Can New Quality Productive Forces Promote the Integrated Development of Agriculture and Logistics Industry? — Evidence from panel data across 30 provinces

Pei Ju Chen[1,*]

[1]Guangzhou City Polytechinc, Guangzhou, 510405

Abstract. Accelerating the deep integration of agriculture and the logistics industry is a key pathway to achieving comprehensive rural revitalization, the strategy of becoming a strong agricultural nation, and high-quality development. However, the mechanisms and impact effects of new quality productive forces in this integration process are not yet clear. To address this, based on panel data from 30 provinces in China, this paper constructs a coupling coordination model and an econometric model to systematically analyze the impact of new quality productive forces on the integrated development of agriculture and the logistics industry. The research findings show that the integration level of agriculture and the logistics industry in most provinces across the country generally exhibits a trend of coordinated development, but with significant regional differences. At the same time, new quality productive forces have a significant promotional effect on their integrated development, and for every additional unit of new quality productive forces, the integration level can be increased by 0.153 units. The research results provide important theoretical support and empirical evidence for accelerating the formation of new quality productive forces in agriculture, achieving regional agricultural modernization pathways, and policy formulation.

1 Introduction

With the continuous development of China's economy and the transformation and upgrading of the industrial structure, promoting the deep integration of agriculture and logistics industry has become an important way to improve agricultural competitiveness, rural revitalization and modern agricultural development. As an important link between urban and rural areas and open up production and marketing, the logistics industry not only provides circulation support for agricultural products, but also plays a key role in optimizing resource allocation, reducing transportation costs and improving supply efficiency [1]. Especially under the promotion of the strategy of "agricultural power", building a modern agricultural logistics system has become an inevitable requirement for the high-quality development of agriculture [2]. Therefore, exploring the coordinated development path of agriculture and logistics not only helps to make up for the shortcomings of the agricultural industry chain, but also provides a new development momentum and space for agricultural and rural modernization.

However, in the process of integrating agriculture and logistics industry,the constraints of traditional productivity are increasingly emerging. The new quality productive forces has gradually become an important driving force for the optimization of industrial structure and the improvement of factor flow efficiency. New productivity refers to the modern production capacity based on advanced elements such as information technology, intelligent manufacturing and green development, which is intelligent, efficient and sustainable. It can not only improve the accuracy and resource utilization of agricultural production, but also promote the intelligent upgrading of logistics services and provide important support for the deep integration of agriculture and logistics industry [3,4]. Especially in modern agricultural production, digital and intelligent technologies are increasingly widely used, and the driving role of new quality productive forces in the integration of agriculture and logistics industry is becoming increasingly prominent [5]. Therefore, in-depth analysis of the mechanism of new quality productive forces in this process of integrated development has important theoretical and practical value for regional agricultural modernization and the construction of efficient logistics system.

Although there have been studies focusing on the integration and development of agriculture and logistics industry, empirical research on how to promote the integration of new quality productive forces is still relatively limited. On the one hand, most of the existing literature remains at the level of qualitative analysis, and there is a lack of systematic quantification of the role of new quality productive forces in different regions. On the other hand, there is a lack of in-depth discussion on the regional differences, influencing factors and driving

* Pei Ju Chen: chenpeiju@gcp.edu.cn

mechanisms for the integrated development of agriculture and logistics industry. To this end, based on the panel data of 30 provinces in China,builds a coupling coordination model and a two-way fixed effect model, and systematically explores the role path and impact effect of new quality productive forces in the integrated development of agriculture and logistics industry. By revealing the differences in the level of integration and development in different regions, this study provides an empirical basis and policy reference for promoting the modernization of regional agriculture and the upgrading of logistics services.

