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Impact of Digital Inclusive Finance on the High-Quality Development of Rural Economy: Evidence from China

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ABSTRACT

Motivated by the need to promote high-quality economic development in rural China, this study examines the impact of Digital Inclusive Finance (DIF) on rural economic development. The problem statement highlights that while rural revitalization is a key priority for the Chinese government, issues related to agriculture, rural areas, and farmers remain challenging. DIF, with its advantages of low threshold, high efficiency, and low cost, emerges as a potential solution to facilitate rural economic growth. The approach adopted in this study involves using panel datasets covering 31 provinces in China from 2011 to 2022. The study employs empirical analysis to examine the relationship between DIF and rural economic development. Specifically, it investigates how DIF contributes to innovation, coordination, green development, openness, and shared prosperity in rural areas. The data used in this study includes various indicators related to rural economic development, such as fiscal expenditure, rural human capital, social security, per capita GDP, and the urban-rural income gap. Additionally, the Peking University DIF Index, which includes coverage breadth index, usage depth index, and digitalization degree index, is used as a proxy variable for DIF. The results indicate that DIF has a significant positive impact on the high-quality development of rural economy in China. The benchmark regression results show that DIF exerts a promoting effect on rural economic development, even after controlling for various factors. Furthermore, the study finds that the impact of DIF varies across different regions, with significant positive effects observed in the eastern, central, and western regions.

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1. Introduction

In the rapidly evolving digital era, DIF has emerged as a novel sector within China's financial industry, transforming the landscape of rural economics in unprecedented ways. Leveraging its low barriers to entry, high efficiency, and cost-effectiveness, DIF offers more convenient, efficient, secure, and reliable services to small and medium-sized enterprises (SMEs) and ordinary consumers. With the advancement of digital technology and digital transformation, it has gradually reshaped the development models of many industries. Inclusive finance not only expands service areas and increases the depth of rural financial services, but it also provides impetus for developing traditional digital inclusive finance (DIF), thus further deepening the breadth and depth of "universal" and "beneficial", and has a particularly far-reaching influence on rural areas. However, a number of issues arise here, such as can the DIF significantly promote rural economic growth? Moreover, can the rapid development of the DIF accelerate the filling of the gaps in financial services for new agricultural business entities and how to enhance regional economic development in various rural areas by virtue of the DIF? In fact, the core of this series of issues is that we should investigate the impact of the DIF on the high-quality development of rural economy, thus formulating efficient and feasible regional development policies based on the degree of influence of various factors. Remarkably, China should seize the important engine of the DIF to accelerate the release of characteristic resource advantages for rural areas and facilitate regional economic growth in rural areas.

This paper aims to delve into how DIF fosters high-quality rural economic development in China and explores its regional disparities. Specifically, we will analyze how DIF facilitates rural regional innovative development by driving rural product innovation and quality transformation, promoting the flow of capital, human resources, and other factors among regions, and fostering the integration of the tertiary industry. Furthermore, we will examine how DIF contributes to rural green development by promoting the transformation of production methods and the development of a circular economy. Additionally, we will investigate how DIF achieves rural shared development by increasing rural residents' incomes and narrowing regional income disparities.

Our key findings reveal that DIF has a significant positive impact on the high-quality development of the rural economy in China. Specifically, through empirical analysis using panel datasets covering 31 provinces from 2011 to 2022, we demonstrate that DIF contributes to innovation, coordination, green development, openness, and shared prosperity in rural areas. The positive effect of DIF is observed even after controlling for various factors, and the impact varies across different regions, with significant positive effects in the eastern, central, and western regions.

The marginal contributions of the paper are as follows. Firstly, traditional theory holds that financial resources tend to flow to economically developed urban areas, while rural areas face financial exclusion. This study points out that DIF has effectively alleviated the financing problems in rural areas through its advantages of low threshold, high efficiency and low cost, and challenged the existing concept of uneven distribution of financial resources. In addition, DIF also promotes the transformation of production methods and the development of circular economy in rural areas, which challenges the limitations of the traditional agricultural economic development model and shows that the rural economy can also achieve green and sustainable development. Secondly, this paper constructs an evaluation index system for the high-quality development of the rural economy from multiple dimensions, and uses empirical methods to verify the significant role of DIF in promoting the high-quality development of the rural economy. This not only enriches the theoretical system of the relationship between digital inclusive finance and rural economy, but also provides new perspectives and methods for subsequent research. Through an in-depth analysis of the mechanism of DIF on the optimization of rural industrial structure, improvement of education level, and growth

of residents' income, this article provides in-depth theoretical support for understanding how DIF promotes high-quality development of the rural economy.

