

# Influence Research of Digital Inclusive Finance on Innovation Efficiency of Agricultural Science and Technology in Jiangsu Province

Zhongyuan Tao<sup>1, a</sup>, Xueying Yu<sup>1, b\*</sup>

<sup>1</sup>School of Finance and Economics, Jiangsu University, 212013, Zhenjiang, China

**Abstract:** Based on the balanced panel data of 13 Jiangsu prefecture-level cities from 2011 to 2020, this study utilizes the overall effect model and intermediary effect model to explore the impact of digital inclusive finance on innovation efficiency of agricultural science and technology. It is found that the digital inclusive finance has a positive and direct impact on the innovation efficiency of agricultural science and technology in Jiangsu. By further inspection, the marketization level has a masking effect between digital inclusive finance and innovation efficiency of agricultural science and technology, and urbanization level plays a part intermediary role between them. Concerning the positive effect of digital inclusive finance on agricultural science and technology innovation efficiency, central region, southern region and north region rank first, second and third respectively in Jiangsu province. Finally, the forecast model shows that in Central, Northern and Southern Jiangsu, the improvement of innovation efficiency of agricultural science and technology will benefit from the driving power of digital inclusive finance except Nantong.

## 1. Introduction

With the Reform and Opening up deepening, innovation activities in the agricultural sector have become increasingly active, but still face problems such as uneven allocation of production factors, low levels of economic development and a wide income gap between urban and rural residents, which hinder the sustainable improvement of the innovation efficiency of agricultural science and technology. In recent years, with the development of digital technology and deepening financial changes, digital inclusive finance has been more widely used, with an average annual increase of 29.1% in the Digital Inclusive Finance Index between 2011 and 2020. To further promote agricultural technology innovation and high-quality development, the 14th Five-Year Plan emphasized the important role of digital inclusive finance in leading agricultural technology innovation and accelerating the process of agricultural modernization.

The overall development of digital inclusive finance in Jiangsu Province is relatively good, ranking among the top in China in terms of financial market players, products and services as well as external environment construction. At the same time, the driving effect of science and technology innovation on agricultural development is increasingly prominent. The contribution rate of agricultural science and technology innovation in Jiangsu Province currently reaches 55.7%, exceeding the national average by 8%, but

still lower than 20% in developed countries, and the driving effect of science and technology innovation has yet to be further strengthened. This paper will discuss the direct effect of digital inclusive finance on the innovation efficiency of agricultural science and technology in Jiangsu Province and the indirect effect through the degree of marketization and the level of urbanization, based on the influence mechanism of digital inclusive finance on the innovation efficiency of agricultural science and technology.

## 2. Literature review and research hypothesis

### 2.1. Research on the effects of digital financial inclusion

Regarding the exploration of the effects of digital inclusive finance, scholars such as Arner, Khin and Ozili focused on macro effects such as social well-being, infrastructure development and economic growth observations [1-5]. While in terms of the impact of digital inclusive finance on technological innovation, studies have also focused more on cities, enterprises and manufacturing industries. For example, Li studied the effects of digital inclusive finance on enterprise innovation in China from an inclusive perspective [4] and Pan explored the effects of digital inclusive finance in enhancing innovation in cities [5]. In general, there is a

\* Corresponding author: [helenxy17175196@163.com](mailto:helenxy17175196@163.com)

<sup>a</sup>[tzy@ujs.edu.cn](mailto:tzy@ujs.edu.cn)

relatively lack of research on the effect of agricultural technology innovation involving digital financial inclusion.

## 2.2. Research on the evaluation of the innovation efficiency of agricultural science and technology

Research on the evaluation of the innovation efficiency of agricultural science and technology has been the focus of academic discussion. For example, Du and Zhao analyzed the innovation efficiency of agricultural science and technology in China using the DEA model and SFA model respectively [6,7]. Xiao and Chen measured the innovation efficiency of agricultural science and technology in Anhui Province and Henan Province, respectively, using DEA models [8,9]. Most domestic scholars evaluate the innovation efficiency of agricultural science and technology from two dimensions: innovation input and innovation output, but there is not yet complete agreement on the selection of specific measurement indicators. Based on the relevant literature, most of them choose the number of scientific researchers and research input funds as agricultural innovation input indicators [7-9], and the number of agricultural patents [8] and agricultural value added [10] as agricultural innovation output indicators. Regarding the evaluation methods, domestic and foreign scholars mostly use statistical regression analysis, data envelopment analysis (DEA), stochastic frontier analysis (SFA), and the method of assigning weights to quantitative evaluation of science and technology innovation efficiency. The DEA method is the most widely used method in evaluation of agricultural science and technology innovation efficiency, as it can compare and evaluate multiple decision units at the same time but does not require any prior processing of the scale and construction of functional forms, thus effectively avoiding subjectivity.

