

The Impact of Digital Financial Inclusion on Agricultural Mechanization: Evidence from 1,869 Counties in China*

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Abstract In light of China's generally backward agricultural mechanization levels, it becomes crucial to shore up this weak link with endogenous driving force. The digital financial inclusion offers a approach to addressing the challenges related to agricultural mechanization. This study, collecting data from 1,869 counties and using the Spatial Autoregressive Model with Spatial Autoregressive Disturbances (SARAR model), analyzes the equilibrium and disequilibrium effects of digital financial inclusion on agricultural mechanization, as well as the mechanisms through which digital financial inclusion operates. The findings indicate that both digital financial inclusion and agricultural mechanization exhibit spatial spillover effects. The development of digital financial inclusion emerges as a significant driver for promoting agricultural mechanization. Furthermore, the impact of digital financial inclusion on agricultural mechanization varies based on the level of agricultural economic development, with counties characterized by less developed agriculture, plain topography, and strong agricultural sectors benefiting more from digital financial inclusion. Additionally, digital financial

inclusion indirectly boosts agricultural mechanization by increasing farmers' income and encouraging investment in fixed assets. Therefore, it is crucial to harness the benefits brought by the development of digital financial inclusion while promoting agricultural mechanization, and regions should tailor their approaches to promote digital financial inclusion development according to their local conditions.

Keywords digital financial inclusion, agricultural mechanization, county, SARAR model

1 Introduction

Agricultural mechanization has played a pivotal role in transforming the agricultural development pattern, improving comprehensive agricultural productivity

* This paper is translated from *Chinese Rural Economy* 中国农村经济, 2022(2), 76–93.

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(Hu & Zhang, 2018), bolstering rural industrial revitalization, and enhancing grain production, agricultural efficiency and farmers' income. In 2021, the *No. 1 Central Document* proposed to promote rural revitalization by improving the level of agricultural mechanization. At present, the foundation of China's agricultural mechanization is frail, marked by uneven and insufficient development, which falls short of meeting the practical requirements to support the rural revitalization strategy and high-quality agricultural development. Improving agricultural mechanization requires the input of capital factors. Unfortunately, the agricultural sector faces constraints in terms of available capital resources, which are often diverted to non-agricultural sectors (Mo & Shen, 2020). The lack of capital factors in the agricultural sector impedes progress in agricultural mechanization and hinders the implementation of the rural revitalization strategy (Tian, 2020). In the era of the burgeoning digital economy, rural digital financial inclusion has emerged as a potent solution to address high transaction costs and information asymmetry in traditional rural finance with digital technology, all associated with agricultural sector financing while greatly alleviating the difficulties and costs. This phenomenon fosters agricultural development, increases farmers' incomes, and consolidates the achievements made in poverty alleviation, presenting a new approach to promoting the high-quality development of agriculture. Specifically, digital financial inclusion is leveraged to propel agricultural mechanization and attain high-quality agricultural development.

Nevertheless, the theoretical and practical quandaries revolve around whether rural finance, particularly the relatively recent emergence of digital financial inclusion, serves as an alternative channel for diverting agricultural funds, following the price scissors between industrial and agricultural products, or an important path to promote agricultural mechanization?

The development of digital financial inclusion not only helps transform the urban economic growth model, but also opens up new prospects for the development of the agricultural economy, gradually becoming the primary driver for rural revitalization (Yin et al., 2020). Within a closed economic system, the development of digital financial inclusion helps promote agricultural mechanization. It has spurred the development of digital technologies such as agricultural artificial intelligence, facilitating the integration of digital technology and agricultural production. This has improved the agricultural mechanization level from the supply side, and accelerated the transformation of agricultural production methods (Wang et al., 2020), becoming a pivotal way for advancing rural revitalization. Digital financial inclusion has reshaped the traditional financial operation model (Li & Liu, 2021). It has expanded the channels for sourcing capital factors within the agricultural sector, and resolved the bottleneck in providing financial services to agriculture and rural areas at a low cost, and through a convenient and sustainable model (Xing, 2021). Academic studies using provincial-level data (Zhang & Zhou, 2021), county-level data (He et al., 2021), and household-level data (Zhou et al.,

2021) show that digital financial inclusion can furnish sufficient capital factors for the agricultural economy to thrive (He et al., 2021). Moreover, it has effectively improved the agricultural mechanization level (Liu & Wang, 2019).

In an open economic system, three aspects are often overlooked when considering whether the development of digital financial inclusion helps promote agricultural mechanization. First, financial exclusion persists within the agricultural sector. Given the higher efficiency typically associated with the non-agricultural sector compared with the agricultural sector, institutions involved in digital financial inclusion often channel their capital resources into non-agricultural sectors to seek higher profits. Not only that, capital factors within the agricultural sector gradually flow toward non-agricultural sectors. If digital financial inclusion fails to address the exclusion of traditional financial products from the agricultural sector, its potential to drive agricultural mechanization remains limited. Second, while the theoretical framework suggests that the development of digital financial inclusion can accelerate the growth of the agricultural economy through innovative financial models, it does not necessarily lead to the spontaneous promotion of agricultural mechanization, especially in scenarios characterized by low agricultural productivity and rural labor outflow. In such cases, the beneficial effects of digital financial inclusion are limited (Wang & Zhu, 2018). Third, the innovation of financial models is accompanied by the instability of financial markets, but the impact of financial

market fluctuations on sectoral economies is uneven. Akhter et al. (2010) find that unstable financial markets are more likely to increase operational risks in the agricultural sector and impoverished groups. Thus, some scholars question the extent to which digital financial inclusion promotes agricultural mechanization, with some arguing that it has a limited short-term impact on China's agricultural and rural economy due to being in its early stages (Matthews, 2019). Despite being a novel financial model that merges traditional finance with the internet, digital financial inclusion seeks profits as other financial services do, which may lead to new disparities between urban and rural areas (Guo et al., 2016). The allocation of capital elements between urban and rural areas may not improve due to the development of digital financial inclusion (Hu & Cheng, 2020). Although digital financial inclusion has made inroads into rural areas, its activity still lags behind that in urban areas (Xing, 2021). Empirical research also highlights that digital financial inclusion can better improve the income level of farmers with financial needs but exert less impact on farmers with less exposure to digital financial inclusion. Farmers with strong digital skills and financial literacy are more likely to derive greater benefits (Peng & Xu, 2021). However, due to the cognitive level of rural workers themselves, rural residents use smartphones mainly for social networking (WeChat and QQ), entertainment (Kwai and Tiktok) and online shopping (Taobao and Pinduoduo), while less than 5% of them use such devices for wealth management purposes (Yu'ebao and mobile banking) (Deng et al., 2019).

