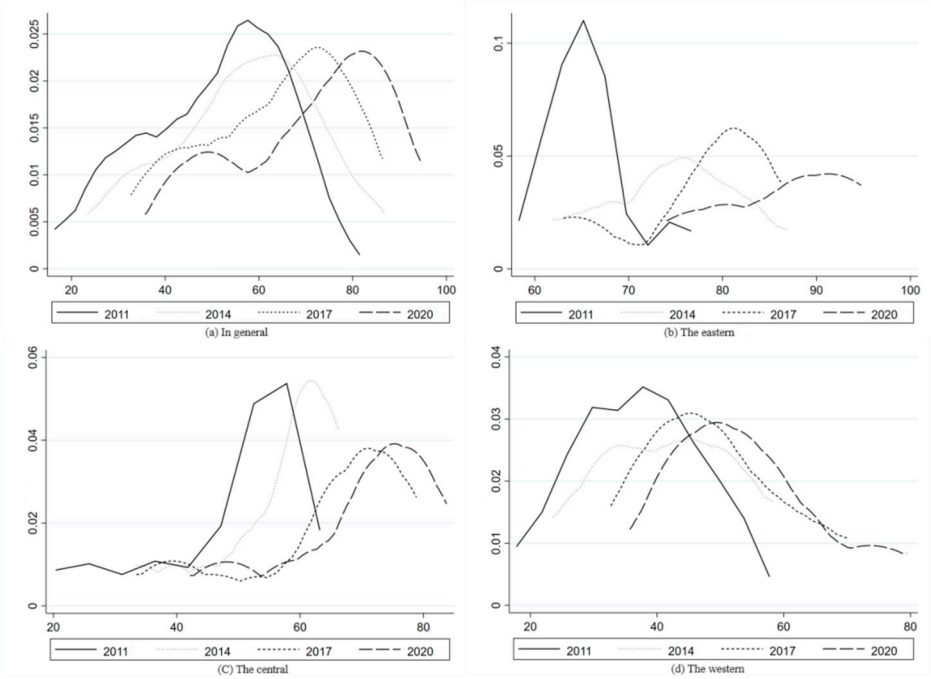

Figure 2. Kernel Density Curves of the Integration Level of Rural Industries in China.

These trends indicate that over the ten years studied, there were no significant disparities in the development levels between the provinces in the western region. In contrast, disparities in the central region initially decreased then expanded, while those in the eastern region significantly reduced. The kernel density curve for China's overall rural industrial integration level also reveals that the national disparity has slightly decreased over the decade. However, the appearance of two distinct peaks, especially the tailing on the right, further emphasizes the spatial imbalance in China's rural industrial integration development, with many provinces still lagging behind in their development levels.

3.2.2. Regional Disparities and Decomposition of Rural Industrial Integration Development

As deduced from the research findings above, China's rural industrial integration development presents a pattern where the east is strong and the west is relatively weaker, with evident spatial heterogeneity. To further understand the disparities in rural industrial integration development in China, decomposition was carried out, and the results are shown in Table 3.

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Table 3. Differences and Decomposition of China's Rural Industrial Integration Development Level.

Year	Overall	Intra-regional Difference			Inter-regional Difference			Contribution Rate (%)		
		Eastern	Central	Western	Eastern-Central	Eastern-Western	Central-Western	G_w	G_{nb}	G_t
2011	0.141	0.037	0.037	0.147	0.101	0.285	0.202	16.40	82.29	1.30
2012	0.150	0.045	0.042	0.162	0.077	0.258	0.198	18.54	79.63	1.81
2013	0.155	0.055	0.046	0.145	0.097	0.271	0.187	17.79	81.21	0.99
2014	0.161	0.073	0.057	0.151	0.100	0.270	0.194	19.80	77.68	2.51
2015	0.151	0.068	0.06	0.135	0.092	0.249	0.190	19.72	76.18	4.09
2016	0.148	0.063	0.066	0.147	0.085	0.237	0.192	20.98	72.84	6.16
2017	0.143	0.064	0.079	0.138	0.084	0.222	0.185	21.89	70.09	8.00
2018	0.141	0.057	0.065	0.144	0.078	0.228	0.184	21.02	73.48	5.49
2019	0.137	0.056	0.054	0.126	0.071	0.215	0.177	20.37	74.12	5.49
2020	0.132	0.055	0.055	0.133	0.070	0.224	0.186	20.16	74.05	5.77

To make the most of this analysis, it would be useful to know the specific metrics or variables included in Table 3, their values, and any other pertinent details. This way, the analysis could provide a more in-depth understanding of the regional disparities and the reasons behind them, enabling more informed conclusions and recommendations.