## 2.3. Mechanisms of how digital inclusive finance influences the innovation efficiency of agricultural science and technology

Digital inclusive finance significantly improves the efficiency of financial services through information technology and digital product innovation, empowers disadvantaged groups, helps to stimulate the research and development of agricultural innovation subjects, and has an important impact on the innovation efficiency of agricultural science and technology. Specifically, digital inclusive finance improves the availability of funds for agricultural SMEs and farmers, and promotes the popularization and low cost of financial services. As digital inclusive finance has the characteristics of convenience, wide coverage and commercial sustainability, it meets the characteristics of frequent innovation activities and small capital needs of SMEs, and can effectively alleviate the financing difficulties faced by agricultural SMEs and farmers in science and technology innovation. Secondly, digital inclusive finance can break through the limitations of time and space, use digital technology and the Internet as a carrier to optimize the

flow of savings and credit products and services and simplify payment procedures. Accordingly, digital inclusive finance saves time and transaction costs in accessing funds and effectively meets the capital needs of agricultural SMEs and farmers, especially during the special period of the COVID-19. Thirdly, digital inclusive finance can help farmers with weak financial risk identification skills to avoid financial risks, thus stimulating their innovation momentum. In recent years, the digital economy has strengthened the roots of financial inclusion, enhanced the transparency of financial market operations, effectively discouraged risks such as financial fraud, and stimulated agricultural SMEs and farmers to carry out innovative activities with the support of digital inclusive finance (see Figure 1). Accordingly, this paper proposes research hypothesis 1: digital inclusive finance directly contributes to the innovation efficiency of agricultural science and technology.

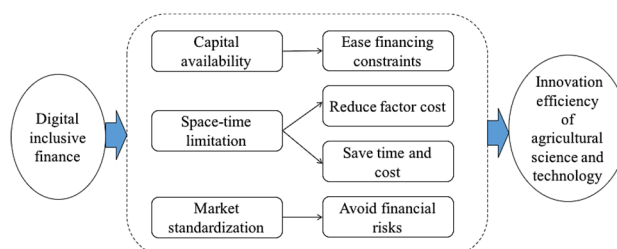


Figure 1. Mechanisms of how digital inclusive finance influences the innovation efficiency of agricultural science and technology

## 2.4. Intermediary effects of marketization, urbanization

The rapid development of digital inclusive finance can optimize the structure of capital supply, expand the scale of capital supply, help agricultural SMEs and farmers break the dilemma of difficult and expensive financing, stimulate innovation momentum and consumption potential, promote the cross-domain flow of technology, services and commodities, and promote a further increase in the level of marketization. The increased level of marketization strengthens the mobility of factors, which can provide a good external environment to support the flow of innovation factors into agriculture and the stimulation of innovation dynamics of researchers, promote healthy competition in agricultural science and technology innovation, and help strengthen the efficiency orientation of agricultural innovation activities as well as the quality assurance of innovation results. Accordingly, this paper proposes research hypothesis 2: digital inclusive finance contributes to the improvement of the innovation efficiency of agricultural science and technology by promoting the process of marketization.

Under the support of digital inclusive finance's advanced digital technology and complex big data risk control models, financial institutions can identify loan risks accurately, expand the scale of credit and improve the efficiency of financial services, which in return bring about financial security and efficiency to support the funds needed for urbanization. At the same time, digital

inclusive finance, with its long-tail effect, can provide agricultural SMEs and farmers with timely and appropriate financial products and services at a lower cost, alleviating their financial troubles in entering the ranks of urbanization. Under the continuous promotion of urbanization, it will boost the inflow of scientific and technological innovations into rural areas, enhance small and medium-sized agricultural enterprises and farmers' sense of awareness and experience of the benefits of agricultural science and technology, and stimulate their enthusiasm for independent innovation. Consequently, it enhances the attraction of rural areas to external resources, and the inflow of advanced educational resources and financial support from cities will help the development of scientific and technological innovation activities. Owing to this, the paper proposes research hypothesis 3: digital inclusive finance promotes the innovation efficiency of agricultural science and technology through increased urbanization.

