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Digital Economy Empowers High-quality Development of Agriculture

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Abstract

The digital economy is a new driving force for the high-quality development of agriculture, and the high-quality development of agriculture is the key to realizing agricultural modernization. This project uses the panel data of 31 provinces in China from 2010 to 2020 as a sample. First, it constructs an index evaluation system from four dimensions of high-quality supply, high-efficiency production, innovative development, and sustainable development. Combined with the entropy method and the TOPSIS model, the The digital economy and the high-quality development level of agriculture; secondly, use the index decomposition method to analyze the characteristics of the differences in the level of digital economy development in different regions of China from the east, middle and west to explore the spillover effect of the digital economy on the high-quality development of agriculture; finally use the mediation effect model to analyze the Carry out an empirical test on the theory of high-quality agricultural development in the digital economy to improve the productivity of digital agriculture, build a general mechanism for the digital economy to promote high-quality agricultural development, and empirically analyze whether the digital economy brings "digital welfare" or "digital divide" to agricultural development ". This project explores the high-quality development of agriculture empowered by the digital economy, aiming to provide theoretical and practical reference for the coordinated development of regional agriculture under the background of the digital economy.

Keywords

Digital Economy; High-quality Development of Agriculture; Realizing Agricultural Modernization.

1. Introduction

With the development of a new round of scientific and technological revolution and industrial transformation, in order to comply with the trend of the digital economy era, the requirement of "building smart agriculture, improving agricultural quality, efficiency and competitiveness" has been included in the "14th Five-Year Plan". The report of the 20th National Congress of the Communist Party of China pointed out that achieving high-quality development is the essential requirement for building a Chinese-style modernization in an all-round way. At the same time, it pointed out that the development of rural agriculture should be given priority to speed up the construction of a strong agricultural country. Therefore, digital productivity represented by the digital economy empowers agriculture to form smart agriculture, which has become a powerful engine to promote the high-quality development of my country's agriculture and ensure "food security". In recent years, while the supply capacity of agricultural products has been continuously improved, it is also faced with new requirements for high-quality development. Traditional agriculture has been greatly impacted. Facing problems such as low production efficiency, shortage of production resources, and insufficient innovation drive, it is necessary to find ways to realize agricultural production. A new path for high-quality development. Based

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on the method of spatial econometrics, this paper explores the influencing factors of the high-quality development of agricultural economy in 31 provinces of China, and provides suggestions for the development of agricultural economy and digital economy.

At present, academic research on high-quality agricultural development is carried out from the following aspects: First, the definition of high-quality agricultural development. Liu Zhongyu et al. (2021) defined the connotation of high-quality agricultural development from the perspective of new development concepts. Xia Xianli et al. (2019) considered that high-quality agriculture includes the organic whole of agricultural production system, management system and industrial system from the perspective of agricultural production. Xin Ling (2019) believes that its development has the characteristics of green development leadership, large-scale production, and diversified industrial integration from a comprehensive perspective. In short, the connotation of high-quality agricultural development can be summarized as, on the basis of economic growth, agricultural production achieves high efficiency, scale, and industrialization, and opens up a high-level development pattern. The second is the measurement and evaluation of the level of high-quality agricultural development . Huang Xiujie et al. (2020) conducted research on the index system and level measurement of China's high-quality agricultural development, and Li Xinwu et al. (2020) explored the spatial distribution characteristics of high-quality agricultural development. Ji Zhiheng (2021) built an index system for high-quality agricultural development based on the new development concept, revealing the regional differences and evolution trends of high-quality agricultural development in China. Sun Yan (2021) constructed an index system from the perspective of the agricultural industry and found that the level of high-quality agricultural development in China is the highest in the eastern coastal region, followed by the central region, and the lowest in the western region. The third is the way to realize the high-quality development of agriculture . Ouyang Zhu et al. (2020) discussed the path to realize high-quality agricultural development from the aspects of industrial integration and technological innovation. Qi Wenhao (2021) analysis believes that the digital economy, by innovating the development model of the rural economy, weakens the dual structural barriers between urban and rural areas, stabilizes agricultural production, and promotes high-quality agricultural development. Chu Mingqin (2020) believes that the development of the digital economy will realize the digitization of the agricultural producer service industry and ultimately promote the high-quality development of agriculture.