Currently, there is debate surrounding the potential of digital financial inclusion to drive agricultural mechanization. It is necessary to examine the role of digital financial inclusion in the process of agricultural mechanization, both theoretically and empirically. Compared with previous studies, this paper makes marginal contributions in the following three aspects. First, it delves into the economic effect of digital financial inclusion from the perspective of agricultural mechanization. Digital financial inclusion has improved the availability of capital factors within the agricultural sector (Xing, 2021), which helps improve the mechanization level in the agricultural sector (Pan & Tian, 2018). Unlike previous studies that primarily focused on the impact of digital financial inclusion on the agricultural economy, while ignoring the relationship between digital financial inclusion and agricultural mechanization, this paper takes agricultural mechanization as the starting point to assess how digital financial inclusion affects agricultural development. Second, this paper analyzes the non-uniform effect of digital financial inclusion on agricultural mechanization. Agricultural mechanization is influenced not only by the development of digital financial inclusion but also by various factors, such as the level of agricultural development, county location and terrain conditions. These factors have often been ignored in the existing research on digital financial inclusion or agricultural mechanization. In an attempt to address this gap, this paper introduces county-level economic conditions and natural features into the

econometric model, thereby exploring the nuanced effects of digital financial inclusion. Third, this paper investigates the spatial agglomeration characteristics of county-level agricultural development. Agricultural development may exhibit spatial agglomeration to some extent. Nevertheless, the majority of previous studies have approached this subject from the standpoint of spatial homogeneity. Digital financial inclusion may exert additional influences on agricultural mechanization, specifically through spatial spillover effects. As such, this paper aims to investigate the spatial spillover effect of digital financial inclusion on agricultural mechanization.

2 Theoretical Mechanism and Research Hypothesis

Leveraging the advantages of digital technology, digital financial inclusion has dismantled the constraints of time and distance, realizing low-cost and highly efficient capital allocation. It has also, to a certain extent, mitigated the sectoral (regional) discrimination inherent in traditional finance. From a supply-side perspective, digital financial inclusion has improved the availability of financial services within the agricultural sector, and provided sufficient capital factors for agricultural mechanization and rural industry development. Digital financial inclusion not only exerts a direct impact on agricultural mechanization but also generates spillover effects.

2.1 | Direct Impact of Digital Financial Inclusion on Agricultural Mechanization

The development of the agricultural economy cannot be realized without financial support. Agriculture, due to its specific characteristics such as low capital demand, challenges in credit assessment, and dispersed demands, often faces difficulties in accessing services from traditional financial institutions. It has been observed that geographical distance (He & Li, 2019) and the exclusion of traditional finance from the agricultural sector (Li & Liu, 2021), have created credit constraints, becoming a primary obstacle to agricultural mechanization (Zhou et al., 2013). The development of digital financial inclusion has dismantled spatial barriers between financial service seekers and providers (Zhang et al., 2019). It accurately assesses the creditability of small-scale financial service seekers, reduces financial transaction costs, optimizes regional financial supply models (Peng & Xu, 2021), injects capital factors into agricultural economic development, promotes agricultural mechanization, and drives the high-quality development of the agricultural economy (Zhang & Wang, 2021). Additionally, digital financial inclusion has transformed the supply mode of traditional finance, improving its efficiency in serving the agricultural sector (Tian, 2020). To some extent, digital financial inclusion has addressed the issue of imbalanced and insufficient development of agricultural mechanization (Zhou et al., 2021). Based on the above analysis, Hypothesis 1 is proposed.

H1: The development of digital

financial inclusion can improve the level of agricultural mechanization.

2.2 | Indirect Impact of Digital Financial Inclusion on Agricultural Mechanization

The development of digital financial inclusion also yields an indirect impact on agricultural mechanization. It enables farmers to access a wide array of financial products and services, stimulating both agricultural productive investment and increasing income for farmers. In theory, these factors collectively promote agricultural mechanization.

2.2.1 *Promoting Agricultural Mechanization by Increasing Fixed Assets Investment*

Digital financial inclusion has increased the marginal return on capital in the agricultural sector (Ma & Qu, 2021). It has reshaped capital outflow dynamics and improved the availability of capital factors in the agricultural sector (Tian, 2020). Agricultural fixed assets investment can benefit from the development of digital financial inclusion. Specifically, digital financial inclusion increases the purchase cost of agricultural machinery and ultimately promotes the level of agricultural mechanization (Luo et al., 2021). Therefore, digital financial inclusion advances agricultural mechanization by boosting fixed assets investment.

2.2.2 *Promoting Agricultural Mechanization by Raising Farmers' Income*

The development of digital financial inclusion paves the way for online bonds, stocks, and a rural internet economy, which significantly increases farmers' income

(Ma & Zhang, 2021). Digital financial inclusion also fuels the development of rural industries (Yin et al., 2021), creating new employment opportunities for farmers and increasing their income. Moreover, it promotes the upgrading of traditional financial service models, thereby improving farmers' access to traditional finance, ultimately alleviating credit constraints for farmers and increasing their income (Yin et al., 2021). However, due to the limited investment projects in rural areas, as income increases, farmers will increase their investment in agricultural capital factors to further improve their agricultural operating income (Pan & Tian, 2018), which enhances the level of agricultural mechanization (Luo et al., 2021). Therefore, digital financial inclusion improves the level of agricultural mechanization by increasing farmers' income.

To summarize, the development of digital financial inclusion serves as a catalyst for heightened agricultural fixed assets investment and increases farmers' income, thus improving the level of agricultural mechanization. Consequently, Hypothesis 2 is poised.

H2: Fixed assets investment and farmers' income play an intermediary role in the impact of digital financial inclusion on agricultural mechanization.

2.3 | The Impact of County-Level Development and Natural Conditions

2.3.1 The Impact of Agricultural Development

The biggest difference between digital

financial inclusion and traditional finance lies in its inclusivity (Zhang et al., 2019). Specifically, digital financial inclusion extends its reach to both agriculturally developed and underdeveloped counties (Zhou et al., 2021). In counties with well-established agriculture, the development of digital financial inclusion can improve the supply mode of capital from the supply side. However, due to already abundant capital factors in such counties, the impact of digital financial inclusion is relatively limited. Conversely, counties with underdeveloped agriculture often face capital factor scarcity, and the advent of digital financial inclusion presents them with an opportunity to access financial services (Wang & Zhu, 2018) that traditional financial institutions often denied to them by reducing their credit constraints. In addition, counties with underdeveloped agriculture place greater emphasis on the development of digital financial inclusion due to a lack of capital factors.

2.3.2 The Impact of Development Positioning

Research by Feng et al. (2021) reveals a significant difference in the level of digital financial inclusion between county-level cities and counties, indicating that county positioning may influence the development level of digital financial inclusion. Hu and Zhang (2018) assert that the role of agricultural mechanization varies among different provinces, suggesting that county positioning may also impact the level of agricultural mechanization. Agricultural counties prioritize agriculture, and the capital factors brought by digital financial inclusion are directed toward enhancing

agricultural efficiency, thus promoting the improvement of the agricultural mechanization level. In contrast, industrial counties mainly focus on industry, where digital financial inclusion may bring opportunities for industrial development but may not necessarily have an impact on agricultural factor investments. This divergence hinders the improvement of local agricultural mechanization.