3.2.3. Spatial Correlation Analysis of Rural Industrial Integration Development

To further delve into whether the development level of rural industrial integration in each Chinese province has any correlation with its neighboring provinces, this study utilizes a spatial weight matrix and adopts the Moran's I index to perform a global spatial autocorrelation analysis on the measurement results of the 31 provinces (cities and autonomous regions). The outcomes are illustrated in Figure 5.

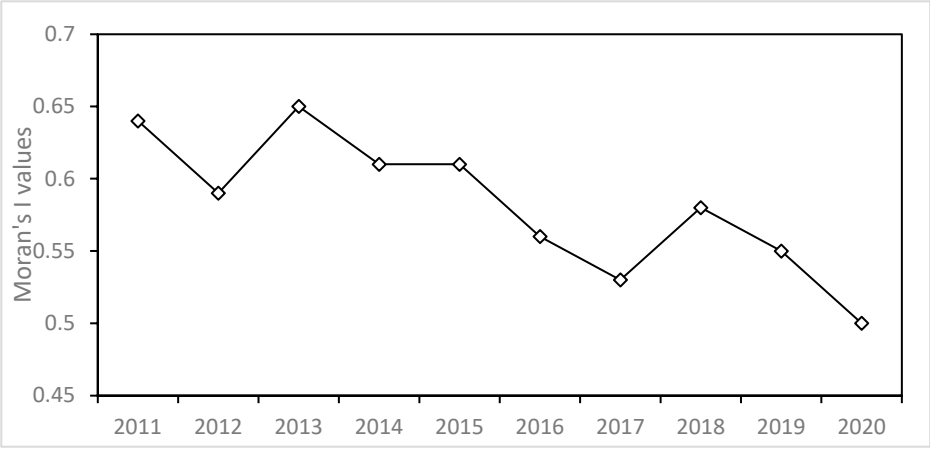

Figure 5. Global Moran's Index of China's Rural Industrial Integration Development Level.

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If the Moran's I values are close to +1, it suggests a clustered pattern, meaning provinces with similar levels of rural industrial integration development are grouped together. If the values are close to -1, it implies a dispersed pattern, suggesting provinces with similar development levels are spaced apart. A value near 0 would indicate a random pattern, meaning there's no discernible spatial correlation among the provinces.

Upon observing specific Moran's I values from Figure 5, further insights can be gleaned about how spatially correlated the provinces are in terms of their rural industrial integration development levels. This information can be invaluable for policymakers aiming to implement region-specific development strategies or to understand how changes in one province might impact neighboring provinces.

Furthermore, understanding the spatial autocorrelation can provide insights into potential spillover effects, where growth in one province could positively or negatively influence development in adjacent provinces. This is crucial for designing comprehensive and effective regional development policies. The Local Moran's Scatterplot was further organized as shown in Figure 6.