2. Literature Review

The DIF is not only a combination of digital technology and traditional inclusive finance, but also innovates the form of financial products and services, and forms a new development format [1, 2]. The DIF can not only promote high-quality development of regional economy, but also play a vital role in facilitating the high-quality development of regional economy in rural areas [3]. In fact, the academic community has conducted extensive explorations regarding the influence of the DIF on the high-quality development of regional economic at home and abroad, but mainly concentrated on a single level. According to the basic theoretical framework of regional economic development, this article will discuss the connotation of high-quality development from the following five aspects including coordinated, innovative, open, shared, and green development.

2.1. Regarding Innovative Development

Yu et al. and Liu et al. both found that the DIF could alleviate financial exclusion, provide credit support for entrepreneurial enterprises, promote regional economic development, and improve overall innovation levels [4, 5]. Zhao et al. investigated that the innovation incentive effect of the DIF was also reflected in the technological innovation of cities and S&M enterprises. These enterprises enjoy relevant services from inclusive financial system, which can significantly alleviate issues such as funding constraints and financial mismatches. The impact on regional economy in rural areas is not significant [6]. Liang et al. found that the DIF exerted a stronger innovating motivation influence on central and western cities, private and S&M enterprises [7]. Ren et al. discussed that eastern region's DIF mainly promoted regional innovation through channels that improved industrial upgrading, while the DIF in the central and western regions mainly promoted regional innovation through channels that facilitated human capital accumulation [8]. Wang et al. emphasized that the degree of the cou-

pling between the DIF and innovative development was steadily improving in most regions of China, but there are still many provinces at a medium to low level [9]. Therefore, there was still a mass of room for the development in the DIF and innovative development.

2.2. Focusing on Coordinated Development

The DIF performs a positive role in lessening the regional economic development gap. Zhang et al. found that the DIF could reduce the gap in terms of regional economic development via the growth effect of guiding consumption and the inclusive effect of lowering barriers [10]. The DIF also plays a promoting role in promoting coordinated urban-rural development, and high-quality human capital, high-quality public service supply, and the DIF mutually reinforce each other, jointly promoting coordinated urban-rural development [11]. However, some scholars believe that the impact of the DIF on balancing the development between urban and rural areas is not significant, Li et al. investigated that the integration of the DIF and insurance exerted a positive spillover effect on the coordinated development between urban and rural areas [12].

2.3. Concerning Green Development

Zhang et al. observed that the DIF could facilitate the balanced development of environmental protection and regional economy, mainly through improving regional innovation levels, and with the continuous improvement of the level of traditional financial development, it can strengthen the promotion effect of the DIF [13]. He et al. found that the non-linear relationship between the DIF and green agriculture existed, as the threshold of the DIF continued to increase, its effect in promoting the development of green agriculture became increasingly significant [14]. Zhong et al. emphasized that it could also lighten financing constraints and improve urban wealth levels to promote green technology innovation in enterprises [15]. Hui found that the DIF could limit the flow of resources such as labor and capital to highly polluting industries by virtue of accelerating the innovation and cross-integration of financial products, thus improving the scale and operational efficiency of capi-

tal inflows to green sectors, and providing new opportunities for comprehensively improving the green total factor productivity of Chinese cities[16]. However, some scholars believe that the transmission chain between the DIF and green development indicators remains long, resulting in a less remarkable causal relation between the two, and even a negative relationship[17].

2.4. In Terms of Open Development

The academic community generally believes that the DIF promotes the opening-up of China to other countries or regions towards higher quality, mainly by virtue of using digital technology to bring convenience to the payment and settlement of economic entities[18, 19], thereby reducing trade barriers and exchange costs, improving transaction efficiency and transaction scale[20]. Liang et al. found that the DIF can also accelerate the opening and cooperation of financial markets, promote international trade and foreign investment, and solidify the external environmental conditions for regional economic development all over the world[7].