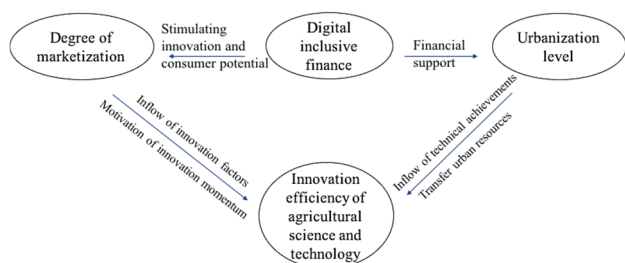


Figure 2. Mediating effects path based on marketization, urbanization

### 3. Model construction and data sources

#### 3.1. Mechanisms of how digital inclusive finance influences the innovation efficiency of agricultural science and technology

With reference to the measurement indicators of related studies [6-13], this paper constructs a system of agricultural science and technology innovation efficiency indicators from two dimensions of input and output (as shown in Table 1), among which the input indicators are not recorded in the available statistics. Thus, the data treatment of the number of agricultural R&D personnel, full-time equivalents of agricultural R&D personnel and

agricultural R&D expenditure is borrowed from Chen and other scholars.<sup>1</sup>

Table 1. Agricultural science and technology innovation efficiency input-output indicator system

Type of indicator	Indicator	Unit
Input indicators	Number of R&D personnel in agricultural science research and development institutions	person
	Full-time equivalents of R&D personnel in agricultural science research and development institutions	man-year
	R&D expenditure of agricultural science research and development institutions	million
Output indicators	Number of agricultural patents granted	Piece
	Number of literature related to innovation in agricultural science and technology	

The results based on the DEA method show that the innovation efficiency of agricultural science and technology in 13 prefecture-level cities in Jiangsu province all show an increasing trend during the period 2011-2020. Among them, Nanjing, Wuxi, Changzhou and Suzhou have already reached the optimal level of 0.9 or above in 2020. Nantong, Yangzhou and Zhenjiang, which are slightly behind the above cities, have already reached an average agricultural science and technology innovation efficiency of 0.827 in 2020. Although Huai'an, Yancheng, Taizhou and Suqian do not have a high starting point in terms of agricultural innovation efficiency, the rate of increase is significant, with an average increase of 3.9% between 2011 and 2020. In contrast, the innovation efficiency of agricultural science and technology in Xuzhou and Lianyungang rose at a smaller rate, with an incremental increase of about 1.5% over the decade. Meanwhile, from 2011 to 2020, the innovation efficiency of agricultural science and technology in all prefecture-level cities in southern Jiangsu province was higher than that in Jiangsu province, while the innovation efficiency of agricultural science and technology in central and northern Jiangsu province was lower than that in Jiangsu province, with the exception of Nantong. Nantong was ahead of Jiangsu Province in agricultural science and technology innovation efficiency until 2014, while it gradually fell behind after 2014 (see Table 2).

Table 2. Output results of agricultural science and technology innovation efficiency in Jiangsu Province from 2011 to 2020

City \ Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Jiangsu	0.687	0.739	0.763	0.773	0.787	0.796	0.804	0.826	0.836	0.843
Nanjing	0.865	0.886	0.923	0.933	0.937	0.951	0.966	0.977	1.000	1.000
Wuxi	0.840	0.884	0.892	0.917	0.953	0.949	0.934	0.94	0.968	0.975
Changzhou	0.754	0.790	0.824	0.823	0.857	0.862	0.848	0.878	0.915	0.936
Xuzhou	0.714	0.735	0.735	0.725	0.696	0.707	0.713	0.739	0.757	0.774
Suzhou	0.855	0.938	0.972	0.969	0.968	0.960	0.966	0.988	0.996	1.000
Nantong	0.766	0.844	0.848	0.805	0.783	0.775	0.809	0.818	0.807	0.821
Lianyungang	0.625	0.677	0.679	0.669	0.676	0.712	0.711	0.713	0.731	0.751