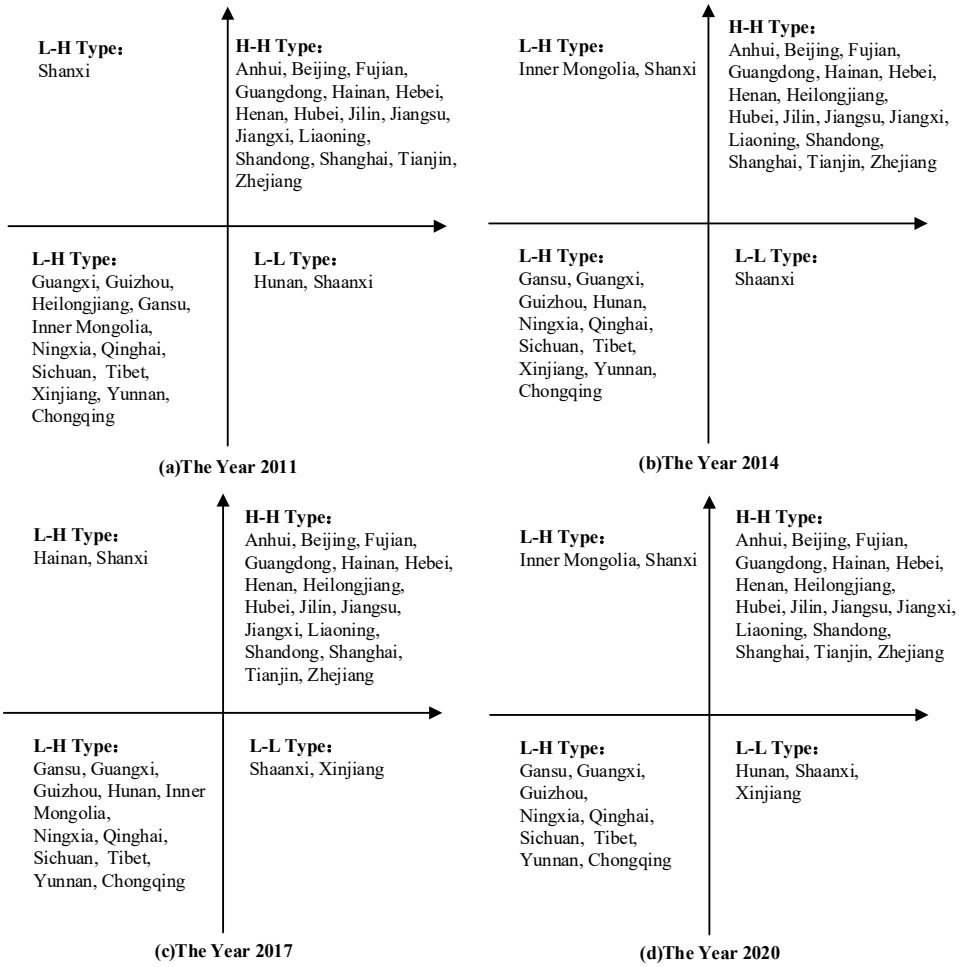

Figure 6. Spatial Auto-correlation Distribution Types in Chinese Provincial Regions.

From the spatial autocorrelation types of rural industrial integration development level in various provinces of China, the overall local Moran's scatter plot mainly presents the H-H and L-L distribution features. This indicates that the rural industrial integration development in China has a positive clustering characteristic. There are very few provinces falling into the L-L type cluster, only appearing in Hainan, Inner Mongolia, and Shanxi. Although there has been a slight increase in provinces in the H-L cluster in recent years, it is still limited to Xinjiang, Shaanxi, and Hunan. Furthermore, eastern provinces (and cities) such as Anhui, Beijing, Fujian, Shanghai, and Zhejiang

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have always been in the H-H cluster, while western provinces (and cities) such as Qinghai, Sichuan, Tibet, Yunnan, and Chongqing have always been in the L-L cluster. This suggests that the spatial correlation of rural industrial integration development level is relatively stable.

4. Discussion

4.1. Problems in China's Rural Industrial Integration Development

Insufficient Driving Force for Rural Industrial Integration. Based on the experience of developed countries, the main drivers for promoting rural industrial integration come from technology, entities, market, and government. Considering China's current development status, the driving force from these four areas is still insufficient. From the perspective of technological innovation, there is a significant gap between China's agricultural science contribution rate and that of developed countries. The application level of new agricultural technologies, agricultural equipment, and modern management methods still needs improvement. In terms of integration entity drive, new business entities such as leading agricultural enterprises, family farms, farmer cooperatives, and professional households all face varying degrees of difficulties in funding, land, and talent needs. Coupled with the low efficiency of national policy implementation, it has, to some extent, discouraged the intrinsic driving force of integrated entities. From the market development drive, China's current agricultural development still has structural contradictions. The main function of agriculture is limited to providing factors and products, resulting in low-profit levels and market competitiveness. As for the government policy drive, China mainly adjusts the external environment of rural industrial integration through relevant fiscal and tax policies. However, some regions excessively rely on state policy support without forming planned industrial development goals, greatly increasing the financial pressure on the government.