To sum up, scholars at home and abroad have provided a good theoretical basis for understanding the status of my country's high-quality agricultural development and the role of the digital economy in promoting high-quality agricultural development from different perspectives. However, scholars' incentives for digital productivity to promote high-quality agricultural development are still in the preliminary exploration stage, and there are few empirical tests on the impact mechanism system. This project will build a comprehensive evaluation system for high-quality agricultural development, and deeply analyze the impact of digital economy on agricultural The driving role and spillover effect of high-quality development, empirical analysis of whether the digital economy brings "digital welfare" or "digital divide" to agricultural development, provides theoretical and practical reference for the coordinated development of regional agriculture under the background of digital economy.

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2. Theoretical Analysis and Research Hypothesis

2.1. Empirical Analysis and Regional Heterogeneity of China's Digital Technology Promoting High-quality Agricultural Development

2.1.1. Model Construction

In order to test the impact of digital technology on high-quality agricultural development and its internal mechanism, this paper constructs a mediation effect model, and adds digital agricultural productivity as an intermediary variable to the model for intermediary testing.

The first stage examines the total impact of the digital economy on the high-quality development of agriculture and builds a benchmark model:

$$agr_{it} = \alpha_0 + \alpha_1 dig_{it} + \alpha_c Z_{it} + \lambda_t + \mu_i + \varepsilon_{it}$$

The second stage examines the influence of the digital economy on the intermediary variable and builds a model:

$$pro_{it} = \beta_0 + \beta_1 dig_{it} + \beta_c Z_{it} + \lambda_t + \mu_i + \varepsilon_{it}$$

The third stage constructs the linear regression equation of the digital economy and intermediary variables on the high-quality development of agriculture:

$$agr_{it} = \gamma_0 + \gamma_1 dig_{it} + \gamma_c Z_{it} + \lambda_t + \mu_i + \varepsilon_{it}$$

Among them, agr_{it} represents the high-quality agricultural development level of the province i in the current period t, and dig_{it} represents the digital economy development level of the province i in the current period t , Z_{it} which is the control variable group at the provincial level. The final measurement found that China's digital economy and high-quality agricultural development have significant heterogeneity in the regional distribution. The central and western regions have latecomer advantages in the digital economy.

(1) SBM-DEA model

DEA model (Data Envelopment Analysis) is a quantitative analysis method for relatively effective evaluation of comparable units of the same type based on multiple input indicators and multiple output indicators, using linear programming methods. The three-stage SBM-DEA model combines the advantages of non-radial SBM model and SFA to reduce the influence of environmental factors, and fully considers the influence of uncertain factors. This paper takes low-carbon agriculture in Anhui Province as an example to evaluate the development level of low-carbon agriculture in Anhui Province.

Assuming that there are n decision-making units (sample cities), there are m input indicators to form an input matrix $X = (X_{ij}) \epsilon R^{m \times n}$; k expected outputs and an undesired output indicator form an output matrix:$Y = Y^g + Y^b = (y_{k(I)n}) \epsilon R^{(k+I) \times n}$ the production possibility set under this sample is defined as:

$$P = \{(x, y^g, y^b) \mid x \geq X\lambda, y^g \leq Y^g \lambda, y^b \geq Y^b \lambda, y \geq 0\}$$

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λ is a non-negative vector in R^n, y^g is the expected output index, and y^b is the undesired output index. Introduce the slack variable s , and use s to calculate the efficiency score of each decision-making unit ρ :

$$\rho = \min \frac{1-\frac{1}{m}\sum_{i=1}^{n}\frac{s_{\bar{i}}}{x_{io}}}{1+\frac{1}{k+l}(\sum_{r=1}^{k}\frac{s_r^g}{y_{ro}^b}+\sum_{r=1}^{l}\frac{s_r^b}{y_{ro}^b})}$$

$$\text{st}\begin{cases} x_0 = X\lambda + s^- \\ y_0^g = Y^g\lambda - s^g \\ y_0^b = Y^b\lambda - s^b \\ s^-, s^g, s^b \geq 0 \end{cases}$$

Among them, $S^- and\ S^b$ represents the sum of the excess of input indicators and undesired output, and S^g represent the shortage of expected output indicators.