2 Analysis of the impact mechanism of new quality productive forces on the integrated development of agriculture and logistics industry

Under the general trend of the global economy's transformation to digitalization and intelligence, new quality productive forces has become the core driving force for the deep integration of agriculture and logistics industry. Its mechanism can be achieved through resource integration, production efficiency improvement and industrial chain extension [6-8]. First of all, as a new productivity based on modern technology and innovative resources, the new quality productive forces not only optimizes the combination of factors of production, but also redefines the connection mode of agriculture and logistics industry on the value chain, providing internal support for the coordinated development of agricultural logistics. From the perspective of resource integration, the new quality productive forces realizes cross-disciplinary coordination between agriculture and logistics industry through the integration of innovative resources, so that resources can be reasonably allocated in production, circulation, consumption and other links, thus promoting the efficient utilization and sharing of resources. The new quality productive forces has transformed the resource structure of the two industries from decentralization to integration, laying a foundation for the circulation efficiency and supply accuracy of agricultural products.Secondly, in terms of improving production efficiency, the new quality productive forces has promoted the linkage between agriculture and logistics industry in the production and service process. Its internal mechanism improves the production efficiency and optimizes the circulation path by improving the standardization and automation level of agricultural production and logistics distribution, reducing the friction in the agricultural production and marketing process. This improvement in efficiency reflects the deep coordination between agricultural production and logistics services, and realizes the agile response and dynamic adjustment of the supply chain. In addition, the new quality productive forces extends the value chain of the agricultural and logistics industry, thus improving the overall value creation ability of the two. Finally, through the investment of new quality productive forces, the service functions of agricultural logistics have been further diversified and accurate, so that the logistics industry has shifted from basic transportation to multi-functional support services, which not only improves the added value of products, but also enhances market competitiveness. This extension makes the agricultural and logistics industry more closely related in the industrial chain, and provides continuous innovation momentum for the development of regional economic integration.

However, due to the different resource endowments and economic development of various provinces and cities in China, there are still significant differences in the level of regional development and integration between agriculture and logistics industry. Therefore, this study uses the coupling degree model and the econometric model to systematically analyze the mechanism of the new quality productive forces in the integration of the two industries. The coupling coordination model quantifies the coordination and regional differences of fusion, and the econometric model can further quantify the specific impact of new quality productive forces on the fusion effect.

3 Research methods and data

3.1 Entropy method

First of all, the entropy method is used to quantify the indicators of new quality productive forces, agriculture and logistics industry to establish a scientific evaluation system. The entropy method is an objective empowerment method. The weight is determined by calculating the information entropy value of each index, which avoids the deviation of subjective empowerment and makes the evaluation results more objective [9]. Because the integration of agriculture and logistics industry involves multi-dimensional indicators such as production efficiency and resource allocation, the entropy method can accurately quantify the actual contribution of each index, reveal the role of new quality productive forces in the integration of the two, and provide solid data support for research.The specific calculation formula is shown in Table 1 below:

Table 1. Steps for calculating the comprehensive development level of each indicator based on the entropy method

Calculation formula	Implication
$y_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}$	Given the original data matrix X = (xij) in the formula, where xij. Represents the value of the i-th indicator on the jth sample.
$P_{ij} = Z_{ij} / \sum_{j=1}^{n} x_{ij}$	Calculate the proportion of each indicator in the sample; the standardized data matrix is Z = (Zij) to calculate the proportion of the i-index in the j sample.
$E_{ij} = -k\sum_{j=1}^{n} p_{ij} \times \ln(p_{ij}),\ k = \frac{1}{\ln(n)}$	Calculate the entropy value. According to information theory, the entropy value Ei reflects the information validity of the i-index; n is the number of samples.
$w_i = \frac{1 - E_i}{m - \sum_{i=1}^{m} E_i}$	Calculate the entropy power. Entropy wi reflects the amount of information of the ith indicator, and m is the number

	of indicators.

By following the aforementioned steps, the entropy method can be used to determine the weights of various indicators, thereby providing an objective basis for the comprehensive evaluation of the development levels of agriculture and the logistics industry.