Neglect of Agriculture's Fundamental Position in Integrated Development. The primary purpose of promoting rural industrial integration development is to increase farmers' income and rural development. Therefore, ensuring the foundational position of agriculture is crucial. If the foundation of agriculture is not solid, downstream high-profit industries can easily squeeze out agriculture, affecting the stability of farmers' incomes. Due to the low value added of agriculture in the industrial integration development, many external capitals tend to use land for non-agricultural and non-grain purposes after entering, causing a decline in grain production and endangering national food security. Furthermore, many regions blindly pursue industrial clustering in developing rural industrial integration, with low development levels and shallow resource utilization. This has not genuinely tapped into local agricultural resources, severely restricting the sustainable development of rural industrial integration.

Low Quality Development of Integration Business Entities. The main entities of rural industrial integration development in China are leading enterprises, family farms, professional households, and farmer cooperatives. Although numerous, most of them have problems of small scale and low-quality integrated development. For example, leading agricultural enterprises, despite their financial, technological, and management advantages, have limited radiative driving capability. In some regions, they even dominate the market and become major competitors to surrounding farmers.

Difficulty in Replicating Successful Integrated Development Models. Based on China's practical experience in rural industrial integration development, there is a significant disparity in integration levels and effects across regions. Most provinces are still in the early stages. The successful models in some regions, although effective locally, might not be universally applicable or easily replicated in other areas.

4.2. Strategies to Enhance the Level of Rural Industrial Integration Development in China

Follow the Basic Rules of Industrial Integration: Boost the driving force of integration from aspects of technology, entities, market, and government to promote deep integration of rural industries.Speed up innovation and application of agricultural technology, establish agricultural technology service platforms to provide continuous momentum for rural industrial integration.Break

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the various constraints of capital, technology, and talent faced by new business entities, allowing all types of business entities to play their best roles and promote staggered coordinated development.Adjust and optimize the agricultural industry structure, develop quality agricultural product production and processing, and actively guide consumers to form modern green consumption habits, promoting the transformation and upgrade of agricultural product consumption structures in the new era.

Recognize the Regional Differences in China's Rural Industrial Integration Development: Implement targeted policy measures and choose development paths tailored to local conditions. Plan agricultural functional industry layouts based on China's main functional zone planning, improve policy support, and establish a distribution pattern with rational functional positioning and full utilization of resource endowment and locational advantages. Economically developed eastern regions with ample technology and resources should play a leading role in rural industrial integration. The central and western regions, with lower levels of integration, should identify their strengths and weaknesses to differentiate and set development examples, aiming for a more harmonious integration and rural revitalization.

Address Current Regional Imbalances and Homogenization Issues: Identify the driving forces and obstacles for rural industrial integration in different areas, supplement the development shortcomings of modern agriculture, and capitalize on the spillover effects of core production elements. Meanwhile, fully leverage the high-level integration provinces to influence their neighboring provinces, achieving technological diffusion, industrial cooperation, division of labor, and fostering regional industrial integration exemplars for high-quality rural industrial development.

Value Agriculture's Fundamental Role in Industrial Integration: Delve deep into agriculture's multifunctionality.Recognize agriculture's economic function, strengthen agricultural infrastructure, stabilize grain sowing, optimize variety structures, and ensure the stable supply of agricultural products.Develop agriculture's social function by branding, raising the added value of agricultural products, absorbing labor, increasing rural income, and maintaining rural social stability.Utilize agriculture's ecological function to mitigate environmental pollution from secondary and tertiary industries, achieving natural disaster prevention, environmental improvement, and ecological nourishment.Cultivate agriculture's cultural function, combining regional agricultural cultural resources to develop agricultural cultural education, health and wellness, leisure agriculture, and rural tourism, achieving harmony between man and nature.

Strengthen the Cultivation of Various Entities: An essential step to promote rural industrial integration is to encourage and support different business entities to grow stronger and enhance their operation levels.Strengthen the construction of leading agricultural enterprises, continuously extend and expand their dominant industry chains, improve their overall supply levels, and solidify their leading role in rural industrial integration. Support the standardized and market-oriented development of farmer cooperatives, encourage integration and upgrading of homogenous or related cooperatives, form various types of joint cooperatives, and leverage their advantages in agricultural resource allocation and technical training. Fully guide family farms and professional households to voluntarily and orderly transfer land management rights, moderately expand operational scales, and implement large-scale and standardized field management. Explore new models of integrated development among various business entities, promote the connection of elements, products, and services between leading enterprises, farmer cooperatives, family farms, and professional households, try to establish agricultural industrialized consortia, and further solidify the foundation of agricultural development.

