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Research on the coupling and coordination of Digital Financial Inclusion and Rural Revitalization

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ABSTRACT

The implementation of the rural revitalization strategy is related to the overall situation of agricultural and rural modernization and socialist modernization. Digital financial inclusion utilizes artificial intelligence, big data, cloud computing and other digital technologies to greatly enhance the availability of financial services. Based on this, this paper calculates the level of rural revitalization and digital financial inclusion in 30 provinces in China from 2013 to 2022, and then measures the coupling coordination degree of the two, analyzes their horizontal characteristics and spatial distribution, and analyzes the influencing factors of the coupling coordination degree. The results show that: First, the level of digital inclusive finance and the level of rural revitalization show an increasing trend year by year. Second, from the perspective of spatial distribution, the coupling coordination degree in eastern region is higher than that in central and western region. Third, the fiscal expenditure on agriculture, the level of agricultural production and the level of science and technology have significantly promoted the coordinated development of both. Therefore, we should vigorously promote the coordinated development of digital inclusive finance and rural revitalization.

KEYWORDS: digital financial inclusion, rural revitalization, coupling coordination degree.

1.INTRODUCTION

A strong country must first strengthen farmers, and only when farmers are strong can the country be strong. Without the modernization of agriculture and rural areas, there can be no modernization of the country. Without the revitalization of the countryside, there will be no great rejuvenation of the Chinese nation. The core goal of rural revitalization is to realize the modernization of agriculture and rural areas, promote the development of rural economy, and increase the income level of farmers.

Finance is the core of the modern economy, and the support of the financial system, especially financial inclusion, is indispensable to winning the battle against poverty and achieving prosperity for the people [1]. Inclusive finance aims to solve the problem of financial support in vulnerable areas such as "agriculture, rural areas" and small, medium and micro enterprises in reality. By providing high-quality and efficient financial services, it helps vulnerable groups to make full use of financial resources, improve their economic capacity and social status, and promote the coordinated development of economy and society [2]. The promotion of rural revitalization requires a large amount of capital investment and financial support, while traditional financial channels are increasingly difficult to meet the diversified, differentiated and long-term financial needs of rural revitalization [3]. Digital inclusive finance makes full use of the advantages of digital technologies such as big data and cloud computing,

and adopts digital means to avoid the financial exclusion and constraint phenomenon in rural areas, which greatly alleviates the imbalance of financial supply and demand in urban and rural areas in China, and provides guarantee for the demand for rural financial services.

Existing literature mainly focuses on the analysis of the impact of digital financial inclusion on rural revitalization (Li Annie and Wang Yong（2024）[4]; Yan Yuhao and Li Wei（2019）[5] ; Xie Di and Su Bo（2021）[6]), starting from the coupling coordination degree of digital financial inclusion and rural revitalization, this paper explores the horizontal distribution and spatial distribution characteristics, and analyzes the factors affecting the synergistic development of digital financial inclusion and rural revitalization, which is of great significance for promoting the synergistic development of the two.

2.THE COUPLING MECHANISM OF DIGITAL FINANCIAL INCLUSION AND RURAL REVITALIZATION

Digital inclusive finance can solve the financing difficulties of agriculture, rural areas and farmers that cannot be solved by traditional finance through digital technology. Risk control technology based on big data can obtain and analyze the credit information data of service objects, alleviate the information asymmetry of rural financial market, and provide more accurate financial services [7]. The core concept of digital inclusive finance lies in "universal" and "benefit". "Universal" means that the service needs to reach a wider audience, while "hui" means that the service should truly benefit the people, especially those rural residents who have been neglected in the past. With digital financial inclusion, rural residents now have access to financial services. They can use the micro-credit provided by financial institutions to support production and business activities, so as to obtain operational income at the same time, they can also use idle funds to purchase inclusive financial products, and further increase their property income. In addition, the financial capital provided by financial institutions in rural areas can strengthen the construction of infrastructure, such as road traffic and communication facilities, which not only helps the growth of township enterprises, but also promotes the innovation and development of rural technology, and ultimately drives the prosperity of the entire rural economy and achieves the grand goal of rural revitalization.