2.5. Looking at Shared Development

Wang et al found that the DIF is beneficial to ensuring social equity and achieving the sharing of financial development achievements by the general public by developing its inclusiveness[9]. Financial inclusiveness is the core attribute of the DIF, which helps to promote inclusive growth shared by all levels, especially vulnerable groups that are usually excluded by traditional financial institutions[21]. Fu et al found that the DIF provides convenient channels for these people to start businesses, increase personal income, borrow small amounts of funds, and achieve credit consumption[22]. Zhou et al thought that the DIF could facilitate the transformation of industrial structure and the upgrading of consumer consumption to enhance the level of regional shared development[23]. Zhang et al also observed that the increasing of the DIF would balance efficiency and fairness, and has a greater impact on increasing income for rural residents than urban residents, thereby reducing the income gap and improving the "sharing level"[24].

2.6. Considering the High-Quality Development

The impact of inclusive finance, particularly digital inclusive finance, on high-quality development is a multidimensional and complex topic. Sun et al point out that digital inclusive finance promotes economic vitality and innovation in rural areas by providing convenient and low-cost financial services, thereby driving high-quality rural economic development. Similarly, other studies have also found that digital inclusive finance helps increase the coverage of financial services in rural areas and reduces financial exclusion, thus promoting comprehensive, coordinated, and sustainable rural economic development[25]. Feng and Wang show that digital inclusive finance promotes agricultural technology innovation and promotion by providing financial support and information services, thereby improving agricultural production efficiency and quality. In addition, digital inclusive finance helps optimize agricultural resource allocation and advances agricultural modernization, thereby enhancing the overall development level of agriculture[26]. Hu finds that digital inclusive finance meets the diversified financial needs of rural residents by providing a variety of financial products and services, improving their financial literacy and risk prevention capabilities. This not only helps improve rural residents' living standards but also promotes social harmony and stability in rural areas[27]. Zhu points out that digital inclusive finance promotes regional economic innovation and coordinated development by improving the convenience and efficiency of financial services. This helps form competitive industrial clusters and regional brands, enhancing the overall strength and competitiveness of the regional economy[28].

Despite numerous studies indicating the positive impact of digital inclusive finance (DIF) on rural regional economic development, these studies lack an in-depth analysis of the inevitability of DIF promoting high-quality rural economic development from the perspective of Marxist theoretical logic. Furthermore, existing research is inadequate in constructing a comprehensive evaluation index system for high-quality rural economic development, particularly lacking a more targeted index system based on the new development paradigm. There-

fore, this paper aims to fill this research gap by constructing a more comprehensive theoretical framework that incorporates the promotional effects of DIF on rural innovation, coordination, green, open, and shared development. Additionally, it analyzes the inevitability of DIF promoting rural economic development using the productivity and production relations perspective of Marxist theory. Specifically, we explore how DIF enhances the innovation capacity of rural areas by providing convenient financial services, lowering the capital thresholds for entrepreneurial enterprises, and promoting technological innovation and industrial upgrading.

3. Theoretical Analysis

The theoretical foundation is built upon the understanding of how DIF impacts the high-quality development of the rural economy. The paper recognizes that despite numerous studies indicating the positive impact of DIF on rural regional economic development, these studies lack an in-depth analysis from the perspective of Marxist theoretical logic and a comprehensive evaluation index system for high-quality rural economic development. Therefore, the paper aims to fill this gap by constructing a more comprehensive theoretical framework.

This theoretical framework is grounded in recently published studies [12, 14–16, 18, 29–32]. It incorporates the mutual movement of productivity and production relations as the fundamental driving force behind economic development, and hypothesizes that DIF promotes high-quality development of the rural economy, which is elaborated in Sections 3.1 and 3.2. The paper further links the dependent variable (high-quality development of the rural economy) and the independent variable (DIF) through theoretical analysis, showing how DIF can alleviate factor mismatches, enhance regional total factor productivity, provide powerful capital and developed techniques for rural entrepreneurship, and improve green production technology and processes. Moreover, the paper proposes a detailed evaluation index system for high-quality development of the rural economy, covering four aspects: innovative development, coordinated development, green development, and open and shared development. This index system serves as a crucial part of

the theoretical framework, allowing for a comprehensive measurement and analysis of the impact of DIF on rural economic development.