3.2 Coupled coordination model

The coupling coordination model is an analytical method used to measure the interaction and coordinated development between two or more systems, which originates from the concept of "coupling" in physics. This model assesses the intensity of interaction and coordination of development between systems by quantifying their coupling relationships, which is particularly suitable for studying system relationships with interdependence and dynamic equilibrium characteristics[10]. In this study, the integrated development of agriculture and logistics industry involves the cooperation of production, circulation and other links, and is affected by the allocation of resources and industrial development in different regions. The coupling coordination model can effectively reflect the synergy between agriculture and logistics industry. By constructing the coupling degree and coordination index to quantify the interaction state of the two, it can reveal the degree of integration in different regions. It can be divided into coupling model and coordination model, as shown in formulas (1), (2) and (3):

$$C = 2\sqrt{U_1 \times U_2}\,/(U_1 + U_2) \quad (1)$$

$$T = \beta_1 \times U_1 + \beta_2 \times U_2 \quad (2)$$

$$D = C \times T \quad (3)$$

In the formula, C is the degree of coupling, between 0 and 1. The larger the value, the closer the coupling relationship between the two systems, and vice versa; U1 and U2 represent the level of comprehensive evaluation in agriculture and logistics industry respectively. T is the comprehensive evaluation value of agriculture and logistics industry; β1 and β1 are weight coefficients, generally taking the equivalent value of 0.5; D is the coordinate value.

3.3 Econometric model

This study refers to existing achievements[1,11],and employs a two-way fixed effects model for regression analysis. This model is a econometric method commonly used in panel data analysis. Unobservable external effects that vary over time or individual are eliminated by controlling the fixed effects of time and individuals, so as to more accurately identify causal relationships between variables. In this study, the two-way fixed effects model is suitable for analyzing the dynamic impact of new quality productive forces on the integration of agriculture and logistics industry, because it can control the heterogeneity (such as basic economic conditions, policy environment, etc.) and time (such as macroeconomic fluctuations) between different provinces. By introducing this model, the actual effect of new quality productive forces on the integrated development of the two industries can be more scientifically estimated to ensure the robustness and reliability of the conclusions.The two-way fixed effects model is shown in formula (4).

$$IDL_{it} = \alpha + \beta NQP_{it} + \gamma_t + \delta_i + \varepsilon_{it} \quad (4)$$

In the formula: IDLit is a dependent variable, representing the level of integration and development of agriculture and logistics industry; NQPit is an independent variable, representing new quality productive forces; it is a cross-off term with double fixed effect; it is the coefficient of NQPit; it is a time fixed effect; it is a unit fixed effect; it is an error term.

4 Analysis and discussion

4.1 Analysis of the integration and development level of agriculture and logistics industry

Figure 1 shows that the integration and development level of agriculture and logistics industry is deeply discussed from the national and regional levels. During this period, the integration and development of China's agricultural and logistics industry have shown a steady upward trend, but there are still significant regional differences between provinces. According to the national average, from 2011 to 2021, the integration and development level of the national agricultural and logistics industry has steadily improved, gradually climbing from 0.218 in 2011 to 0.418 in 2021, with an average annual growth rate of about 0.02. This shows that the synergy between China's agricultural and logistics industry is increasing day by day. Under the background of the country's vigorously promoting agricultural modernization and the construction of rural logistics network, the integration and development of the two has gradually become an important support for promoting the high-quality development of agriculture. However, the level of development varies from region to region, and the degree of integration and growth rate vary significantly from region to region.

From the perspective of regional distribution, the integration level of agriculture and logistics industry in the eastern coastal areas is relatively high, especially in economically developed provinces such as Guangdong, Jiangsu, Shandong and Zhejiang. From 2011 to 2021, their integration level has always been in a high position. Taking Guangdong Province as an example, its integration and development level reached 0.739 in 2021, which is much higher than the national average, showing the significant advantages of the starting area in industrial chain integration and technology application. These provinces have good infrastructure conditions, the logistics industry is highly modernized, and have a developed agricultural supply chain management system, which provides favorable conditions for the deep integration of agriculture and logistics industry. In contrast, the integration and development level of the central and western regions is relatively low, especially

in Xinjiang, Ningxia, Qinghai and other provinces. Although it has also improved to some extent in recent years, the overall growth rate is relatively slow. Xinjiang's integration level in 2021 was 0.418, which is lower than the national average, indicating that economically underdeveloped regions are still facing great challenges in the construction of agricultural logistics networks and the application of modern logistics technology.