<sup>1</sup> According to Chen et al. [9]: number of agricultural R&D personnel=number of national R&D personnel × (gross agricultural output value / gross output value), Full time equivalent of agricultural R&D personnel=full time equivalent of national R&D personnel × (gross

agricultural output value / gross output value), Agricultural R&D expenditure=national R&D expenditure × (Total agricultural output value / GDP)

Huai'an	0.584	0.609	0.618	0.652	0.708	0.719	0.721	0.722	0.727	0.733
Yancheng	0.536	0.581	0.610	0.631	0.66	0.679	0.726	0.747	0.747	0.747
Yangzhou	0.653	0.694	0.725	0.741	0.768	0.781	0.779	0.795	0.829	0.835
Zhenjiang	0.710	0.759	0.823	0.843	0.838	0.857	0.857	0.875	0.88	0.855
Taizhou	0.578	0.662	0.699	0.729	0.765	0.747	0.779	0.819	0.777	0.786
Suqian	0.452	0.544	0.575	0.613	0.623	0.647	0.644	0.723	0.736	0.748

Data source: Derived from DEAP 2.1 operation.

### 3.2. Model settings

In order to study the impact of digital inclusive finance on the innovation efficiency of agricultural science and technology in Jiangsu Province, and test the mechanism through which digital inclusive finance promotes the efficiency of agricultural science and technology innovation by increased degree of marketization and urbanization, the overall regression model and the mediating effect model are constructed in this paper as shown below.

$$Sci_{it} = \alpha_0 + \alpha_1 Dfi_{it} + \theta X + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

$$M_{it} = \lambda_0 + \lambda_1 Dfi_{it} + \theta X + \gamma_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$Sci_{it} = \beta_0 + \beta_1 Dfi_{it} + \beta_2 M_{it} + \theta X + \gamma_i + \delta_t + \varepsilon_{it} \quad (3)$$

In Equation (1),  $Sci_{it}$  represents the agricultural science and technology innovation efficiency index of the  $i$  prefecture-level city in the  $t$  year;  $Dfi_{it}$  represents digital financial inclusion (composite index) for the  $i$  prefecture-level city in the  $t$  year;  $X$  represents the group of control variables affecting the innovation efficiency of agricultural scientific and technology;  $\gamma_i$  and  $\delta_t$  denoting urban fixed effect and time fixed effect, respectively;  $\varepsilon_{it}$  is a random perturbation term.  $M$  in equations (2) and (3) are mediating variables, and the remaining signs are similar to population regression models.

### 3.3. Variable design and data sources

Based on the previous mechanism analysis, this paper selects innovation efficiency of agricultural science and technology as the explained variable, digital inclusive financial index (composite index) as the core explanatory variable, agricultural productivity development, industrial structure, economic development level and infrastructure construction as the control variables, and marketization degree and urbanization rate as the intermediary variables (see Table 3). In the data collation process, linear interpolation is used to complete the missing values of some variables.

**Table 3.** Name and source of model variables

Variable type	Variable name	Variable symbol	Data source
Explained variable	The innovation efficiency of agricultural science and technology	$Sci$	《Jiangsu Statistical Yearbook》
			China Patent Database and CNKI
Core explanatory variable	Digital financial inclusion (Composite Index)	$Dfi$	Institute of Digital Finance, Peking University

Control variables	Agricultural productivity development	$Pro$	《Jiangsu Statistical Yearbook》
	Industrial structure	$Str$	《China Statistical Yearbook for Regional Economy》
	Economic development level	$Fin$	
	Infrastructure construction	$Inf$	
Intermediary variables	Marketization degree	$Mar$	Fan Gang Marketization Index
	Urbanization rate	$Urb$	State Statistics Bureau

Explained variable: The explained variable in this paper is the innovation efficiency of agricultural science and technology ( $Sci$ ), calculated using data envelopment analysis.

Core explanatory variable: The core explanatory variable in this paper is digital inclusive finance ( $Dfi$ ), which is measured using the Digital Inclusive Finance Composite Index published by the Digital Finance Centre of Peking University [14].

Control variables: This paper focuses on the study of the innovation efficiency of science and technology in the agriculture field, so choose the total annual power of agricultural machinery in each region is used to measure the level of agricultural productivity development, the value added of the primary industry as a proportion of GDP measures the industrial structure, the logarithm of GDP measures the level of economic development; and infrastructure construction is measured by the total area of crops sown in each region.