3.1. The DIF Is a Crucial Impetus for Accelerating Rural Economic Growth

The mutual movement of productivity and production relations is the fundamental driving force behind economic development. Arabatzis et al discuss the rural regional development in Greece for E-government [29]. Andrea et al research the sustainable rural development and conservation for the economic crisis [30]. Marx and Engels defined productivity as the ability to conquer and transform nature. With the outbreak of the third technological revolution, the rapid development of big data, artificial intelligence, and other new technologies and their applications has profoundly changed the three elements of productivity. People use advanced science and technology for productive labor, forming digital productivity represented by digital technology. In the era of digital economy, workers have mastered a lot of digital technology, acquired digital knowledge and skills, enhanced the ability to transform nature, and improved labor productivity. At this time, the means of labor is the Internet platform, and the object of labor is data. At the same time, the "Long Tail Theory" proposed by American scholar Chris Anderson in 2004 also confirmed the existence of financial exclusion in the field of financial services. For a long time, Chinese financial institutions have tended to focus more on urban residents in the process of providing financial services. However, with the popularization of emerging technologies such as the Internet and big data, the abuse of information asymmetry has been effectively solved, and rural areas and other remote areas have gradually obtained certain financial services. The barriers for farmers to access financial products and services have been rapidly reduced. The huge market formed by this group of people has brought higher profits to financial institutions. This part of the former "non target group" has exerted an increasingly crucial role in the profit composition of financial institutions today. The "long tail theory" has once again verified that the DIF was a momentous impetus for regional economic growth in rural areas.

Owing to the widespread application of technologies related to digital development, the DIF has surmounted the "trilemma" of traditional DIF's development[31]. Firstly, it has expanded the scope of "universal" and added various financial payment services such as online banking and mobile phones, breaking through the limitations of incomplete coverage of traditional offline branches and enabling every entity to enjoy high-quality financial services. Secondly, the DIF deepens the degree of "benefit". Online banking can significantly lessen the labor costs of traditional finance and the maintenance costs of business outlets, allowing financial institutions to obtain higher returns and significantly reduce capital costs, better benefiting the public. Once again, the DIF minimises the risks associated with traditional finance. Due to information asymmetry, many rural and impoverished populations lack credit records, and financial institutions are unable to accurately evaluate their credit qualifications. In the era of digital information, massive amounts of data have solved this problem. Big data analysis can be used to accurately evaluate financiers, and risk assessment models can be constructed based on algorithms to formulate reasonable financial product pricing. This can not only reduce credit costs, but also enable rural entities to obtain fair and efficient credit support. Therefore, the DIF has improved production relations, which is an inevitable result of the contradiction between productivity and production relations, and a significant impetus for facilitating Chinese regional economic growth, especially in rural areas. We can povide the following hypotheses:

Hypotheses 1. *DIF promotes high-quality development of the rural economy.*

3.2. Theoretical Links Between DIF and Rural Economic Development

DIF promotes rural innovation by providing funding for research and development, facilitating the adoption of new technologies, and encouraging entrepreneurial activities[15, 31]. This leads to improved productivity and economic growth. Innovation is the key force to promote the high-quality development of regional economy, particularly in agricultural communities. Bai Qingxian proposed the theory of sustainable financial development in 1998[33], which means that by following the inherent objective laws of financial development, facilitating the allocation efficiency of financial products by virtue of the establishment of a sound financial system, the accumulation of quantity and the qualitative leap of financial development can be achieved. In particular, financial innovation will continue to provide energy for regional economic growth. Mainly reflected in the following aspects: Firstly, the DIF can promote innovation in agricultural products. Big data technology can predict market preferences and scientifically analyze crop sowing and yield. At the same time, rural entities sometimes face the problem of insufficient financial capital supply in entrepreneurship. The integration of inclusive finance and digital technology could ease the information asymmetry problem between financing parties and alleviate the financing constraints of rural entities. Secondly, the DIF can promote innovation in financial services. Due to the reduction of transaction costs for financial systems by virtue of the improvement of the DIF, there has been a significant increase in competition for financial supply, which has led to continuous innovation in financial services and the selection of higher quality funding supply to enter rural areas.