2.3.3 *The Impact of Terrain Conditions*

Compared with other industries, agricultural factor inputs are constrained by terrain conditions. In plain counties, it is often more advantageous to employ agricultural machinery as a substitute for human labor and animal labor, thus promoting large-scale mechanized farming. Conversely, mountainous counties face constraints imposed by terrain conditions, making it less practical to replace human and animal labor with large-scale agricultural machinery (Zhou et al., 2013). Therefore, digital financial inclusion experiences high levels of development in mountainous areas, but the level of agricultural mechanization may not witness significant improvements. As such, it is hypothesized that the level of agricultural mechanization may be high in plain counties despite the relatively lower development level of digital financial inclusion, whereas the level of agricultural mechanization may be low in mountainous counties despite the high development level of digital financial inclusion. Based on the above analysis, Hypothesis 3 is proposed.

H3: The development of digital financial inclusion better enhances the level of agricultural mechanization in

counties with underdeveloped agriculture, agricultural counties, and plain counties.

3 Research Design

3.1 | Data Source

This paper uses two types of data: county-level statistical data and data on digital financial inclusion. The county-level statistical data have been obtained from the *China Statistical Yearbook (County-Level)* and the statistical yearbooks of various provinces and cities from 2015 to 2020 (calendar years). Several indicators, such as the total retail sales of consumer goods, cultivated land area, the output value of industrial enterprises above the designated size from 2017 to 2019, and the total power of agricultural machinery from 2018 to 2019 have been sourced from statistical yearbooks of various provinces and cities. Other indicators have been sourced from the *China Statistical Yearbook (County-Level)*. The data pertaining to digital financial inclusion have been derived from the Peking University Digital Financial Inclusion Database calculated by Guo et al. (2020). In this analysis, county names serve as unique identifiers, enabling the matching of digital financial inclusion data with the county statistical data extracted from the *China Statistical Yearbook (County-Level)*. To create county panel data, the missing values for certain variables at the county level have been supplemented through interpolation, resulting in a balanced panel dataset for 1,869 counties across China from 2014 to 2019.

3.2 | Variables

3.2.1 Explained Variable

This paper selects the level of agricultural mechanization as the explained variable. To qualify this variable, values are drawn from the research conducted by Wu et al. (2017), Zhou and Kong (2019). It involves the differences in the total power required for agricultural machinery in various counties with distinctive cultivated land areas. The quantification method employed here calculates the agricultural mechanization level by taking the ratio of the total power of agricultural machinery within each county to the cultivated land area within the same county.

3.2.2 Core Explanatory Variable

The digital financial inclusion index is selected as the core explanatory variable. This paper incorporates not only the total index of digital financial inclusion into the econometric model, but also involves the coverage breadth, usage depth, and digitization level of digital financial inclusion. This enables an examination of the impact of various dimensions of digital financial inclusion on agricultural mechanization. The data related to digital

financial inclusion come from the digital financial inclusion database calculated by Guo et al. (2020), which uses dimensionless methods and an Analytic Hierarchy Process to calculate scores for the digital financial inclusion index and its various dimensions for each county and city, based on the digital financial inclusion index system. For the convenience of empirical analysis, the scores for the digital financial inclusion index and its various dimensions in this paper have been standardized by dividing the original index by 100.

3.2.3 Control Variable

Given the county-level focus of this paper's investigation into the impact of digital financial inclusion on agricultural mechanization, the selection of control variables follows methodologies used by Zhou and Kong (2019), Wang and Zhu (2018), among others. This paper incorporates seven control variables, namely information technology level, human capital level, urbanization level, financial development level, government intervention level, enterprise development level, and social consumption level. The specific definitions of these variables are shown in Table 1.

Table 1 Variable Definition and Descriptive Statistics

Variable	Variable definition	Average value	Standard deviation
Agricultural mechanization level	Ratio of total power of agricultural machinery to cultivated land area in a county (kWh/mu)	2.5704	1.3944
Digital financial inclusion index	Digital financial inclusion index score (original value/100)	0.8710	0.2575
Coverage breadth	Digital financial inclusion index coverage score (original value/100)	0.8100	0.2397
Usage depth	Digital financial inclusion index usage depth score (original value/100)	0.9917	0.3349

(To be continued)

(Continued)

Variable	Variable definition	Average value	Standard deviation
Digitalization level	Digital financial inclusion index digitalization level score (original value/100)	0.6328	0.2735
Informatization level	Ratio of fixed telephone users to the total population of a county (household/person)	0.3786	0.2668
Human capital level	Ratio of regular high school students to the total population of a county (person/person)	0.1254	0.0802
Urbanization level	Ratio of employees in the secondary and tertiary industries to the total population of a county (person/person)	0.6404	0.5813
Financial development level	Ratio of residents' savings deposit balance to the total population of a county (10,000 yuan/person)	2.4997	2.2485
Government intervention level	Ratio of public finance expenditure to county regional GDP (10,000 yuan/10,000 yuan)	0.2854	0.3495
Enterprise development level	Ratio of the total output value of industries above designated size to the total output value of a county (10,000 yuan/10,000 yuan)	0.6064	1.9415
Social consumption level	Ratio of total retail sales of consumer goods to the total population of a county (10,000 yuan/person)	1.4674	1.6976

3.3 | Model Construction

Digital financial inclusion differs significantly from traditional finance in its ability to transcend temporal and spatial boundaries. Consequently, its impact on agricultural mechanization also breaks down spatial limitations to a certain extent. Previous studies have verified that both digital financial inclusion (Guo et al., 2020) and agricultural mechanization (Wu et al., 2017) exert spatial spillover effects. It is necessary to explore the spatial attributes of digital inclusive finance and agricultural mechanization when analyzing the impact of digital financial inclusion on agricultural mechanization. As a result, spatial econometric models should be adopted to analyze this relationship. Currently, two primary spatial econometric models, the Spatial Autoregressive Model (SAR model) and the Structural Equation Modeling (SEM model), are widely used. These models explore the spatial autoregressive term and the spatial error term, respectively. However, there are situations where spatial autoregressive terms and spatial error terms

may coexist within the same model. This paper attempts to introduce a SARAR model that can solve such a problem, with digital financial inclusion as the core explanatory variable and agricultural mechanization as the dependent variable, to explain the impact of digital financial inclusion on agricultural mechanization. The spatial econometric model can be expressed as follows:

$$SARAR: \begin{cases} Y_{it} = \rho WY_{it} + C_{it}\alpha_{it} + D_{it}\beta_{it} + \mu_{it}, \\ \mu_{it} = \lambda W\mu_{it} + \varepsilon_{it}. \end{cases} \quad (1)$$