Rural revitalization emphasizes the "hematopoietic" function of finance, rather than the "blood transfusion" function of financial funds. The demand for finance in rural revitalization forces the rural financial market to improve its system from the aspects of building a credit environment and expanding the scope of agricultural and rural collateral, which effectively reduces the default probability of credit entities and reduces the transaction costs and risks of financial institutions doing inclusive finance. Improve the inclusion of financial services of inclusive financial institutions and achieve the dual goals of inclusive and profitable financial services [8]. With the comprehensive development of rural economy and the improvement of farmers' income, farmers' demand for financial services is also increasing, and farmers' financial literacy and awareness of digital inclusive finance are improved, prompting digital inclusive finance to more accurately meet the needs of rural areas and promote its continuous innovation and development.

The in-depth implementation of the rural revitalization strategy has created an unprecedented development space for digital inclusive finance, and the rapid development of digital inclusive finance has further promoted the effective implementation of the rural revitalization strategy. With the comprehensive promotion of rural revitalization, the vitality of the rural market has been fully activated, releasing the huge potential of financial demand, which provides a steady stream of power for the expansion and innovation of digital inclusive finance. By accurately meeting the financial needs of rural areas, digital inclusive finance not only accelerates the process

of rural revitalization, but also improves the penetration rate and coverage of financial services in rural areas, achieving positive interaction and win-win development between the two sides.

3. RESEARCH DESIGN AND METHOD

3.1 Measuring method

In this paper, entropy method is used to calculate each index system. First, the data is standardized. The formula is as follows: positive indicator is shown in equation (1), negative indicator is shown in equation (2).

$$x'_{ij} = \left\{ \frac{x_{ij} - \min(x_{1j}, x_{2j} ..., x_{nj})}{\max(x_{1j}, x_{2j} ..., x_{nj}) - \min(x_{1j}, x_{2j} ..., x_{nj})} \right\} \tag{1}$$

$$x'_{ij} = \left\{ \frac{\max(x_{1j}, x_{2j} ..., x_{nj}) - x_{ij}}{\max(x_{1j}, x_{2j} ..., x_{nj}) - \min(x_{1j}, x_{2j} ..., x_{nj})} \right\} \tag{2}$$

The calculation steps of the entropy method are as follows:

First, calculate the information entropy of an index:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} \sum_{j=1}^{n} x_{ij}} \tag{3}$$

$$E_j = -\frac{1}{\ln m} \sum_{i=1}^{m} p_{ij} \ln p_{ij} \tag{4}$$

Where E_j is the information entropy of the exponential subindex, and x'_{ij} is the normalized matrix element.

Second, calculate the weight:

$$w_{ij} = -\frac{1 - E_j}{\sum_{j=1}^{n} (1 - E_j)} \tag{5}$$

Third, calculate the score:

$$S_i = \sum_{j=1}^{n} w_j x_{ij} \tag{6}$$

3.2 Coupling coordination degree model

Referring to the modification of domestic coupling coordination degree model made by Wang Shujia et.al（2021）[9], the coupling coordination degree model between the two systems is shown in Equation (7).

$$C_{it} = \sqrt{\frac{\lambda_a \lambda_b}{\left(\frac{\lambda_a + \lambda_b}{2} \right)^2}} = \frac{2\sqrt{\lambda_a \lambda_b}}{\lambda_a + \lambda_b} \tag{7}$$

In formula (7), λ_a and λ_b represent the comprehensive evaluation index of digital financial inclusion and rural revitalization. C_{it} indicates the coupling degree in the t year of province i. The value range is [0,1]. In order to better reflect the cooperative relationship between the two, a coupling coordination model is further constructed. The calculation formula is shown in Equation (8) and Equation (9).

$$T_{it} = \alpha\lambda_a + \beta\lambda_b \tag{8}$$

$$D_{it} = \sqrt{C_{it} \times T_{it}} \tag{9}$$

Take $\alpha = \beta = 0.5$, T_{it} is the comprehensive evaluation index calculated by weighted average, D_{it} is the measured coupling coordination degree, and $D_{it} \in [0,1]$, the greater the value of D_{it}, the higher the level of collaboration between the two.