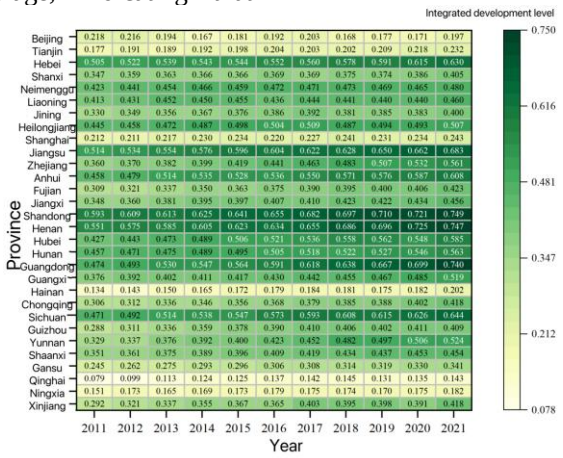

Figure 1. Trend chart of the comprehensive development level of the new quality productive forces and logistics industry

Further analysis of the integration growth rate of different provinces shows that the growth range of different regions varied significantly between 2011 and 2021. Eastern coastal areas such as Guangdong, Zhejiang, Jiangsu and other provinces not only have a high level of integration, but also have a relatively fast average annual growth rate; while the integration growth rate of some western provinces, such as Qinghai, Gansu, Ningxia and other regions, is relatively slow. The chart shows that the integration level of Guangdong Province increased from 0.474 in 2011 to 0.739 in 2021, with a significant growth rate of about 0.026, while Qinghai Province increased from 0.079 in 2011 to 0.143 in 2021, with an average annual growth rate of only about 0.006. This difference may stem from differences in infrastructure inputs, logistics technology application and policy support. Overall, despite the continuous improvement of the integration level of agriculture and logistics industry across the country, the regional imbalance is still prominent, and the integration level in the eastern region is significantly ahead of the central and western regions. Therefore, how to promote the integrated development of the agricultural and logistics industry in the central and western regions and narrow the regional gap is an important issue that needs urgent attention in future policy formulation.

4.2 Analysis of the impact of new quality productive forces on the integrated development of agriculture and logistics industry

The regression analysis results from Table 1 indicate that new quality productive forces has a significant positive impact on the integrated development of agriculture and the logistics industry. In models (1) to (5), the regression coefficients for the new quality productive forces variable are all significantly positive at the 1% significance level, with the coefficient values gradually decreasing from 0.221 to 0.153. This suggests that investment in new quality productive forces can indeed effectively promote the integrated development of agriculture and the logistics industry, and its marginal promotional effect shows a certain downward trend after incorporating more control variables. These results demonstrate that after considering factors such as environmental regulation, energy structure, population size, and regional development levels, new quality productive forces still plays a significant positive role in promoting integrated development, indicating the robustness of its impact.

Further analysis shows that after adding environmental regulation variables to the model (2), the coefficient of neopological productivity decreased slightly, but it remained significant, indicating that environmental regulation has strengthened the positive impact of new quality productive forces on the development of integration to a certain extent. However, the regression coefficient of environmental regulation itself is only positive at a level of 10% (1.273), indicating that its direct contribution to the development of integration is relatively weak and unstable. After the models (3) and models (4) further incorporate the energy structure and population number variables, the impact effect of new quality productive forces has weakened. In particular, the regression coefficient of the energy structure is negative and significant at a significant level of 1%, indicating that while the improvement of new quality productive forces drives the development of integration, the high carbon emissions in the energy structure may have a certain inhibitory effect. This shows that optimizing the energy structure will be an important direction to further improve the level of integrated development. In addition, the regression coefficient of the population is positive and significant in both models (4) and (5), reflecting that the expansion of population size can promote the integrated development of agriculture and logistics to a certain extent, which may be due to the large demand in the consumer market to help promote the improvement of the logistics system.

Finally, after adding the regional development level to model (5), the coefficient of new quality productive

forces is stable at 0.153, which is still significantly positive, indicating that regardless of the level of regional economic development, the positive effect of new quality productive forces on the integrated development of agriculture and logistics industry still exists. On the whole, these results verify the core driving role of new quality productive forces in integrated development, and also reveal the differentiated impact of environmental regulation, energy structure and population factors on integrated development in different regions and development levels.