In equation (1), Y_{it} represents the agricultural mechanization level at County i in the period of t , C_{it} represents the digital financial inclusion index (including three dimensions of coverage breadth, usage depth, and digitization level), and D_{it} denotes the control variable. ρ represents the autoregressive coefficient of the agricultural mechanization level, i.e., the degree to which changes in the agricultural mechanization level in adjacent counties affect the agricultural mechanization level in the county. α_{it} stands for the impact of the core explanatory variable on the agricultural mechanization level, while β_{it} is the degree

to which the control variable affects the agricultural mechanization level. μ_{it} is the difference in estimated coefficients caused by spatial econometric model errors, ε_{it} is the impact of other uncontrollable factors on the agricultural mechanization level, and λ is the impact of measurement errors on the agricultural mechanization level. W represents the spatial weight matrix, with the reciprocal of the spatial distance between two counties as the weight between counties. The specific setting method for W is:

$$W = \begin{cases} 1/d_{ij}, & i \neq j; \\ 0, & i = j. \end{cases} \quad (2)$$

In equation (2), i and j represent two different counties, while d_{ij} represents the spatial distance between County i and County j .

4 Empirical Result Analysis

4.1 | Spatial Correlation Test

Given the observed cross-regional

movement of agricultural machinery (Wu et al., 2017) and the capacity of digital financial inclusion to transcend temporal and spatial boundaries, it becomes imperative to conduct a spatial correlation test between digital financial inclusion and agricultural mechanization when examining their relationship. If changes in digital financial inclusion or agricultural mechanization exhibit spatial correlation, spatial spillover effects need to be discussed when analyzing the impact of digital financial inclusion on agricultural mechanization (Feng et al., 2021). Conversely, the investigation can focus solely on the direct impact of digital financial inclusion on agricultural mechanization. Drawing on the research conducted by Ma and Zhang (2021), and Sun and Wang (2021), this paper adopts the Moran's Index to analyze the spatial dependence of the digital financial inclusion index on the agricultural mechanization level.¹ The test results are shown in Table 2.

Table 2 Spatial Correlation Test Results

Year	Digital financial inclusion index			Agricultural mechanization level		
	Moran's I	SD (I)	Z	Moran's I	SD (I)	Z
2014	0.033***	0.009	4.091	0.154***	0.009	18.095
2015	0.087***	0.009	10.420	0.161***	0.009	18.945
2016	0.006	0.009	1.146	0.165***	0.009	19.420
2017	0.097***	0.009	11.489	0.176***	0.009	20.674
2018	0.112***	0.009	13.277	0.160***	0.009	18.792
2019	0.177***	0.010	17.377	0.048***	0.010	5.146

Note. ***, ** and * represent significance levels of 1%, 5%, and 10%, respectively.

¹ Unlike Sun and Wang's (2021) research, this paper uses a spatial geographic distance weight matrix for spatial correlation testing.

It can be seen from Table 2 that, with the exception of the Moran's Index for the 2016 digital financial inclusion index, which did not pass the test, the Moran's Index of digital financial inclusion index and the agricultural mechanization level in other years are statistically significant at the 1% level, signifying a spatial dependence relationship between digital financial inclusion and agricultural mechanization. Both Moran's Index of digital financial inclusion and the agricultural mechanization level exhibit positive values, indicating a clustering pattern between digital inclusive finance and agricultural mechanization. To be specific, there is a spatial spillover effect between the development of digital financial inclusion and agricultural mechanization among counties. Therefore, it is imperative to consider spatial spillover effects when analyzing the impact of digital financial inclusion on agricultural mechanization.

4.2 | Analysis of the Equilibrium Effects of Digital Financial Inclusion on Agricultural Mechanization

Using a spatial econometric model and county-level short panel data from 2014 to 2019, this study seeks to explore the impact of digital financial inclusion on agricultural mechanization. Due to the use of panel data, it is necessary to discuss whether mixed effects, random effects, or fixed effects are more suitable for analyzing the impact of digital financial inclusion on agricultural mechanization. The Breusch-Pagan test suggests that random effects are more suitable than mixed effects, while the Hausman test indicates that fixed effects are more appropriate than random effects. Hence, this paper selects the fixed-effects SARAR model to analyze the impact of digital financial inclusion on agricultural mechanization. The estimated results are shown in Table 3.

Table 3 Benchmark Model Regression Results

Variable	(1)	(2)	(3)	(4)
Digital financial inclusion index	0.6246*** (0.0088)			
Coverage breadth		0.4718*** (0.0077)		
Usage depth			0.6195*** (0.0075)	
Digitalization level				0.0228 (0.0427)
Informatization level	0.5189*** (0.0189)	0.5893*** (0.0196)	0.3914*** (0.0181)	0.6312*** (0.0226)
Human capital level	0.2972*** (0.0098)	0.4099*** (0.0100)	0.1660*** (0.0097)	0.4377*** (0.0115)
Urbanization level	0.2104*** (0.0116)	0.2891*** (0.0122)	0.1288*** (0.0111)	0.2184*** (0.0139)
Financial development level	-0.0277*** (0.0097)	-0.0619*** (0.0101)	-0.0385*** (0.0092)	-0.0621*** (0.0116)

(To be continued)

(Continued)

Variable	(1)	(2)	(3)	(4)
Government intervention level	-0.1138*** (0.0279)	-0.1718*** (0.0291)	-0.0733*** (0.0265)	-0.0714** (0.0335)
Enterprise development level	0.0172 (0.0145)	0.0074 (0.0151)	0.0362*** (0.0137)	0.0192 (0.0174)
Social consumption level	0.0991*** (0.0245)	0.2214*** (0.0256)	0.0518** (0.0233)	0.1411*** (0.0295)
Spatial autoregressive term	-0.3274*** (0.0535)	-0.3134*** (0.0534)	-0.3038*** (0.0557)	-0.4262*** (0.0567)
Spatial autocorrelation term	0.7843*** (0.0236)	0.7880*** (0.0227)	0.7428*** (0.0293)	-0.7930*** (0.0225)
Spatial error term	0.3037*** (0.0034)	0.3295*** (0.0037)	0.2733*** (0.0031)	0.4383*** (0.0049)
Year	Yes	Yes	Yes	Yes
County	Yes	Yes	Yes	Yes
Adjusted pseudo R^2	0.5361	0.5352	0.5601	0.3402
Generalized likelihood ratio test	-8,319.5595	-8,778.0757	-7,712.1158	-10,387.636
Number of observations	11,214	11,214	11,214	11,214

Note. ***, ** and * represent significance levels of 1%, 5%, and 10%, respectively, with robust standard errors in parentheses.