3.3 Index system

As for the indicator system of rural revitalization, this paper refers to the research of Xu Xue and Wang Yongyu (2022) [10] and measures the indicators of rural revitalization from five aspects: industrial prosperity, ecological livability, rural style civilization, effective governance and prosperity based on the availability of data. For the digital financial inclusion index, this paper adopts the digital financial inclusion index compiled by Peking University.

3.4 Data source and description

In view of the continuity and reliability of data acquisition, panel data of 30 provinces (autonomous regions and municipalities directly under the Central Government) in China from 2013 to 2022 are selected in this paper, excluding Hong Kong, Macao and Tibet. These data come from China Statistical Yearbook, China Rural Statistical Yearbook, China Urban and Rural Statistical Yearbook, China Social Statistical Yearbook and provincial statistical yearbook. For the missing data, interpolation method is used for supplementary processing.

4. FEATURE ANALYSIS

4.1Characteristics of the level of rural revitalization in China

Figure 1 shows the average change trend of China's rural revitalization level and five sub-indexes from 2013 to 2022. Through the calculation of the level of rural revitalization, it can be concluded that the overall average of China's rural revitalization level is low, and the average level of 2022 will be 0.376, and there is still a lot of room for improvement. Therefore, China still puts the rural revitalization strategy in the global focus at this stage and constantly promotes agricultural modernization. In addition, the level of rural revitalization has increased year by year. In 2013, the average level of rural revitalization in China was only 0.228. In the development process of 10 years, the level of rural revitalization in China has increased by 65 percent, indicating that the implementation of various policies and the deployment of relevant strategies have effectively promoted rural development. From the five sub-indicators of industrial prosperity, ecological livability, rural culture, effective governance and rich life, except for the effective governance index in 2014 and the industrial prosperity index in 2016, which showed a downward trend in 2016, the remaining indicators showed a year-on-year growth trend from 2013 to 2022.

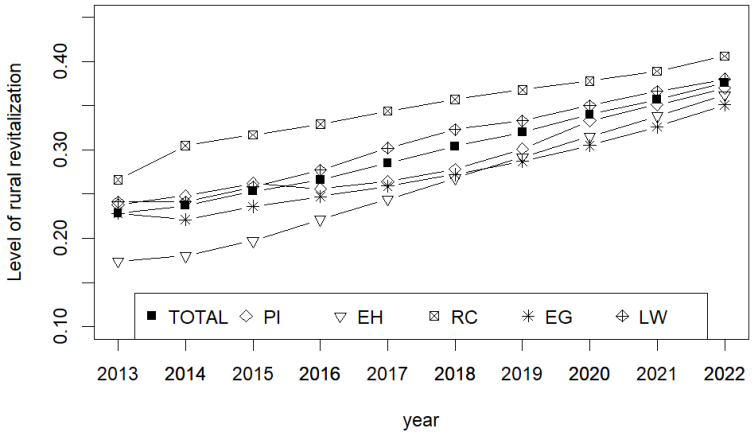

Figure 1. Level of rural revitalization

4.2 Digital financial inclusion level characteristics

Figure 2 shows the average trend of the level of digital financial inclusion in China from 2013 to 2022. It can be seen that the level of digital financial inclusion has shown a steady upward trend, with the national average level of digital financial inclusion being 0.157 in 2013 and rising to 0.381 in 2022, with a growth rate of 1.427 times in ten years. In terms of the level of digital financial inclusion in provinces, only 12 out of 30 provinces in 2013 exceeded the national average level of digital financial inclusion, and by 2022, 14 out of 30 provinces exceeded the national average level of digital financial inclusion, including Beijing, Shanghai and Zhejiang Province, which has been at the national high level of digital financial inclusion. A high level of digital financial inclusion is more conducive to improving social well-being, alleviating financing problems, narrowing the urban-rural income gap, and helping realize rural revitalization.