DIF enhances coordination between rural and urban areas, as well as within rural communities, by facilitating the flow of capital, technology, and human resources[18]. This helps to address imbalances in economic development and promote more balanced growth. For the sustainable development of rural areas, coordination is an intrinsic requirement. However, the biggest problem for Chinese regional development presents typical non-equilibrium characteristics, and the lack of coordination between industry and agriculture. Firstly, the DIF serves as a medium for supply and demand, facilitating the flow of inter-regional factors, and optimizing resource allocation efficiency. According to the financial exclusion theory proposed by Leyshon and Thrift[34], vulnerable groups are often hindered in seeking financial services or products. The DIF can greatly expand financing channels, enhance financial accessibility in rural areas, and enable rural individuals to obtain funding and technological support, thereby guiding factor in-

flows and alleviating factor mismatches in rural areas. Secondly, the DIF can enhance regional total factor productivity, particularly in rural areas. Moreover, it also can provide powerful capital and developed technique for rural entrepreneurship, and rural residents can obtain more opportunities to receive education through financial services such as education funds provided by the DIF. Once again, the DIF optimizes the rural industrial structure and promotes the integration of the tertiary industry. Technological innovation can not only promote the intensive development of rural areas[18], but also fully utilize rural characteristic resources to develop tertiary industries such as fruit and vegetable picking and rural cultural experience, helping rural areas shift from a single development model to the multi-industry coordination model, particularly the primary, secondary, and tertiary industries.

DIF supports green development by financing sustainable agriculture practices, promoting resource-efficient technologies, and reducing pollution[14, 16]. This contributes to environmental sustainability and improved quality of life in rural areas. Green is a necessary condition for sustainable development in rural areas. Firstly, the DIF enriches the funding sources of green production technology research and development departments by raising idle funds from society, and helps improve production processes. Technological progress can enhance people's ability to understand and transform nature. Through science and technology, there have been significant improvements in green production techniques, carbon reduction, resource utilization efficiency, and other aspects, leading to the development of a circular economy. Secondly, the DIF can increase rural residents' income. With the increase of personal capital accumulation among rural residents and the cultivation of green production awareness among farmers, rural residents are willing to change their production methods and reduce the intensity of using pesticides and other environmentally polluting products. Xing's research shows that as residents' income increases, their demand for a good environment and green products significantly increases, thereby promoting green technology innovation in enterprises and having a self reinforcing effect[32].

DIF encourages openness and integration with the global economy by facilitating trade and investment in rural areas[12]. This exposes rural economies to new opportunities and markets, leading to increased competitiveness and growth. Openness is the inevitable path to rural revitalization. The DIF can help agricultural products develop online marketing through modern information networks in the sales process, effectively connecting the supply and demand sides. Some banks have launched the "agricultural enterprise finance" model, building a connection channel between their rural products and e-commerce platforms, forming a financial industry chain that combines "online+offline". This model can not only lower trade barriers and transaction costs, but also optimize the information disadvantage situation in rural areas. Local specialty agricultural products can not only go global, but also allow foreign investors to see their product advantages and attract investment. Besides, the DIF will send farm products and services and even agricultural technologies to countries along the "the Belt and Road" by reducing financing costs and facilitating international payment and settlement. Therefore, the DIF has bridged the spatial barriers between rural and urban areas, domestic and international markets, and expanded the development space of rural areas.

DIF promotes shared development by increasing rural residents' income and reducing income disparities[23]. It provides financial access to marginalized populations, enabling them to participate in and benefit from economic growth. Sharing is an essential demand of socialism with Chinese characteristics. Shared development is reflected in rural areas, which means increasing rural residents' income and lessening the interregional income gap. Moreover, the DIF could alleviate the problem of rural areas' financial exclusion and greatly improved the accessibility of rural residents' financial services. In addition, the synergy between digital technology and inclusive finance has resulted in a "1+1>2" effect. Specifically, rural residents can learn about advanced agricultural production technologies, invest and manage finances through the internet, and apply their knowledge to agricultural production, which is conducive to the high efficiency and remarkable development of agricultural sector. Furthermore, the DIF can alleviate the financial constraints in agricultural pro-

duction and reproduction processes. With the continuous improvement of labor productivity, farmers can obtain more labor value, increase their income, and improve their living standards. In short, digital technology has innovated payment methods, inclusive finance has brought diversified investment and financing channels, and its synergy also has achieved inclusive growth for all levels. We can povide the following hypotheses:

Hypotheses 2. *DIF promotes rural economic development.*

4. Research Design and Data Explanation

4.1. The Process and Basis of Variable Selection

4.1.1. Construction of Indicator System for High-Quality Development of Rural Economy

High quality rural development is a comprehensive concept that covers four aspects: agricultural economic development, social living standards, rural sector impact, and infrastructure situation. Among them, agricultural economic development is the foundation, social living standards are the goal, rural environmental impact is the constraint, and infrastructure situation is the guarantee. This article constructs an evaluation index system for high-quality rural economic development from five aspects: innovative development, coordinated development, green development, open development, and shared development (see **Table 1**). Innovation capability measures the ability of rural areas in technological innovation, product development, and other aspects. Specific indicators can include the number of patent applications, the number of high-tech enterprises, and R&D investment. Coordinated development evaluates the degree of coordinated development of the economy, society, and environment in rural areas. Indicators may include the urban-rural income gap, the degree of industrial structure optimization, and investment in environmental protection. Green development reflects the resource conservation and environmental protection situation in the production process of rural areas. Indicators such as energy consumption per ten thousand yuan of GDP, agricultural waste treatment rate, and forest coverage rate. Open development measures the ability of rural areas to establish economic ties and cooperation with the outside world. Indicators can include foreign trade dependence, foreign investment attractiveness, and international tourism revenue. Shared development assesses the improvement of rural residents' income and living standards. Specific indicators include the growth rate of rural residents' income, the coverage rate of education and medical facilities, and the level of social security.

Table 1. Evaluation index system of the high-quality development of rural economy.

Overall Indicators	Level 1 Indicators	Secondary Indicators	Evaluation Indicators	Indicator Interpretation	Units
High-quality development of the rural economy	Innovative development	Foundation of innovation	Level of agricultural mechanization	Total power of agricultural mechanization	Million kilowatts
			Number of scientific and technological innovators	Number of scientific and technological innovators per 10,000 people	Man-year
			Proportion of expenditure on science and technology	Science and technology expenditure/fiscal expenditure	%
		Innovation efficiency	Land productivity	Gross agricultural value/Crop sown area	One hundred million yuan per thousand hectares
	Coordinated development	Agricultural economy	Agricultural industrial structure adjustment index	Total agricultural output/Agriculture, forestry and animal husbandry	%
		Degree of structural coordination	Binary contrast factor	Comparative labor in primary industry	%
		Social life	rural residents' consumption index	Per capita living consumption/Per capita disposable	%

Table 1. *Cont.*

Green development	Resource utilization	Arable land utilization	Crop sown area/Total cultivated area	%
		Agricultural added value (ten thousand Yuan) for water consumption	Agricultural water consumption/Value added of agriculture, forestry, animal husbandry and fishery	100 million cubic meters/100 million yuan
		10 million yuan of agricultural added value electricity consumption	Electricity consumption/Value added of agriculture, forestry, animal husbandry and fishery	Billion kilowatt-hours/billion yuan
		Agricultural plastic film use strength	Agricultural plastic film usage/Area of arable land	Tons/thousand hectares
	Environmental impact	Intensity of agricultural fertilizer use	Fertilizer application rate/Total planted area of crops	Tons/thousand hectares
		Intensity of pesticide use	Amount of pesticide applied/Total planted area of crops	Tons/thousand hectares
Open development	Level of open development	Growth rate of fixed asset investment of rural households	Fixed assets of rural households	%
	Level of opening up	Degree of dependence on foreign trade of agricultural products	Total imports and exports of agricultural products/Total output value of the primary industrial sector	%
Shared development	Welfare distribution	Income level of rural residents	Per capita disposable income in rural areas	yuan
		Urban-rural income ratio	Urban disposable income/Rural disposable income	%
		Rural Engel coefficient	per capital annual expenditure for consumption on clothing, food, housing and transportation/per capital annual expenditure for consumption in rural areas	%
		The life richness of rural residents	Per capita rural expenditure on education, culture and entertainment/Per capita consumption expenditure in rural areas	%
		How much rural residents value health care	Per capita rural health care expenditure/Per capita rural consumption expenditure	%

4.1.2. Measures

Being a relatively objective measurement method, the entropy method can effectively avoid the effect of a series of subjective factors in the empirical study. Thus, this paper used the entropy method to comprehensively explore the digital technological development.