5. Conclusion

This paper establishes an measurement index system from various dimensions of rural industrial integration development and adopts a multi-index comprehensive measurement method to measure the level of rural industrial integration development in China and its provinces from 2011 to 2020. According to the measurement results, the spatial distribution characteristics and dynamic

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development trends of the integration level were further analyzed. The research found that the overall level of rural industrial integration development in China and its provinces from 2011 to 2020 showed an upward trend, and some areas have reached a relatively high level of integration. However, there is still a noticeable spatial imbalance in development. Specifically, the gap in the level of rural industrial integration development between the eastern provinces and the central and western regions is significant. Among them, the western region lags the most, followed by the central region. Based on the global Moran's Index changes over the past decade, this gap has been gradually narrowing in recent years.

There is significant homogenization of low-quality development in China's provincial rural industrial integration, and the level of rural industrial integration development presents a spatial pattern of high in the northeast and low in the southwest. The dominant regional features are "H-H type" and "L-L type" clustering, showing significant positive spatial correlation. Moreover, according to the provincial panel data from 2011 to 2020, the spatial correlation of the integration development level in each province is relatively stable. At the same time, the development of rural industrial integration in most provinces in China is relatively stable, with only a few provinces experiencing upgrades or downgrades. The development level of neighboring areas has a significant impact on the development status of the province. Furthermore, during the development process of rural industrial integration in China, there is a phenomenon of "easy to downgrade, hard to upgrade." Some provinces are gradually falling behind other regions over time, and most other provinces are more likely to maintain their current status. Very few areas can achieve leapfrog development.

References:

1. Chen Xiwen. Implementing the Rural Revitalization Strategy and Promoting the Modernization of Agriculture and Rural Areas[J]. Journal of China Agricultural University (Social Sciences Edition), 2018, 35(01): 5-12.
2. Su Yiqing, You Yuting, Wang Zhigang. Development of Rural Industry Integration: Theoretical Discussion, Current Situation Analysis, and Policy Recommendations[J]. China Soft Science, 2016, No.308(08): 17-28.
3. Zhao Xia, Han Yijun, Jiang Nan. Rural Industry Integration: Definition, Practical Significance, and Driving Factor Analysis[J]. Problems of Agricultural Economics, 2017, 38(04): 49-57+111.
4. Chen Xueyun, Cheng Changming. Industrial Integration Path of Rural Revitalization Strategy: Logical Necessity and Empirical Determination[J]. Problems of Agricultural Economics, 2018, No.467(11): 91-100.
5. Li Zhi, An Yan, Hou Liwei. A Review and Outlook on the Development of Rural Industry Integration[J]. China Agricultural Bulletin, 2018, 34(16): 157-164.
6. Dara, P., Sari, A..Corporate Governance Mechanism and the Level of Internet Financial Reporting: Evidence from Indonesian Companies[J]. Procedia Economics and Finance, 2012(2):157-166.
7. Xiong Aihua, Zhang Han. Rural Industry Integration: Development Models, Condition Analysis, and Policy Recommendations[J]. Theoretical Journal, 2019, No.281(01): 72-79.
8. Liu Haiyang. Case Study on the Development of Rural Industry Integration[J]. Economic Overview, 2016, No.371(10): 88-91.
9. Liang Ruihua. Practical Exploration and Recommendations on the Development of Rural Industry Integration in China[J]. Zhongzhou Academic Journal, 2018, No.255(03): 51-55.
10. Yang Tao. Practical Characteristics and Enhancement Path of Rural Industry Integration[J]. Zhongzhou Academic Journal, 2019, No.269(05): 37-42.
11. Andersson, F. N. G., Edgerton, D. L., & Opper,. A matter of time: Revisiting growth convergence in China[J]. World Development, 2013(45): 239–251.
12. Shi Xiuyi, Xu Yingzhi. The Construction of Pastoral Complexes, Integration of Rural Industries, and Increased Income for Rural Residents[J]. Journal of China University of Geosciences (Social Sciences Edition), 2023, 23(02): 57-72.
13. Ge Jihong, Wang Meng, Tang Yingmei. Integration of Rural Industries, Urban and Rural Resident Consumption, and Income Gap - Can Efficiency and Equity be Achieved Simultaneously?[J]. China Rural Economy, 2022(03): 50-66.
14. Kuang Yuanpei, Xiao Ye. Economic Growth Effect Analysis of the Development of Rural Industry Integration - Based on the County Statistical Yearbook Data from 2007 to 2019[J]. Journal of Hunan Agricultural University (Social Sciences Edition), 2022, 23(02): 10-17+91.
15. Wang Miaomiao, Yue Zongbin, Wang Baoqing. Multidimensional measurement Research on the Development of Industry Integration in Shandong Province[J]. Jiangxi Agricultural Journal, 2022, 34(11): 190-195.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 October 2023 doi:10.20944/preprints202310.1915.v1