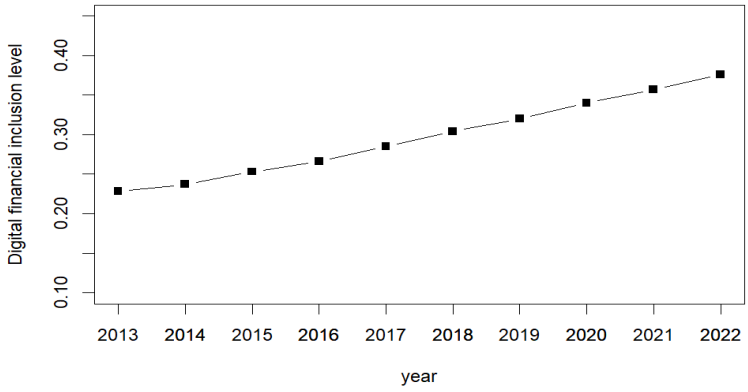

Figure 2. Digital financial inclusion level

4.3 Coupling and coordination analysis of digital inclusive finance and rural revitalization

4.3.1Coupling coordination level characteristics

In this paper, the coupling coordination levels are divided according to Table 1. Figure 3 shows that from 2013 to 2016, the coupling degree between digital financial inclusion and rural revitalization was in the moderately coordinated range. After entering 2017, until 2022, the coupling degree of digital financial inclusion and rural revitalization has entered a highly coordinated range. This shows that with the continuous development of digital technology, big data, artificial intelligence, 5G and other technologies are applied to the development of rural industries, digital inclusive finance provides rural areas with more diversified financial services and more effective financial support, rural infrastructure has been more solid financial guarantee, and effectively promotes the realization of rural revitalization goals.

Table 1. Coupling coordination degree level

	[0,0.20)	[0.20,0.30)	[0.30,0.50)	[0.50,0.80)	[0.80,1]
Coupling coordination level	Forced coordination	Low coordination	Moderate coordination	Highly coordinated	Extreme coordination

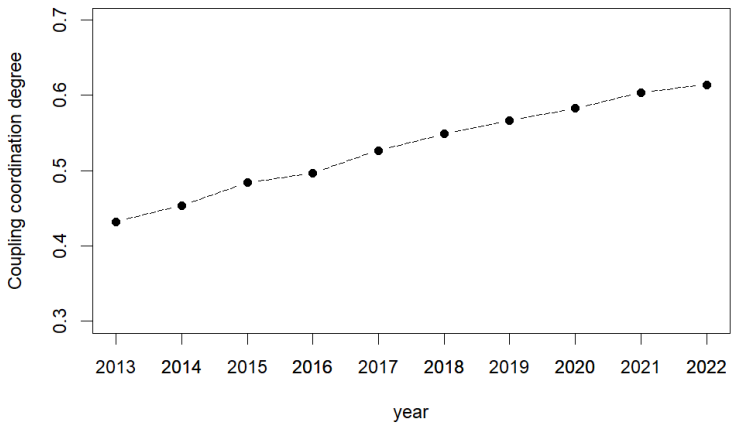

Figure 3. Coupling coordination degree

4.3.2 Spatial characteristics of coupling coordination degree

In order to further study, the coordinated development of digital financial inclusion and rural revitalization in various provinces in China, the coupled coordinated spatial distribution maps of digital financial inclusion and rural revitalization in 2013 and 2022 were drawn respectively.