The core explanatory variables in columns (1) to (4) of Table 3 are the digital financial inclusion index, coverage breadth, usage depth, and digitization level, respectively. The goodness of fit of columns (1) to (3) is greater than 0.5, while that of column (4) is 0.3402, indicating the reliability of the estimation results of the SARAR model. The analysis of the impact of digital financial inclusion on agricultural mechanization is as follows.

The first is the impact of digital financial inclusion on agricultural mechanization. As shown in column (1) of Table 3, the impact of the digital financial inclusion index on the agricultural mechanization level is significantly positive at the 1% level. This result validates Hypothesis 1, which posited that improving the level of digital financial inclusion is beneficial for promoting the development of agricultural mechanization. Possible reasons are listed as follows. First, due to its inclusive nature, digital financial inclusion not only provides capital factors for the industrial and service sectors but also

provides sufficient capital factors for the development of the agricultural economy. This increase in agricultural capital input leads to improvements in the agricultural mechanization level. Second, digital financial inclusion platforms represented by Huabei and Payday Loan have improved individual digital skills in a convenient and unsecured way. By lowering the financing threshold for the agricultural sector, these platforms enable individual farmers to quickly obtain financial support from financial institutions. The expansion of financing channels for the agricultural sector ultimately enhances the level of agricultural mechanization. Third, digital financial inclusion provides a guarantee for the construction of digital economy platforms, which offers an opportunity for the development of agricultural mechanization. For example, a farmer in Heze City, Shandong Province, saw a garlic planter on the Kwai APP, contacted the poster through the Kwai platform and purchased a garlic planter for garlic cultivation in 2020, resulting in the transition

from manual garlic planting to mechanical planting within a 20-kilometer radius.²

The second is the impact of various dimensions of digital financial inclusion on agricultural mechanization. As shown in columns (2) to (4) of Table 3, the impact of coverage breadth and usage depth on the agricultural mechanization level is significantly positive at the 1% level, while the impact of the digitalization level on the agricultural mechanization level is not significant, indicating that the coverage breadth and usage depth are the main factors driving agricultural mechanization. Comparing the estimated coefficients of coverage breadth and usage depth, it is found that the estimated coefficient of usage depth is greater than that of coverage breadth, indicating that the deeper the integration of digital financial inclusion and agriculture, the higher the agricultural mechanization level. A potential reason is that the coverage of digital financial inclusion may affect the process of agricultural mechanization, but the impact of digital financial inclusion on agricultural mechanization depends on whether farmers use it in the production process. Therefore, the usage depth of digital financial inclusion exerts a greater effect on agricultural mechanization. The impact of the digitalization level on the agricultural mechanization level is not significant because the digitalization level of digital financial inclusion in the process of agricultural mechanization has not yet exerted its full impact on the agricultural economy. In light of these findings, it is advisable to accelerate the widespread adoption of digital information technology in the future.

This would not only provide technical support and innovation opportunities for promoting rural revitalization and agricultural mechanization, but also further unlock digital dividends in the high-quality development of the agricultural economy.

The third is the spatial spillover effects of digital financial inclusion. As shown in Table 3, the spatial autoregressive terms of the impact of the digital financial inclusion index and various dimensions on the agricultural mechanization level are significantly negative at the 1% level, indicating that digital financial inclusion not only promotes the development of agricultural mechanization in a particular county but also retrains the agricultural mechanization in adjacent counties. This phenomenon can be attributed to the cross-regional movement of agricultural machinery (Wu et al., 2017), indicating that agricultural machinery not only serves local agricultural production but also supports agricultural production in adjacent counties. Specifically, the improvement of the agricultural mechanization level in County A inhibits the purchase of agricultural machinery in the surrounding counties, which is not conducive to the improvement of the agricultural mechanization level in those surrounding counties. Despite being inclusive in nature, digital financial inclusion primarily aims to seek profits. Thus, digital financial inclusion tends to gather in counties with higher levels of agricultural mechanization (or greater agricultural economic development),

² The case comes from the authors' research in Heze City, Shandong Province in July 2020.

hindering the development of agricultural mechanization in surrounding counties.

4.3 | Analysis of the Disequilibrium Effects of Digital Financial Inclusion on Agricultural Mechanization

In this section, the methodology follows the research conducted by He et al. (2020), including the level of agricultural economic development in the county in the model, which is represented by the added value of the primary industry in 2013. The interaction term between the digital financial inclusion index and the level of agricultural economic development is introduced into the econometric model to explore the disequilibrium effects of digital financial inclusion on agricultural mechanization. In addition, this section

ranks the counties based on the added value of the primary industry in 2014. The first 623 counties are categorized as counties with developed agriculture, and the last 623 counties as counties with backward agriculture, and the rest as counties with moderate agricultural scale, to explore the heterogeneity of the impact of digital financial inclusion. The estimated disequilibrium effects of digital financial inclusion on agricultural mechanization are shown in Table 4.

The core explanatory variables in columns (1), and (5) to (7) of Table 4 are the digital financial inclusion index, while the core explanatory variables in columns (2) to (4) are the coverage breadth, usage depth, and digitization level of digital financial inclusion. Columns (5)–(7) respectively show the impact of digital financial

Table 4 Regression Results of Disequilibrium Effects

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Digital financial inclusion index	0.0556*** (0.0029)				0.2409*** (0.0666)	0.1046*** (0.0095)	0.0035 (0.0029)
Coverage breadth		0.0676*** (0.0030)					
Usage depth			0.0433*** (0.0023)				
Digitalization level				0.0057** (0.0025)			
Interaction term	-1.3049*** (0.0364)	-1.3123*** (0.0383)	-1.1533*** (0.0290)	-0.0556* (0.0320)	-0.0271*** (0.0055)	-0.0265*** (0.0074)	-0.0191 (0.0472)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted pseudo R^2	0.5230	0.5062	0.5678	0.3579	0.6244	0.5276	0.4152
Generalized likelihood ratio test	-8,137.2311	-8,533.0736	-7,534.2514	-10,385.041	-3,445.0006	-2,394.3395	-1,403.9244
Number of observations	11,214	11,214	11,214	11,214	3,738	3,738	3,738

Note. ***, ** and * represent significance levels of 1%, 5%, and 10%, respectively, with robust standard errors in parentheses.

inclusion on agricultural mechanization in counties with underdeveloped, moderate, and developed agricultural scales. The specific analysis of the disequilibrium effects of digital financial inclusion on agricultural mechanization is as follows.

The first is the impact of digital financial inclusion on agricultural mechanization. As shown in columns (1)–(4) of Table 4, after adding the interaction term, the impact of the digital financial inclusion index on the agricultural mechanization level remains significantly positive at the 1% level. This reaffirms that the development of digital financial inclusion promotes agricultural mechanization, thereby confirming *H1*. Comparing the estimated coefficients in Table 4 and Table 3, it is found that the impact of digital financial inclusion on agricultural mechanization diminishes slightly after incorporating the interaction term. This suggests that without considering the local agricultural economic development status, the impact of digital financial inclusion on agricultural mechanization may be overestimated.