Intermediary variables: The degree of marketization is reflected by the total marketization process score in the Fan Gang Marketization Index; the urbanization rate is the proportion of resident population to total population.

### 3.4. Descriptive statistics

The calculation results show that the mean value of agricultural science and technology innovation efficiency from 2011 to 2020 is 0.79, and the standard deviation is small, indicating that the difference in agricultural science and technology innovation efficiency among 13 prefecture-level cities in Jiangsu Province is not disparate. In terms of the digital inclusive finance development index, the maximum value is 313.90 and the minimum value is 50.35, indicating that digital inclusive finance in Jiangsu Province has increased significantly in the past ten years and the upward trend is more obvious. The minimum value of the economic development level is 15.36, while the maximum value is 18.81, indicating that the economic development level of Jiangsu Province varies significantly

among prefecture-level cities. The large difference in the extreme values of agricultural productivity development, industrial structure and infrastructure construction reflects

the different endowment of agricultural resources and the importance attached to agricultural development and development orientation of the 13 prefecture-level cities.

**Table 4.** Descriptive statistics

Variable	Symbol	Quantity	Minimum value	Maximum value	Mean	Standard deviation
The innovation efficiency of agricultural science and technology	<i>Sci</i>	130	0.45	1.00	0.79	0.12
Digital financial inclusion (Composite Index)	<i>Dfi</i>	130	50.35	313.90	198.51	73.35
Breadth of digital financial inclusion coverage	<i>Bre</i>	130	48.47	316.84	194.84	71.17
Depth of use of digital inclusive finance	<i>Dep</i>	130	65.15	307.90	200.41	69.20
Digitalization of Digital Inclusive Finance	<i>Dig</i>	130	9.49	325.92	207.21	93.76
Agricultural productivity development	<i>Pro</i>	130	93.24	765.19	365.22	212.71
Industrial structure	<i>Str</i>	130	0.57	11.05	4.056	2.93
Economic development level	<i>Fin</i>	130	15.36	18.81	17.04	0.79
Infrastructure construction	<i>Inf</i>	130	129.80	1472.02	591.33	375.14
Marketization degree	<i>Mar</i>	130	6.99	18.74	13.24	2.64
Urbanization rate	<i>Urb</i>	130	49.80	86.80	65.96	8.39

## 4. Empirical tests and analysis

### 4.1. Overall effect

Based on the estimation results of equation (1), it is proved that digital inclusive finance has a direct effect on the innovation efficiency of agricultural science and technology, and the test results of model (1) to model (5) show that equation (1) itself is robust (see Table 5). Model (1) only introduces the variable of the level of development of digital inclusive finance, while model (2)

adds four control variables of agricultural productivity development, industrial structure, economic development level and infrastructure construction to model (1). Models (3) to (5) add urban fixed effects, time fixed effects and two-way fixed effects in that order. The results of model (5) show that for digital inclusion finance, it rejects the original hypothesis at the 1% significant level, indicating that digital inclusion finance will have a significant positive impact relationship on the innovation efficiency of agricultural science and technology, which will increase by 0.532 percentage points when each 1% increase in digital inclusion finance, which is also consistent with the results of hypothesis 1 above.

**Table 5.** Overall effect model

Variable	(1)	(2)	(3)	(4)	(5)
<i>Dfi</i>	0.518*** (6.85)	0.185*** (5.22)	0.159*** (4.65)	0.539*** (3.08)	0.532*** (3.21)
<i>Pro</i>		-0.111 (-1.37)	-0.067 (-0.86)	-0.072 (-0.88)	-0.025 (-0.32)
<i>Str</i>		-0.238*** (-4.42)	-0.265*** (-5.15)	-0.246*** (-4.61)	-0.274*** (-5.39)
<i>Fin</i>		0.503*** (11.84)	0.549*** (13.05)	0.462*** (9.98)	0.507*** (11.22)

<i>Inf</i>		-0.160** (-2.48)	-0.163*** (-2.66)	-0.163** (-2.56)	-0.166*** (-2.76)
<i>Cons</i>	-0.000 (0.00)	0.001 (0.04)	-0.201*** (-3.40)	0.657* (2.06)	0.487 (1.60)
<i>City</i>	<i>No</i>	<i>No</i>	<i>Yes</i>	<i>No</i>	<i>Yes</i>
<i>Year</i>	<i>No</i>	<i>No</i>	<i>No</i>	<i>Yes</i>	<i>Yes</i>
<i>N</i>	130	130	130	130	130
<i>R</i> <sup>2</sup>	0.268	0.906	0.916	0.909	0.919

Data source: STATA 14.0 operation. Note: T values in parentheses, \*, \*\* and \*\*\* represent coefficients that are significant at 10%, 5%, and 1% confidence levels, respectively, and are the same in the table below.