From a national perspective, the coupling coordination degree of digital financial inclusion and rural revitalization in China's provinces shows a rising trend. The average coupling coordination degree of digital financial inclusion and rural revitalization in 2013 was 0.432, and the average coupling coordination degree of digital financial inclusion and rural revitalization in 2022 was 0.614, an increase of 42%. From the perspective of spatial distribution, the coupling coordination degree has obvious difference in geographical location. The coupling coordination degree between digital financial inclusion and rural revitalization in eastern China is significantly higher than that in central and western China, and this phenomenon is more obvious in the early stage of development. The possible reasons are: the rural revitalization strategy was first proposed in the report of the 19th National Congress of the Communist Party of China. In order to achieve this strategic goal, digital inclusive finance helps rural construction and development with a model different from traditional financial services. The digital economy in the eastern region is developing rapidly, with rich industries and leading digital inclusive finance level, which can better serve rural revitalization, so the relationship between the two is more coordinated. Comparatively speaking, due to the constraints of natural resources and ecological environment, the agricultural production mode in the central and western regions is relatively backward, the strength of agricultural innovation is weak, the level of digitalization is low, and the level of financial services is insufficient, which makes the coordination between the two more difficult. To sum up, in recent years, the synergy between digital financial inclusion and rural revitalization in provinces has been continuously improving, but there is still a large space for development, and it is still necessary to further promote the coordinated development of the two.

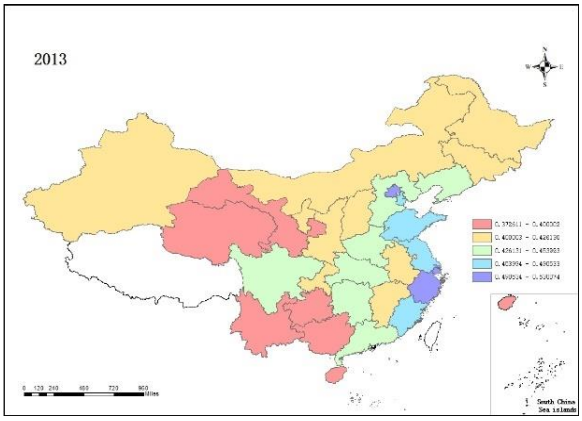

Figure 4. Spatial distribution of coupling coordination in 2013

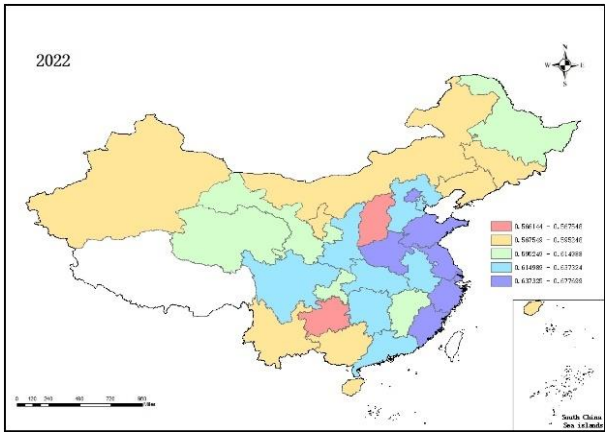

Figure 5. Spatial distribution of coupling coordination in 2022

5. RESULT ANALYSIS

5.1 Model construction and variable selection

In order to examine the factors affecting the coupling and coordination of digital financial inclusion and rural revitalization, the following model is constructed:

$$D_{it} = \beta_0 + \beta_1 gdp_{it} + \beta_2 fae_{it} + \beta_3 apl_{it} + \beta_4 tech_{it} + \beta_5 feg_{it} + \beta_6 ind_{it} + \eta_t + \upsilon_i + \varepsilon_{it} \quad (10)$$

In the equation, β_0 is the intercept term, β_1 to β_6 is the regression coefficient of explanatory variables, η_t represents the fixed effect of years. υ_i represents the province fixed effect. ε_{it} represents the random error term.

The explained variable is the coupling coordination degree of digital financial inclusion and rural revitalization (D). Explanatory variables are: (1) Level of economic development (gdp). Economic development is the basis of rural revitalization, economic development brings more financial and technical support, and promotes the improvement and upgrading of rural infrastructure. Finance is the core of modern economy, and financial development and economic development promote each other. Therefore, the level of regional economic development will affect the coupling level of the two. The logarithm of gross regional product is used to represent. (2) Financial Agricultural Branch (fae). Agriculture and forestry are important parts of rural revitalization, which can not only promote rural development, but also promote the inheritance of rural culture.