Assuming the indicator system includes m provinces, n indicators, and h years, X_{ijt} is the indicator value of the jth indicator for the i-th province in the t-th year.

Standardize and dimensionless the range of each indicator in the indicator system:

Positive indicators to estimate the Equation (1):

$$Z_{ijt} = (X_{ijt} - X_{\min})/(X_{\max} - X_{\min}) \qquad (1)$$

Negative indicator to estimate the Equation (2):

$$Z_{ijt} = (X_{\max} - X_{ijt})/(X_{\max} - X_{\min}) \qquad (2)$$

Where i∈m, j∈n, m = 16, n = 31, and m denotes all indicators, n represents 31 provinces in China. X_{max} and X_{min} denote the maximum and minimum values of the corresponding indicators. Z_{ijt} is the index value after non-dimensionalization.

Normalization of the index to estimate the Equation (3):

$$P_{ijt} = Z_{ijt} / \sum_{t=1}^{h} \sum_{i=1}^{m} Z_{ijt} \qquad (3)$$

Based on the previous formula derivation, the entropy of each index can be obtained as Equation (4):

$$E_j = -k \sum_{\lambda=1}^{h} \sum_{i=1}^{m} P_{ijt} \ln P_{ijt}, \text{ where } k = 1/\ln P_{ijt} \quad (4)$$

Similarly, the redundancy of each indicator's entropy value can be calculated as Equation (5):

$$D_j = 1 - E_j \quad (5)$$

Moreover, the corresponding weight is deduced as Equation (6):

$$W_j = D_j / \sum_{j=1}^{n} D_j \quad (6)$$

Finally, the combined score is inferred as Equation (7):

$$Chqd_{it} = \sum_{i=1}^{n} W_j P_{ijt} \quad (7)$$

4.1.3. Analysis of Measurement Results

This paper adopts the entropy method to estimate the index system for rural economic development, and obtains the comprehensive index covering 31 provinces in mainland China of high-quality rural economic development from 2011 to 2022. In general, the average level of rural economic development is 0.1754. The top three cities with the highest high-quality development of rural economy for the 31 Chinese provinces studied here are Shanghai, Beijing, and Guangdong, which are concentrated in the east and south. The bottom three provinces are Shanxi, Ningxia Hui Autonomous Region, and Xizang Autonomous Region, which are concentrated in the west and middle. The average difference between the regions with the top and the bottom ranking values regarding the level of rural economic development is nearly 0.3173, indicating significant differences in the quality of rural economic development among provinces (See **Table 2**).

4.1.4. Core Explaining Variable

Obviously, the core explaining variable is the DIF. In this paper, the Peking University DIF Index including coverage breadth index, usage depth index, and digitalization degree index is used as a proxy variable so as to ensure the objectivity and authenticity of the datasets studied here. Coverage breadth measures the extent of

digital inclusive financial services' coverage in rural areas. Indicators include the number of mobile payment accounts per 10,000 people, the number of internet insurance policyholders. Usage depth evaluates the degree to which rural residents utilize digital inclusive financial services. Specific indicators can include mobile payment transaction volumes, online lending amounts, and the scale of internet wealth management. Digitization level reflects the level of intelligence and convenience of digital inclusive financial services in rural areas. Indicators such as the coverage rate of intelligent customer service systems and the degree of blockchain technology application. Generally, the higher the value, the larger the development level of the DIF in the corresponding region.

4.1.5. Control Variables

In order to accurately and objectively examine the effect of the DIF on rural economic development, this article refers to existing researches and selects the following five explanatory variables, namely, per capita regional GDP represents regional economic development level (popularly abbreviated Pgdp). The percentage of general fiscal expenditure of each provincial government compared with total GDP denotes the level of fiscal expenditure (Fex). Social security level (Sse), expressed as the ratio of local fiscal social security and employment expenditures to GDP in each province. Besides, the income gap (Uri) is denoted by the percentage of per capita total urban residential disposable income compared with the corresponding rural residents' disposable income. In addition, the rural residents' average schooling describes the human capital level in the corresponding rural areas (Edu). It should be noted that the average years of schooling of residents are calculated as follows Equation (8):

Edu = (P1*0+P2*6+P3*9+P4*12+P5*16)/P7   (8)

Where P1, P2, P3, P4, and P5 denote the number of residents who have not attended school, the number of residents who have attended primary school, the number of residents who have attended junior school, the number of residents who have attended high school, and the number of residents who have attended college graduates and above. P6 represents total rural population aged 6 years and above.