### 4.2. Robustness test

To further test the robustness of the results, following three evaluation dimensions of digital inclusive finance are introduced and estimated separately in this paper (as shown in Table 6). The results of the robustness test are basically consistent with the regression results in Table 5, and the signs of the coefficients are consistent. Although the depth of use of digital inclusive finance does not significantly affect the innovation efficiency of

agricultural science and technology, the significant positive effects of the breadth of coverage and digitalization of digital inclusive finance on the innovation efficiency of agricultural science and technology still exist, and the coefficient of the breadth of coverage (0.944) is larger than the baseline regression coefficient, indicating that digital inclusive finance has a greater effect on the innovation efficiency of agricultural science and technology in terms of the breadth of coverage, which can expand financial services to remote areas that are difficult to be reached by traditional financial institutions, improve the financial accessibility of agricultural operators, meet their financing needs arising from agricultural science and technology innovation, and help improve the innovation efficiency of agricultural science and technology.

**Table 6.** The test of agricultural science and technology innovation efficiency from various dimensions of digital inclusive finance

<i>Variable</i>	(1)	(2)	(3)	(4)	(5)
<i>Dfi</i>	0.518*** (6.85)	0.185*** (5.22)	0.159*** (4.65)	0.539*** (3.08)	0.532*** (3.21)
<i>Pro</i>		-0.111 (-1.37)	-0.067 (-0.86)	-0.072 (-0.88)	-0.025 (-0.32)
<i>Str</i>		-0.238*** (-4.42)	-0.265*** (-5.15)	-0.246*** (-4.61)	-0.274*** (-5.39)
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<i>Inf</i>		-0.160** (-2.48)	-0.163*** (-2.66)	-0.163** (-2.56)	-0.166*** (-2.76)
<i>Cons</i>	-0.000 (0.00)	0.001 (0.04)	-0.201*** (-3.40)	0.657* (2.06)	0.487 (1.60)
<i>City</i>	<i>No</i>	<i>No</i>	<i>Yes</i>	<i>No</i>	<i>Yes</i>
<i>Year</i>	<i>No</i>	<i>No</i>	<i>No</i>	<i>Yes</i>	<i>Yes</i>
<i>N</i>	130	130	130	130	130
<i>R</i> <sup>2</sup>	0.268	0.906	0.916	0.909	0.919

### 4.3. Heterogeneity test

The calculation of model (9) to model (11) shows that digital inclusive finance has a significant positive effect on the change of agricultural science and technology innovation efficiency in central, southern and northern Jiangsu regions, and the original hypothesis is rejected at 1%, 5% and 10% significant levels, respectively (see

Table 7), thus indicating that the promotion effect of digital inclusive finance on agricultural science and technology innovation efficiency in central Jiangsu region is higher than that in southern and northern Jiangsu regions. However, the promotion effect in northern Jiangsu region appears to be weaker, indicating that digital inclusive finance has a less significant effect on agricultural innovation efficiency improvement generated in regions with weak financial services and innovation bases.

**Table 7.** Heterogeneity test of different locations in Jiangsu Province

Variable	(9)	(10)	(11)
<i>Dfi</i>	0.462** (2.31)	0.996*** (2.95)	0.371* (1.75)
<i>Pro</i>	-0.078 (-0.13)	-4.475*** (-3.58)	-0.220 (-0.88)
<i>Str</i>	-1.020** (-2.51)	0.921* (1.99)	-0.350*** (-6.35)
<i>Fin</i>	0.407*** (3.79)	-0.245 (-0.49)	0.262*** (3.19)
<i>Inf</i>	1.144 (1.36)	2.345** (2.54)	-0.078 (-1.19)
<i>Cons</i>	1.021** (2.18)	0.249 (0.24)	-0.242 (-0.46)
<i>City</i>	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes
<i>N</i>	50	30	50
<i>R</i> <sup>2</sup>	0.901	0.883	0.881