The second is the impact of interaction terms on agricultural mechanization. As shown in columns (1) to (3) of Table 4, the impact of interaction terms on the agricultural mechanization level is significantly negative at the 1% level. The impact of interaction terms in column (4) on the agricultural mechanization level is significantly negative at the 10% level. This implies that, when digital financial inclusion is equally advanced in counties with underdeveloped agriculture, those with higher levels of agricultural economic development tend to have lower levels of

agricultural mechanization. This indicates that digital financial inclusion can better enhance the agricultural mechanization level in counties with underdeveloped agriculture than in those with developed agriculture. There can be two possible reasons behind this phenomenon. One of them is that in addition to the inclusive nature of digital financial inclusion, it bridges the spatial distance of financial supply and provides different types of financial services that traditional finance often denies to counties with backward agriculture and their agricultural sectors, thereby alleviating the credit constraints of these counties and sectors. Another reason is that digital financial inclusion incurs a lower cost than traditional finance. Consequently, the agricultural sector can obtain funds at a lower price, reducing the cost of obtaining capital factors for counties with underdeveloped agriculture and its agricultural sectors and promoting the development of agricultural mechanization.

The third is the differences in the impact of digital financial inclusion under different levels of agricultural economic development. As shown in columns (5)–(7) of Table 4, the impact of the digital financial inclusion index on the agricultural mechanization level in the counties with underdeveloped agriculture and moderate agricultural scale is significantly positive at the 1% level; while the impact of the digital financial inclusion index on the agricultural mechanization level in the counties with developed agriculture is not significant. Generally, digital financial inclusion promotes improvements in agricultural mechanization, which reaffirms *H1*. In

counties with underdeveloped agriculture and those with moderate agricultural scale, the impact of the interaction term on the agricultural mechanization level is significantly negative at the 1% level. Conversely, in counties with developed agriculture, the impact of interaction terms on the agricultural mechanization level is not significant. A comparison of the estimated coefficients of the digital financial inclusion index and the interaction term of counties with underdeveloped agriculture and moderate agricultural scale reveals that the absolute value of the estimated coefficients of the digital financial inclusion index in counties with underdeveloped agriculture and moderate agricultural scale is higher, indicating that digital financial inclusion plays an inclusive role in promoting agricultural mechanization. It narrows the gap in agricultural mechanization levels between counties with developed and underdeveloped agriculture.

4.4 | Analysis of the Mechanism through Which Digital Financial Inclusion Affects Agricultural Mechanization

Building upon the preceding analysis, it becomes evident that digital financial inclusion exerts an influence on agricultural mechanization, both directly and indirectly. This indirect impact is achieved by increasing farmers' income and stimulating investment in fixed assets. To verify such an inference, this section seeks to explore the underlying mechanism through which digital financial inclusion affects agricultural mechanization. Within this examination, farmers' income is measured by the natural logarithm of the per capita disposable income (in yuan) among county residents, while investment in fixed assets is gauged by the natural logarithm of the total investment in fixed assets in the county (in yuan). The results of the regression analysis are shown in Table 5.

Table 5 Test Results of the Impact Mechanism

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Digital financial inclusion index	0.0747*** (0.0033)		0.6602*** (0.0089)	0.0083*** (0.0025)		0.6258*** (0.0088)
Farmers' income		0.0893*** (0.0334)	0.4573*** (0.0248)			
Fixed asset investment					0.0813*** (0.0198)	0.1392*** (0.0321)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
County	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted pseudo R ²	0.5572	0.3072	0.5170	0.8510	0.3077	0.5145
Generalized likelihood ratio test	2,822.1166	-10,396.833	-8,152.4003	5,540.0639	-10,397.007	-8,310.1367
Number of observations	11,214	11,214	11,214	11,214	11,214	11,214

Note. ***, ** and * represent significance levels of 1%, 5%, and 10%, respectively, with robust standard errors in parentheses.

Column (1) of Table 5 presents the impact of digital financial inclusion index on farmers' income, column (2) demonstrates the impact of farmers' income on the agricultural mechanization level, column (3) examines the impact of digital financial inclusion index and farmers' income on the agricultural mechanization level, column (4) delves into the impact of digital financial inclusion index on fixed assets investment, column (5) is the impact of fixed assets investment on the agricultural mechanization level, and column (6) is the impact of digital financial inclusion index and fixed assets investment on the agricultural mechanization level.

The impact of digital financial inclusion index on farmers' income and fixed assets investment is positive, and significant at the 1% level. The impact of farmers' income and fixed assets investment on the agricultural mechanization level is also positive, and significant at the 1% level. It can be seen from column (3) of Table 5 that the impact of the digital financial inclusion index and farmers' income on the agricultural mechanization level is both positive, and significant at the 1% level. It can be seen from column (6) of Table 5 that the impact of the digital inclusive financial index and fixed assets investment on the agricultural mechanization level is positive, and significant at the level of 1%, indicating that digital financial inclusion influences agricultural mechanization both directly and indirectly, which confirms Hypothesis 2. Several factors contribute to these outcomes. Digital financial inclusion influences the agricultural sector systematically. It not only exerts a direct

impact on agricultural mechanization but also affects other factors of the agricultural sector. Specifically, it directly promotes agricultural mechanization, raises farmers' income and increases investment in fixed assets in the agricultural sector. Moreover, digital financial inclusion provides services for farmers who are not served by traditional financial institutions, indirectly increasing farmers' income by reducing their credit constraints. With the increase of farmers' income, part of the income is invested in agriculture, thus improving the level of agricultural mechanization in the agricultural sector. In summary, the development of digital financial inclusion improves the agricultural mechanization level by increasing fixed assets investment and farmers' income.

4.5 | Differences in the Impact of Digital Financial Inclusion on Agricultural Mechanization across Diverse Terrains and County Positions

The progression of agricultural mechanization at the county level is subject to not only local economic and social development but also the constraints imposed by terrain conditions (Wang & Tian, 2018). Based on the previous analysis, the impact of digital financial inclusion on agricultural mechanization varies depending on the county's geographical location. Hence, it becomes imperative to account for the disparities in terrain and county location when analyzing the influencing factors of agricultural mechanization. This section draws on the research of Wang

and Tian (2018) to categorize counties into plain counties, hilly counties and mountainous counties according to terrain conditions³, and into agricultural counties and industrial counties based on their status as county-level cities⁴. This categorization

is conducive to exploring the differential impact of digital financial inclusion on agricultural mechanization under different terrain conditions and county positioning. The results of the regression analysis are shown in Table 6.