(2) Malmquist exponential model

Malmquist productivity refers to the economic growth rate caused by the input of production factors other than labor and capital. The Malmquist index model can be used to measure the total factor productivity in different periods. On the one hand, it can judge the stability of the efficiency of each evaluated unit, on the other hand It is also possible to observe the change trend of the efficiency value of each evaluated unit. It uses DEA as a tool to project the input and output results of the current period to the next period. The total factor productivity index from period t to period t+1 can be expressed as:

$$M(x^{t+!}, y^{t+1}, x^t, y^t) = \sqrt{\frac{D^t(x^{t+1}, y^{t+1})D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)D^{t+1}(x^t, y^t)}}$$

$$Effch = \frac{D^t(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}$$

$$Tech = \sqrt{\frac{D^t(x^{t+1}, y^{t+1})D^t(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})D^{t+1}(x^t, y^t)}}$$

Among them, $(x^{t+1}, y^{t+1}), (x^{t+1}, y^{t+1})$ respectively represent the input-output vectors of period t and period t+1 . For any decision-making unit, when M is greater than 1 , it means that the total factor productivity of the evaluated object has increased from period t to t+1 ; when M is less than 1 , it indicates that the total factor productivity has declined; when M is equal to Total factor productivity has not changed over the period.

2.1.2. Index Selection

(1) All factors of agricultural production

The explained variables, core variables and intermediary variables used in this paper are shown in the table below. With reference to the research of Ge Heping (2021), the DEA-Malmquist index is used to calculate the total factors of agricultural production in 30 provinces in China.

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Table 1. Index Selection

variable	content	index
Explained variable	High-quality development of agriculture	Agricultural high-quality development level value
core explanatory variable	Digital technology	Digital technology development level value
Mediator variable	Digital Agriculture Productivity	All factors of agricultural production

(2) Measurement of digital technology development level and regional differences

We analyzed the development level of digital technology from multiple dimensions, selected eight index values from digital information and digital network , and built a comprehensive evaluation index system. The specific index system is shown in the table below. The data comes from the data of 30 provinces in China except Tibet (data missing) from 2014 to 2020. The original data comes from the "China Statistical Yearbook" and "China Information Yearbook".

Table 2. Evaluation Index System of Digital Technology Development Level

dimension layer	Index layer	unit
Digitalization	Digital Finance Development Level	Digital Financial Inclusion Index
	Cable Density	Cable length per unit area
	Mobile phone base station density	Number of mobile phone base stations per unit area
	Number of telecommunications services per capita	
	Proportion of software service industry to employees	
digital networking	Mobile device penetration	Number of mobile devices per person
	Mobile Internet usage per capita	million GB
	Proportion of population using mobile network to resident population	

(3) Measuring the level of high-quality agricultural development and its regional differences

We analyzed the development level of digital technology from multiple dimensions, selected thirteen index values from agricultural innovation stations, green development, market development, and shared development, and built a comprehensive evaluation index system. Specifically, innovation is the driving force for high-quality agricultural development , Through

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continuous innovation to enhance the driving force of agriculture, green development is also the only way for high-quality agricultural development. The purpose of high-quality agricultural development is to allow farmers to share the fruits of agricultural development, improve the quality of life, and narrow the gap between urban and rural areas. The specific indicator system is shown in the table below. The data comes from the data of 30 provinces in China except Tibet (data missing) from 2014 to 2020. The original data comes from the "China Statistical Yearbook" and "China Information Yearbook".

Table 3. Evaluation index system of agricultural high-quality development level

dimension layer	Index layer	specific calculation
Agricultural innovation and development	Level of Agricultural Mechanization	The total power of agricultural mechanization
	Ratio of agricultural financial investment	Agricultural Fiscal Expenditure / Total Fiscal Expenditure
	Labor productivity	Output value of agriculture, forestry, animal husbandry and fishery / total number of employees in the primary industry
	land productivity	Gross agricultural output value / planted area of crops
Agricultural Green Development	Intermediate Energy Consumption of Agriculture, Forestry, Animal Husbandry and Fishery Industry	Proportion of intermediate energy consumption in output value of agriculture, forestry, animal husbandry and fishery
	Fertilizer application per unit area	Fertilizer application amount / cultivated area
	Amount of pesticide application per unit area	Agricultural use / cultivated area
Agricultural Market Development	Proportion of investment in agricultural fixed assets	Investment in fixed assets of agriculture, forestry, animal husbandry and fishery / total investment in fixed assets
	Proportion of trade volume of agricultural products	Trading volume of agricultural products / added value of the primary industry
	Proportion of import and export transaction volume of agricultural products	Import and export transaction volume of agricultural products / added value of the primary industry
Agricultural Shared Development	Income Level of Rural Residents	Per Capita Net Income of Rural Residents
	The overall economic level of rural residents	Engel coefficient
	Differences in consumption levels between urban and rural areas	Per capita consumption expenditure of urban residents / per capita consumption expenditure of rural residents