16. Huang Qinghua, Li Yamei, Pan Xinxin. Selection of Development Mode and Multidimensional Effect measurement of Rural Industry Integration in Chongqing[J]. Agricultural Economics and Management, 2020(02): 10-19.
17. Li Hongwei, Wei Shengwen, Zhang Dongwei. measurement Research on Coordinated Development of Rural Industry Integration in the Tianshui Region[J]. Agricultural Science and Technology and Equipment, 2021, No.306(06): 94-96.
18. Qin Yue. Comprehensive measurement Research on the Development of Rural Industry Integration in the Three Northeast Provinces - Based on the TOPSIS Method[J]. Northern Economy and Trade, 2020, No.430(09): 4-7.
19. Hacklin, F., Battistini, B., Von Krogh, G.,. Strategic choices in converging industries[J]. MIT Sloan Manage. Rev. 2013(55): 65–73.
20. Tang Decai, Zhang Yan, Shi Yu. Current Situation, Issues, and Development Paths of Rural Industry Integration in China[J]. Jiangsu Agricultural Science, 2019, 47(19): 1-5.
21. Xin Ling, Hao Han. Research on measurement Methods for China's Agricultural Modernization Development Level[J]. Agricultural Modernization Research, 2022, 43(05): 747-758.
22. Liu Pengling, Wan Yingying, Wu Wenjun, et al. measurement System of Rural Industry Integration Development and Its Application[J]. Journal of Shanxi Agricultural University (Social Sciences Edition), 2019, 18(04): 7-13.
23. Chen Shengwei, Feng Ye. Comprehensive measurement Research on the Development of Rural Industry Integration Based on Entropy Method and TOPSIS Method - Taking Shandong Province as an Example[J]. Dongyue Forum, 2020, 41(05): 78-86.
24. Guo Jun, Zhang Xiaorong, Kong Xiangzhi. Rural Industry Integration and Farmers' Income Increase - Based on the Case of Rural Industry Integration in Henan Province[J]. Agricultural Economic Issues, 2019, No.471(03): 135-144.
25. Li Mingxian, Liu Chenfan. Research on the Interest Linking Mechanism of Rural Industry Integration to Increase Farmers' Income - Taking Farmer Professional Cooperatives as an Example[J]. Hunan Social Sciences, 2019, No.193(03): 106-113.
26. Zhang Lin, Wen Tao. The Real Dilemma, Model Innovation, and Policy Coordination of Rural Financial Development - From the Perspective of Industry Integration[J]. Financial Research, 2019, No.423(02): 53-62.
27. Hu Hai, Zhuang Tianhui. Development of Rural Industry Integration under the Vision of Symbiosis Theory: Symbiotic Mechanism, Real Dilemma, and Promotion Strategy[J]. Agricultural Economic Issues, 2020, No.488(08): 68-76.
28. Ju Liyu. Current Situation and Countermeasure Analysis of Farmers' Cooperative Development in Qingdao under the Background of Industry Integration - Based on the Survey of 10 Typical Cooperatives[J]. Anhui Agricultural Science, 2017, 45(09): 241-243.
29. Xu Zhaoxu. On the Role of Leading Enterprises in the Development of Market Agriculture - Taking Xiamen Zhongsheng Grain and Oil Enterprise Co., Ltd. in Fujian Province as an Example[J]. Agricultural Economic Issues, 2003, 24(8): 41-43.
30. Kong Xiangzhi, Tan Yuelin, Zheng Liwen. Elite Control, Asset Specificity, and Cooperative Distribution System Arrangement[J]. Local Finance Research, 2014(10): 28-32.
31. Chen Shibao, Li Wei, Chen Yaping. Thinking about Promoting the Development of Rural Industry Integration in the New Era. Agricultural Economics and Management, 2018(01): 5-10.
32. Cheng Li, Hu Diancheng. Study on the Impact Effect of Rural Industry Integration on Farmers' Income: Taking Chongqing as an Example. Journal of Chongqing University of Technology (Social Science Edition), 33(3): 18-27.
33. Cui Baoyu, Cheng Chunyan. Relationship Governance and Contract Governance of Farmer Professional Cooperatives. Journal of Northwest A&F University (Social Science Edition), (6): 40-47.
34. Jessica M W, Vivian C, Wai F L, et al. Rural sustainability: Challenges and opportunities, revitalising rural communities, 2021, 12(4): 1-15.
35. Francks P. Rural industry, growth linkages, and economic development in nineteenth-century Japan[J]. The journal of Asian studies, 2002, 61(1): 33-55.
36. Griffith D C. Rural industry and Mexican immigration and settlement in North Carolina[J]. New destinations: Mexican immigration in the United States, 2005: 50-75.
37. Kerr D, Winklhofer H. The effect of rapid rural industry changes on the development of a decision support system for dairy farmers in Australia[J]. Computers and Electronics in agriculture, 2006, 50(1): 61-69.
38. Kader R A, Mohamad M R B, Ibrahim A A H C. Success factors for small rural entrepreneurs under the one-district-one-industry programme in Malaysia[J]. Contemporary management research, 2009, 5(2).
39. Dave B, Daniel L, Andrew M, et al. Are the creative industries meritocratic? An analysis of the 2014 British Labour Force Survey, Cultural Trends, 2015, 25(2), 116-131.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 30 October 2023 doi:10.20944/preprints202310.1915.v1