Table 6 Regression Results of Heterogeneity Discussion

Variable	Differences in county terrains			Differences in county positioning	
	Plain county (1)	Hilly county (2)	Mountainous county (3)	Agricultural county (4)	Industrial county (5)
Digital financial inclusion index	0.6989*** (0.0216)	0.4657*** (0.0150)	0.0594*** (0.0012)	0.6539*** (0.0098)	0.4469*** (0.0194)
Control variable	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
County	Yes	Yes	Yes	Yes	Yes
Adjusted pseudo R^2	0.4838	0.3059	0.7456	0.5404	0.5452
Generalized likelihood ratio test	-981.4748	-2,733.8661	-3,062.5978	-6,992.0674	-1,173.6171
Number of observations	5,634	1,806	3,774	2,052	9,162

Note. ***, ** and * represent significance levels of 1%, 5%, and 10%, respectively, with robust standard errors in parentheses.

As shown in columns (1)–(3) of Table 6, the impact of the digital financial inclusion index on the agricultural mechanization level in counties with different terrains is positive and statistically significant at the 1% level. To delve deeper into the differences in the impact of digital financial inclusion on agricultural mechanization across counties with different terrains, this paper attempts to conduct an inter-group difference test. The results show significant inter-group differences in the impact of digital financial inclusion on agricultural mechanization between plain and mountainous counties. Likewise, significant inter-group differences are noted in the impact of digital financial inclusion on

agricultural mechanization between hilly and mountainous counties. However, there is no significant inter-group difference in the impact of digital financial inclusion on agricultural mechanization when comparing plain and hilly counties. In comparison to mountainous counties, digital financial inclusion can improve the agricultural mechanization level in both plain and hilly counties.

- ³ The specific method for dividing plain counties, hilly counties, and mountainous counties is to determine the type of county based on the proportion of plain, hilly, and mountainous areas within the county. To illustrate, consider the case in Juxian County, situated in Rizhao City, Shandong Province. In this county, the mountainous terrain accounts for 13.25%, the hilly area accounts for 61.35%, the plain area encompasses 23.1%, and the low-lying area constitutes 2.3%. Therefore, this paper identifies Juxian County as a hilly county.
- ⁴ In this paper, industrial counties refer to county-level cities, while agricultural counties refer to counties.

As shown in columns (4) and (5) of Table 6, the impact of the digital financial inclusion index on the agricultural mechanization level is positive, and statistically significant at the 1% level for both agricultural and industrial counties. The inter-group difference test shows significant inter-group differences in the impact of digital financial inclusion on agricultural mechanization in agricultural and industrial counties, indicating that digital financial inclusion improves the agricultural mechanization level better in agricultural counties than in industrial counties. The development of digital financial inclusion significantly enhances the agricultural mechanization level in agricultural counties, but has little impact on the agricultural mechanization level in industrial counties. This is probably because agricultural counties are dominated by agriculture, while industrial counties are oriented toward industry. Given the higher productivity levels associated with industrial activities, industrial counties tend to allocate the capital resources facilitated by digital financial inclusion primarily to the industrial sector. Consequently, it becomes challenging for the agricultural sector in industrial counties to access the capital resources introduced by digital inclusive finance, resulting in a limited impact on agricultural mechanization. Conversely, in agricultural counties, the industrial sectors have a limited capacity to absorb capital, while more capital resources facilitated by digital financial inclusion are channeled into agricultural activities, leading to an improvement in agricultural mechanization in these counties.

5 Endogeneity Discussion and Robustness Test

5.1 | Endogeneity Discussion

The relationship between digital financial inclusion and agricultural mechanization may be subject to endogenous problems. To tackle this challenge, scholars have employed various instrumental variables such as the spatial distance from Hangzhou (Zhang et al., 2019), the number of historical telephone users (Qian et al., 2020), and the digital financial inclusion index with a one-period lag (Yi & Zhou, 2018). This paper adopts the methodology used in the research conducted by Qian et al. (2020). It leverages both the digital financial inclusion index of prefecture-level cities where the counties are located and the county-level digital financial inclusion index with a one-period lag as instrumental variables for the county-level digital financial inclusion index. This approach aims to mitigate endogeneity concerns in the relationship between digital financial inclusion and agricultural mechanization. To ensure the consistency of analysis, the SARAR model is used in this section, with the results of the regression analysis shown in Table 7.

As shown in Table 7, except in column (8), the impact of instrumental variables on the agricultural mechanization level is positive, and statistically significant at the 1% level, which verifies the robustness of the basic conclusions drawn in this paper. Comparing the estimated coefficients in columns (1)–(4) of Table 7 with those in columns (1) to (4) of Table 3, it is found that all the estimated coefficients of instrumental

Table 7 Regression Results of Endogeneity Discussion

Variable	Instrumental variable: Digital financial inclusion index of prefecture-level cities where the counties are located				Instrumental variable: County-level digital financial inclusion index with one period lag			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Digital financial inclusion index of prefecture-level cities where the counties are located	0.0680*** (0.0009)							
Coverage breadth of the prefecture-level cities where the counties are located		0.0480*** (0.0008)						
Usage depth of the prefecture-level cities where the counties are			0.0762*** (0.0008)					
Digitalization level of the prefecture-level cities where the counties are				0.0017*** (0.0004)				
County-level digital financial inclusion index with a one-period lag					0.0904*** (0.0067)			
County-level coverage breadth with a one-period lag						0.0413*** (0.0075)		
County-level usage depth with a one-period lag							0.0528*** (0.0058)	
County-level digitalization level with a one-period lag								0.0038 (0.0028)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted pseudo R^2	0.5355	0.5346	0.5600	0.3402	0.4556	0.4545	0.2668	0.4175
Generalized likelihood ratio test	-8,320.7968	-8,786.5337	-7,714.9265	-10,387.497	-6,179.0119	-6,094.2905	-6,144.3185	-6,193.4656
Number of observations	11,214	11,214	11,214	11,214	9,345	9,345	9,345	9,345

variables are smaller than those of original variables, indicating an endogeneity in the relationship between digital financial inclusion and agricultural mechanization. When examining the estimated coefficients in columns (5)–(8) of Table 7 in comparison to those in columns (1)–(4) of Table 3, it is found that all the estimated coefficients of instrumental variables are smaller than

those of original variables, indicating that digital financial inclusion not only affects the current level of agricultural mechanization but also the agricultural mechanization level in the lag period.

5.2 | Robustness Test

This section draws on the robustness test methods adopted by Sun and Wang (2021)

to test the robustness of the impact of digital financial inclusion on agricultural mechanization from four aspects.

The first is re-quantifying digital financial inclusion. When discussing the impact of digital financial inclusion on agricultural mechanization earlier, the county-level digital financial inclusion index divided by 100 is adopted as the core explanatory variable. This section attempts to use the natural logarithm of

the digital financial inclusion index as the core explanatory variable to study its impact on agricultural mechanization. As shown in column (1) of Table 8, the natural logarithm of digital financial inclusion has a significantly positive impact on the agricultural mechanization level, which is consistent with the previous results. Thus, the estimated results of the impact of digital financial inclusion on agricultural mechanization are robust.