Table 2. Regression analysis results

Variable	(1) Integrated development level	(2) Integrated development level	(3) Integrated development level	(4) Integrated development level	(5) Integrated development level
Regional New quality productive forces	0.221***	0.219***	0.197***	0.157***	0.153***
	(0.033)	(0.033)	(0.031)	(0.032)	(0.032)
Environmental regulations		1.273*	0.595	0.835	0.838
		(0.704)	(0.675)	(0.661)	(0.662)
Energy structure			-0.089***	-0.079***	-0.066***
			(0.015)	(0.015)	(0.022)
population size				0.185***	0.154**
				(0.046)	(0.061)
Regional development level					0.014
					(0.018)
N	330	330	330	330	330
R2	0.982	0.982	0.984	0.985	0.985

Standard errors in parenthes,* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusion

Based on the panel data of 30 provinces in China, systematically analyzes the impact mechanism of new quality productive forces on the integrated development of agriculture and logistics industry and its regional differences by building a coupling coordination model and a two-way fixed effect model. The research results show that the integration and development level of agriculture and logistics industry in the country has been significantly improved, and the integration level of the eastern region is significantly higher than that in the central and western regions. However, the imbalance of regional development still exists. The eastern region has stronger integration advantages due to good infrastructure and advanced logistics management system, while the integration level of the central and western regions is relatively lagging behind.

The results of regression analysis show that new quality productive forces has a significant positive promoting effect on the integrated development of agriculture and logistics industry, and its impact effect is still significant after controlling variables such as environmental regulation, energy structure, population and regional development level. This shows that new quality productive forces, as the core driving force to promote the integration of the two industries, can provide impetus for the sustainable development of agriculture and logistics industry by improving production efficiency, optimizing resource allocation and extending the industrial chain. At the same time, environmental regulation has strengthened the positive impact of new quality productive forces to a certain extent, and the energy structure with high carbon emissions has an inhibitory effect on integrated development, suggesting that in future development, attention should be paid to the optimization of energy structure to enhance the benefits of integration.

This study starts from the perspective of new quality productive forces, systematically discusses its role in promoting the integration and development of agriculture and logistics industry, and expands the perspective of empirical research in this field. The results can also provide a scientific basis for decision-making for regional policymakers.

References

1. Yang,J.,Wang,QM.(2024)The impact of the digital economy on the integration and development of logistics and modern agriculture.China Business and Market,38(08):17-32.
2. Teng,H.(2024)Research on the high-quality development of intelligent logistics empowering the feed industry under the strategic background of agricultural power.Feed Research,47(15):185-189.
3. Huang,JK.(2024)Agricultural New Productivity: Connotation and Extension, Potential, Challenges and Development Ideas.China Rural Survey,(05):19-34.
4. Liu,HD.(2024)new quality productive forces empowers rural rejuvenation: action and practice path.CHONGQING SOCIAL SCIENCES,(09):21-31.
5. Wang,XL.,Bai,BY.,Liu,F.(2024)Analysis of the value of new quality productive forces under the breakthrough of digital technology innovation - based on the goal of modern industrial system construction.Industrial Technology & Economy,43(10):42-51.
6. Chen,SS.,Xu,HR.(2024)Digital economy, new quality productive forces and modernization of rural industries.Technoeconomics & Management Research,(09):37-42.
7. Lin,QN.,Li,JD.,Mao,SP.(2024)Theoretical logic, Chinese practice and focus of the formation of new agricultural productivity.Journal of Northwest A&F University (Social Science Edition),10:1-11.
8. Xu,C.(2024)new quality productive forces, Chinese-style industrial chain modernization and common

prosperity.Statistics & Decision,40(19):5-10.

9. Bai,WT.,Chen,JC.,Hou,J.(2024)Threshold effect of digital technology to empower agro-ecological efficiency.Research of Agricultural Modernization,10:1-14.
10. Zhang,ZQ.,Zhang,DJ.,Chen,L.(2024)Evaluation of the coupling and coordination of ecological efficiency between urbanization and cultivated land utilization in the Yellow River Basin, spatial and temporal characteristics and driving factors.Transactions of the Chinese Society of Agricultural Engineering,40(16):240-250.
11. Yang,X.,Wang,YP.,Wang,J.(2023)Inspection of the impact effect and mechanism of digital rural development on the intensity of agricultural carbon emissions.Statistics & Decision,39(11):66-71.