#### 4.4. The intermediary effect test of marketization and urbanization

From the test results of the mediating effect of marketization, the regression coefficient of digital inclusive finance on the degree of marketization is positively significant, indicating that digital financial inclusion has improved the level of marketization development. After the variables of digital financial inclusion and marketization degree are added to the regression model, the regression coefficient of marketization degree is significantly -0.128 (see models (12) and (13) in Table 8). At this point, the mediating effect between the degree of marketization in hypothesis 2 and digital financial inclusion and agricultural innovation efficiency is not valid. The reason may be related to the lack of capital flow deviation under effective supervision in current practice. According to the research method of Wen [15],  $\lambda_1\beta_2$  and  $\alpha_1$  are different signs, so the theory is based on masking effect, and the effect size is  $|\lambda_1\beta_2/\alpha_1| = 27.62\%$ . In other words, when the degree of marketization is controlled and the flow of capital is strictly regulated, the promoting effect of digital financial inclusion on agricultural scientific and technological innovation will be enhanced.

**Table 8.** Intermediary effects model

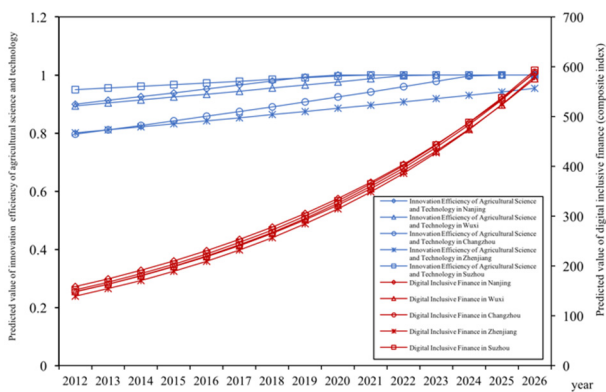
Variable	Marketization		Urbanization	
	(12)	(13)	(14)	(15)
	<i>Mar</i>	<i>Sci</i>	<i>Urb</i>	<i>Sci</i>
<i>Dfi</i>	1.148*** (3.83)	0.521*** (3.28)	2.679*** (10.46)	0.525*** (3.41)
<i>Mar</i>		- 0.128*** (- 3.38)		
<i>Urb</i>				0.323*** (4.51)

<i>Cons</i>	3.855** (2.41)	0.349 (1.18)	4.293*** (8.80)	0.616** (2.16)
<i>Control</i>	Yes	Yes	Yes	Yes
<i>City</i>	Yes	Yes	Yes	Yes
<i>Year</i>	Yes	Yes	Yes	Yes
<i>N</i>	130	130	130	130
<i>R</i> <sup>2</sup>	0.411	0.926	0.570	0.931

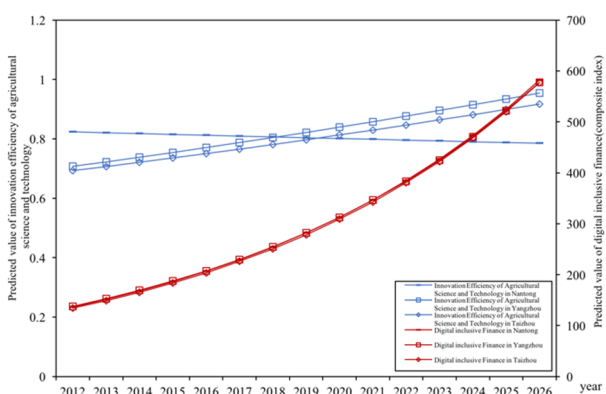
According to the test results of the intermediary effect of urbanization, the regression coefficient of digital inclusive finance on the urbanization rate is positively significant, which indicates that digital inclusive finance raises the level of urbanization. After including both digital inclusive finance and urbanization rate variables in the regression model, the coefficients of both are still significant (see model (14) (15) in Table 8), proving that raising the level of urbanization plays a part in digital inclusive finance promoting agricultural science and technology innovation Hypothesis 3 was verified by the partial mediating effect of increased urbanization in the development of efficiency. The accelerated urbanization process can enhance the close connection between rural and urban areas, promote the flow of urban science and technology resources to rural areas, and enhance the capacity for autonomous innovation in agriculture.