2.1.3. Comprehensive Evaluation Results and Analysis of Regional Differences

Through the previous measurement of the level of digital technology development and the level of high-quality agricultural development , it is found that China's digital technology and high-quality agricultural development have significant heterogeneity in the regional distribution. Wang Guiduo et al. (2021) believe that differences in the development of digital economy between regions will have a heterogeneous impact on industrial upgrading in different regions. Therefore , there may also be regional differences in the promotion effect of digital technology on high-quality agricultural development, and it is necessary to analyze this.

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Referring to the division of Zhao Tao et al. (2020) , the 30 provinces in China are spatially divided into eastern and central and western regions for regional heterogeneity analysis . The estimated results are shown in the table. Among them , digital technology in the eastern region does not significantly promote the high-quality development of agriculture , but digital technology can significantly improve the development of digital agricultural productivity ; The lifting effect is not significant. The possible reason is that the development level of digital technology in the eastern region is much higher than that in the central and western regions. According to the law of diminishing marginal utility, during the sample period of the study, the eastern region may have passed the period when digital technology has brought huge dividends to the high-quality development of agriculture.

Table 4. Evaluation index system of high-quality agricultural development level

variable	East area			Midwest		
	Iagr	IIpro	IIIagr	IVagr	Ⅴpro	Ⅵagr
dig	0.098 (0.148)	0.315*** (0.085)	0.012 (0.165)	0.198** (0.078)	0.061 (0.112)	0.199** (0.078)
pro			0.277 (0.238)			-0.009 (0.063)
control variable	Y	Y	Y	Y	Y	Y
Constant term	0.008 (0.571)	0.035** (0.329)	-0.210 (0.605)	-0.072 (0.139)	-0.291 (0.248)	-0.073 (0.181)
time effect	Y	Y	Y	Y	Y	Y
province effect	Y	Y	Y	Y	Y	Y
N	77	77	77	77	77	77
F value	48.090	18.019	48.892	67.902	31.025	64.628
R^2	0.925	0.822	0.945	0.962	0.945	0.986