It is represented by the proportion of agriculture and forestry expenditure to fiscal expenditure. (3) Agricultural production level (apl). The development of agricultural production has provided a solid material foundation and technical support for rural revitalization. The logarithmic characterization of gross agricultural product was adopted. (4) Technology level(tech). Through the combination of technology and traditional finance, digital inclusive finance has stimulated the huge potential of inclusive finance and promoted the leapfrog development of inclusive finance. Select the proportion of regional science and technology expenditure in fiscal expenditure. (5) Forestry Development (feg). Forestry is the main part of ecological construction and plays a guarantee role in agricultural development. The logarithmic characterization of total forestry output value was adopted. (6) Industrial structure (ind). The development process of a country or region is actually a process of changing industrial structure. The value added of the secondary industry is expressed as a proportion of GDP.

5.2 Analysis of influencing factors

As can be seen from Table 2, the coefficients of fiscal agricultural expenditure, agricultural production level and scientific and technological level are all positive and significant, indicating that fiscal agricultural expenditure, agricultural production level and scientific and technological level have a positive promoting effect on the coupling and coordination of digital inclusive finance and rural revitalization and development. The coefficient of economic development level is positive but not significant, indicating that economic development level has not played a full role in the coupling and coordinated development of digital financial inclusion and rural revitalization. The coefficients of forestry development and industrial structure are both negative and not significant, indicating that forestry development and industrial structure have no obvious inhibiting effect on their coupling and coordinated development.

Table 2. Regression results of the coordinated panel model of digital financial inclusion and rural revitalization

variable	（1）	（2）	（3）	（4）	（5）	（6）
gdp	0.087*** （0.032）	0.096*** （0.027）	0.035 （0.029）	0.014 （0.026）	0.015 （0.026）	0.032 （0.033）
fae		0.156*** （0.053）	0.100** （0.043）	0.126*** （0.040）	0.125*** （0.040）	0.124*** （0.040）
apl			0.083*** （0.019）	0.082*** （0.016）	0.083*** (0.017)	0.083*** （0.018）
tech				0.380** （0.155）	0.381** (0.156)	0.325* (0.163)
feg					-0.003 （0.006）	-0.004 (0.007)
ind						-0.037 (0.045)
N	300	300	300	300	300	300
R^2	0.921	0.936	0.986	0.985	0.984	0.984
Provincial fixed effect	YES	YES	YES	YES	YES	YES
Time-fixed effect	YES	YES	YES	YES	YES	YES

6.CONCLUSION

This paper aims to study the coupling mechanism of digital inclusive finance and rural revitalization, analyze the panel data of 30 provinces in China from 2013 to 2022 by constructing the rural revitalization index system and using the digital inclusive finance index, and calculate the coupling coordination degree of the two for spatiotemporal analysis, drawing the following conclusions:

First, the level of digital financial inclusion and rural revitalization in China from 2013 to 2022 shows an increasing trend year by year, but due to the constraints of geographical location, resource conditions and economic development level, there are certain differences between the level of digital financial inclusion and rural revitalization in different provinces.

Second, from the national level, the coupling coordination degree of digital financial inclusion and rural revitalization in China from 2013 to 2022 shows a rising trend. From the perspective of spatial distribution, there are certain differences in the coupling coordination degree of provinces, among which the coupling coordination degree of eastern region is higher, the coupling coordination degree of central region has been improved to a certain extent during the development process, and the coupling coordination degree of western region is lower. In general, there is still a large room for improvement in the coordinated development of digital inclusive finance and rural revitalization in China.

Third, from the analysis results of influencing factors, the financial and agricultural expenditure, agricultural production level, and scientific and technological level can significantly improve the coupling coordination degree of China's digital inclusive finance and rural revitalization.

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