#### 5. Drive prediction

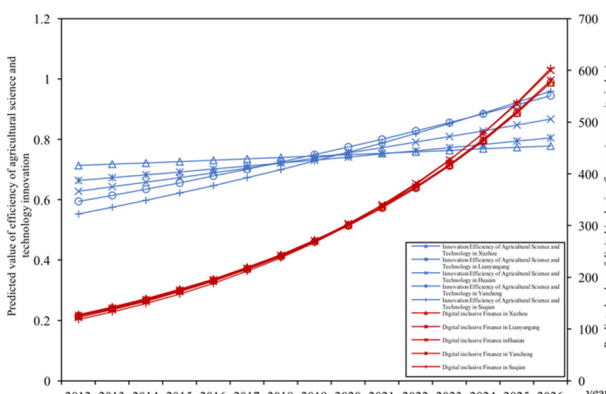
Based on the analysis of the impact mechanism of digital inclusive finance on the innovation efficiency of agricultural science and technology in Jiangsu Province in the previous section, a Grey prediction model GM (1, 1) was constructed by MATLAB statistical software from 2011 to 2020 to simulate the trend of agricultural science and technology innovation efficiency in southern, central and northern Jiangsu Province in the next five years (i.e. 2022-2026) (see Figure 3, Figure 4 and Figure 5).



**Figure 3.** Forecast of innovation efficiency of agricultural science and technology in southern Jiangsu, 2022-2026



**Figure 4.** Forecast of innovation efficiency of agricultural science and technology in central Jiangsu, 2022-2026



**Figure 5.** Forecast of innovation efficiency of agricultural science and technology in northern Jiangsu, 2022-2026

The simulation results show that during 2022-2026, the trend of digital financial inclusion in the 12 prefectures in southern Jiangsu, northern Jiangsu and central Jiangsu, excluding Nantong, which is highly consistent with the trend of agricultural science and technology innovation efficiency, which shows a significant increase in the basic trend. In 2026, Nanjing, Suzhou, Changzhou and Wuxi are all forecast to reach 1 (extreme value), while Yangzhou and Suqian are both forecast to reach 0.95 or above, ranking the top in the central and northern regions respectively.

## 6. Policy recommendations

### (1) Strengthening the promotion and publicity of digital inclusive finance

The development of digital inclusive finance is still at initial stage, and farmers and agricultural SMEs are not strongly aware of it. To solve this, the authority should enhance the layout of digital inclusive finance business outlets, the construction of modern information infrastructure in rural areas across the province, especially in northern Jiangsu, and further increase the coverage rate of outlets as well as the speed of information dissemination. Accordingly, the authority should strengthen the publicity of digital inclusive finance policies and business knowledge, popularize necessary education to enhance the financial literacy of agricultural business entities and improve the utilization efficiency of digital inclusive finance.

### (2) Strengthening the supervision of the flow of digital inclusive finance science and technology credit funds

When the authority increases the proportion of digital inclusive finance credit for agricultural science, technology and relieving the financial bottleneck constraint of agricultural science and technology innovation, it is also necessary to further strengthen the supervision of digital inclusive finance credit projects in order to prevent the erroneous allocation of science and technology credit funds and ensure that the funds are "dedicated". To prevent the erroneous allocation of technology credit funds and to ensure that the funds are used exclusively for the intended purpose, it is necessary to further strengthen the examination and supervision of digital inclusive finance projects and funds. It should also strengthen monitoring during the lending process and verify the true flow of funds by reviewing the vouchers for the use of funds, focusing on the match between the innovative use of credit funds and the client's recent substantive innovative activities; and strengthen post-loan management services and timely management of the settlement of client funds and evaluation of client creditworthiness.

### (3) Increasing the financial support for urbanization by digital inclusive finance

The authority should strengthen the credit support function of digital inclusive finance for rural public goods and services, increase financial support for urbanization infrastructure, the budget for credit funds for modern education, healthcare and information in rural areas. Besides, it is necessary to strengthen subsidized financial support for the introduction of agricultural science and technology talents. At the same time, it is needed to actively explore a joint capital injection model based on digital inclusive finance and developers to further promote high-level urbanization, enhance the attractiveness of rural areas in gathering external resources, promote the flow of more high-quality urban resources, scientific and innovative elements into rural areas and agriculture.



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