Table 8 Regression Results of Robustness Test

Variable	Replacing the core explanatory variable (1)	Reconstructing the weight matrix (2)	Replacing the econometric model		Subdividing the regions		
			SAR model (3)	SEM model (4)	Eastern part (5)	Central part (6)	Western part (7)
Natural logarithm of the digital financial inclusion index	1.5117*** (0.0816)						
Digital financial inclusion index		0.6247*** (0.0088)	0.6336*** (0.0089)	0.6300*** (0.0089)	0.4225*** (0.0183)	0.5824*** (0.0118)	0.4536*** (0.0192)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted pseudo R^2	0.3624	0.5287	0.5185	0.5444	0.2281	0.7251	0.5095
Generalized likelihood ratio test	-10,229.636	-8,300.3167	-8,396.5209	-8,334.5071	-1.6960	-3,367.0034	-2,957.4700
Number of observations	11,214	11,214	11,214	11,214	2,964	4,038	4,212

Note. ***, ** and * represent significance levels of 1%, 5%, and 10%, respectively, with robust standard errors in parentheses.

The second is reconstructing the weight matrix. In the previous discussion on the impact of digital financial inclusion on agricultural mechanization, the model used a geographic distance weight matrix. This section attempts to construct a weight matrix based on shared spatial elements. Specifically, if County i and County j share

a common boundary, the weight assigned to County i and County j is set at 1; otherwise, it is designated as 0. As shown in column (2) of Table 8, after reconstructing the weight matrix, digital financial inclusion maintains a significantly positive impact on agricultural mechanization, which is consistent with the previous results. Thus,

the estimated results of the impact of digital financial inclusion on agricultural mechanization are robust.

The third is replacing the econometric model. In the earlier discussion regarding the impact of digital financial inclusion on agricultural mechanization, the SARAR model was used to simultaneously analyze the spatial autoregressive term and error term of digital financial inclusion. However, these two terms may not coexist simultaneously. This section attempts to use the SAR model to analyze the spatial autoregressive term and the SEM model to analyze the spatial error term. As shown in columns (3)–(4) of Table 8, after replacing the econometric model, digital financial inclusion continues to demonstrate a significantly positive impact on agricultural mechanization, which is consistent with the previous results. Thus, the estimated results of the impact of digital financial inclusion on agricultural mechanization are robust.

The fourth is subdividing regions. In the previous discussion on the impact of digital financial inclusion on agricultural mechanization, all counties were considered as a population sample. However, based on the previous empirical analysis, there are significant disparities between different types of counties. This section attempts to divide counties into eastern, central, and western parts to discuss the differences of the impact of digital financial inclusion on agricultural mechanization in different parts. As shown in columns (5)–(7) of Table 8, after subdividing regions, digital financial inclusion has a significantly positive impact on agricultural mechanization in different counties. Thus, the estimated results of

the impact of digital financial inclusion on agricultural mechanization are robust.

6 Conclusions and Policy Implications

The perennial problems such as difficulties in financing, high financing costs, and complexity of financing in agricultural production have led to a lack of agricultural production capital. The scarcity of capital has, in turn, impeded the improvement of the agricultural mechanization level and the high-quality development of agriculture. In the context of rapid digital financial inclusion, enhancing the agricultural mechanization level through digital financial inclusion is an inherent requirement for digital financial inclusion to serve agricultural modernization in the context of the new normal, and an effective path to address the deficit in rural financial supply within the paradigm of dual circulation. Based on the panel data from 1,869 counties in China, this paper adopts the SARAR model to analyze the equilibrium effect, disequilibrium effect, and the underlying mechanism through which digital financial inclusion affects agricultural mechanization. The following conclusions are derived.

First, both digital financial inclusion and agricultural mechanization lead spatial spillover effects. Specifically, the development of digital financial inclusion and agricultural mechanization at the county level influences the digital financial inclusion and agricultural mechanization level in neighboring counties.

Second, the improvement of digital financial inclusion and its various dimensions enhance the agricultural mechanization level. Nevertheless, the impact of digital financial inclusion on agricultural mechanization will be overestimated without accounting for the local agricultural economic development status.

Third, the impact of digital financial inclusion on agricultural mechanization is imbalanced. Compared with agricultural counties, digital financial inclusion improves the agricultural mechanization level in counties with backward agriculture.

Fourth, digital financial inclusion directly promotes agricultural mechanization and fosters it indirectly by raising farmers' incomes and promoting fixed asset investment.

Fifth, digital financial inclusion better promotes the agricultural mechanization level in agricultural counties and plain counties.

In the context of comprehensively promoting rural revitalization, the conclusions drawn from this study provide the following policy implications.

First, agricultural mechanization should be promoted through the development of digital financial inclusion, which is a new path. Efforts should be made to enhance the ability of digital financial inclusion to serve the agricultural and rural sectors. Counties with developed agriculture should be supported to accelerate the development of digital financial inclusion service models in line with agricultural economic development and rural characteristics. Meanwhile,

caution exercised to prevent excessive leveraging in the agricultural sector should also be avoided when promoting agricultural mechanization through digital financial inclusion.

Second, different regions should tailor their approaches to the development of digital financial inclusion. Due to significant differences in its impact on agricultural mechanization in different regions, resource endowment, agricultural economic development level, and county positioning should be considered when taking appropriate approaches to enhancing agricultural mechanization through digital financial inclusion. Meanwhile, corresponding measures should be taken to avoid the "digital divide" caused by the development of digital financial inclusion in agricultural mechanization.

Third, regional cooperation on digital financial inclusion and agricultural mechanization should be strengthened. Due to the spatial spillover effects of digital financial inclusion and agricultural mechanization, cooperation between different counties should be strengthened to establish an integrated digital economy platform and an agricultural machinery service platform that facilitate resource sharing and the co-construction of inter-regional digital economy development and agricultural machinery services, ultimately improving the level of high-quality agricultural development empowered by the digital economy.

Acknowledgments This paper is supported by "Mechanism and Policy Optimization of Digital Finance on the Release of County Structure Dividends in Shandong Province" (No. 20CSDJ48),

a special project supported by the Shandong Social Science Planning: Digital Shandong Research Project; the "Research on the Impact Mechanism and Optimization Path of High Standard Farmland Construction on Agricultural Land Efficiency" (No. 202102063), a postdoctoral innovation project in Shandong Province; and the "Research on

the Implementation Effect and Mechanism of High Standard Farmland Construction: From the Perspective of Agricultural Land Efficiency" (No. QDSKL2101025), a program supported by the Qingdao Philosophy and Social Science Planning Project.

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