40. Vuin A, Carson, Doris A, et al. The role of heritage tourism in attracting "active" in-migrants to "low amenity" rural areas. Rural Society, 2016, 25(2), 134–153.
41. Young N, Matthews R. Resource economies and neoliberal experimentation: The reform of industry and community in rural British Columbia[J]. Area, 2007, 39(2): 176-185.
42. Kerr D, Winklhofer H. The effect of rapid rural industry changes on the development of a decision support system for dairy farmers in Australia[J]. Computers and Electronics in agriculture, 2006, 50(1): 61-69.
43. Chuta E, Liedholm C. Rural small-scale industry: empirical evidence and policy issues[J]. Agricultural development in the third world., 1984: 296-312.
44. Johnston A, Huggins R. Drivers of university–industry links: The case of knowledge-intensive business service firms in rural locations[J]. Regional Studies, 2016, 50(8): 1330-1345.
45. Hossain D, Gorman D, Chapelle B, et al. Impact of the mining industry on the mental health of landholders and rural communities in southwest Queensland[J]. Australasian Psychiatry, 2013, 21(1): 32-37.
46. Fai F, Tunzelmann N. Industry-specific competencies and converging technological systems:evidence from patents[J]. Structural Change&Economic Dynamics, 2001, 12(2):141-170.
47. Gambardella A, Torrisi S. Does technological convergence imply convergence in markets? Evidence from the electronics industry[J]. Research Policy, 1998, 27(5):445-463.
48. Kumar A, Roy A, Priyadarshinee R, et al. Economic and sustainable management of wastes from rice industry: combating the potential threats[J]. Environmental Science and Pollution Research, 2017, 24(34): 26279-26296.
49. Ramli N N, Shamsudin M N, Mohamed Z, et al. The impact of fertilizer subsidy on Malaysia paddy/rice industry using a system dynamics approach[J]. International Journal of Social Science and Humanity, 2012, 2(3): 213.
50. Donkor E, Owusu V. Effects of land tenure systems on resource-use productivity and efficiency in Ghana's rice industry[J]. African Journal of Agricultural and Resource Economics, 2014, 9(311-2016-5617): 286-299.
51. Son Nghiem H, Coelli T. The effect of incentive reforms upon productivity: Evidence from the Vietnamese rice industry[J]. Journal of Development Studies, 2002, 39(1): 74-93.
52. Vaghefi N, Shamsudin M N, Radam A, et al. Impact of climate change on food security in Malaysia: economic and policy adjustments for rice industry[J]. Journal of integrative environmental sciences, 2016, 13(1): 19-35.
53. Cummings J, Shwiff S A, Tupper S. Economic impacts of blackbird damage to the rice industry[J]. 2005.

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