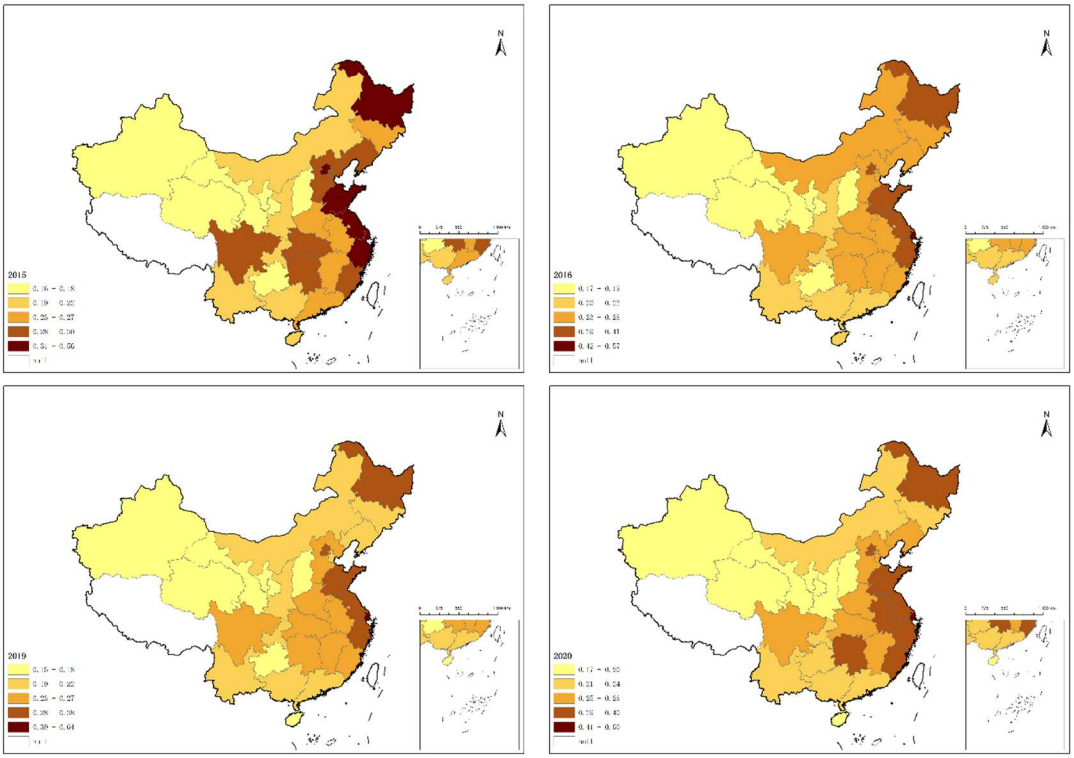

Figure 1. Temporal and spatial evolution of high-quality agricultural development level in various cities across the country

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In terms of digital technology, the central and western regions have latecomer advantages. By introducing digital technology from the eastern region, they can build rural information networks and digital logistics networks, improve the speed of rural information circulation, reduce coordination and transaction costs, and improve the efficiency of agricultural factor allocation.

Therefore, digital technology can effectively promote the high-quality development of agriculture in the central and western regions, and the marginal effect is in an increasing stage. In addition, the impact of digital technology on digital agricultural productivity is significant in the eastern region but not in the central and western regions . The possible reason is that the development level of digital technology in the eastern region is high , and then digital technology is closely related to agricultural laborers, agricultural labor materials, and agricultural labor. The integration of objects is higher than that in the central and western regions, so the effect of digital technology on digital agricultural productivity in the eastern region is more significant than that in the central and western regions.

3. Conclusions and Suggestions

3.1. Conclusion

From China's overall perspective, digital technology can significantly promote the high-quality development of agriculture, and promote the high-quality development of agriculture by improving the productivity of digital agriculture. From the perspective of regional heterogeneity, digital technology in the central and western regions can significantly promote the high-quality development of agriculture, but the role of promoting high-quality agricultural development in the eastern region is not obvious. In addition, digital technology in the eastern region can significantly improve the productivity of digital agriculture, while the effect of digital technology on the high-quality development of agriculture in the central and western regions is not obvious.

3.2. Countermeasures and Suggestions

(1) Suggestions for the eastern region. First , create an innovative environment and encourage public innovation. Create a good environment for digital agricultural innovation and entrepreneurship , and encourage talents with new knowledge and new technologies to return to their hometowns to start businesses. By taking advantage of the first-mover advantage and continuously innovating in the countryside , readjusting the utility curve, the marginal utility returns to the incremental stage again, and continues to release the boosting effect of digital technology on agricultural and rural development. Second , strengthen in-depth cooperation among provinces in the region to promote the high-quality and balanced development of overall digital technology and agriculture in the east. The provinces in the region need to strengthen cooperation. Hebei Province and Hainan Province, which rank at the bottom, should actively interact and communicate with surrounding provinces, especially with regional central cities such as Shanghai and Beijing, so that the technology, talents , Factors such as funds and data continue to spill over to surrounding and backward provinces , thereby driving the high-quality development of digital technology and agriculture in the last provinces , and ultimately realizing the high-quality and balanced development of digital technology and agriculture in the region as a whole.

(2) Suggestions for the central and western regions. First , make good use of the advantages of latecomers and actively learn from the experience of digital agriculture development in the eastern region. The central and western regions should seize opportunities, actively learn from the eastern region , introduce technology, talents and other elements, and deeply integrate with local agricultural development characteristics , form a differentiated digital agricultural

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development path, and seize digital technology to boost agricultural high-tech. Dividends for quality development. Second, increase investment in rural digital infrastructure in the central and western regions to improve the development level of regional digital agricultural productivity. The development level of digital agricultural productivity in the central and western regions is relatively low. One of the important reasons is that there are differences in geographical environment, development policies, and economic development conditions between the eastern region and the rural informatization infrastructure. The slow development of rural digital technology based on modernization facilities has ultimately resulted in a low level of productivity development in digital agriculture in the central and western regions, restricting the high-quality development of agriculture. Therefore , in order to develop digital agriculture in the central and western regions , rural digital infrastructure needs to go first.

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