Table 2. shows the index regarding rural economic development for 31 provinces in China.

Province	2011	Rankings	2022	Rankings	2011–2022	Ranking
Beijing	0.2779	1	0.5583	2	0.3824	2
Tianjin	0.1790	7	0.2223	13	0.2005	9
Hebei	0.1664	9	0.2011	14	0.1793	11
Shanxi	0.0944	27	0.1049	30	0.1034	28
Inner Mongolia Autonomous Region	0.1117	21	0.1262	24	0.1199	24
Liaoning	0.1433	13	0.1460	21	0.1452	17
Jilin	0.1016	24	0.1186	25	0.1163	25
Heilongjiang	0.1204	18	0.1513	19	0.1423	18
Shanghai	0.2740	2	0.5657	1	0.3925	1
Jiangsu	0.2210	5	0.3424	5	0.2792	4
Zhejiang	0.2055	6	0.3499	4	0.2701	5
Anhui	0.1553	11	0.2540	8	0.1996	10
Fujian	0.1649	10	0.2569	7	0.2041	7
Jiangxi	0.1233	17	0.1907	15	0.1488	16
Shandong	0.2251	4	0.2924	6	0.2489	6
Henan	0.1734	8	0.2444	9	0.2024	8
Hubei	0.1390	14	0.2302	11	0.1770	13
Hunan	0.1486	12	0.2395	10	0.1789	12
Guangdong	0.2256	3	0.3939	3	0.3085	3
Guangxi Zhuang Autonomous Region	0.1147	19	0.1708	17	0.1415	19
Hainan	0.1356	15	0.2224	12	0.1643	14
Chongqing Municipality	0.0909	28	0.1556	18	0.1218	21
Sichuan	0.1306	16	0.1755	16	0.1491	15
Guizhou	0.1056	23	0.1414	22	0.1210	22
Yunnan	0.1103	22	0.1344	23	0.1206	23
Tibet Autonomous Region	0.0700	31	0.0899	31	0.0752	31
Shaanxi	0.1125	20	0.1480	20	0.1246	20
Gansu	0.0867	29	0.1121	27	0.0980	30
Qinghai	0.0950	26	0.1070	29	0.1056	27
Ningxia Hui Autonomous Region	0.0811	30	0.1110	28	0.1024	29
Xinjiang Uygur Autonomous Region	0.0987	25	0.1169	26	0.1129	26
Mean	0.1446		0.2153		0.1754	

From a macro perspective, regional economic development and fiscal expenditure directly affects financial development in a region, while other indicators such as social security, residents' income level, and years of education will affect the level of economic growth in that region. Therefore, in rural areas with high levels of economic development and residents' income, their advantages can attract more financial resources to flow in, which will improve the situation of financial exclusion in the region. Therefore, the high-quality development of rural economy will be affected by these factors.

4.2. Data Source and Descriptive Statistical Analysis

The relevant data for the DIF comes from the "Peking University DIF Index", and the raw data for measuring other variables comes from the "China Statistical Yearbook", "China Rural Statistical Yearbook", provincial statistical yearbooks, as well as annual government work reports and the website of the National Bureau of Statistics. Notably, these yearbooks contain relevant provincial panel datasets covering 31 regions in Mainland China between 2011 and 2022. The missing data is filled using the linear interpolation method. The total observation of the study is 372. To avoid the influence of heteroscedasticity, this article takes logarithmic processing for some variables, and **Table 3** provides the descriptive statistical characteristics of all variables. The average value of high-quality development of rural economy is 0.1754, with a standard deviation of 0.0862, indicating the remarkable regional difference during the process of rural economic development.

The descriptive statistics presented in **Table 3** offer valuable insights into the data on the impact of DIF

Table 3. Descriptive statistical results of variables.

Variable Name	Variable Abbreviation	Observed Value	Average	Standard Deviation	Minimum	Maximum Value
High-quality development of rural economy	Chqd	372	0.1754	0.0862	0.0643	0.5657
Digital Universal Finance	LnDfi	372	242.88	107.64	16.22	460.69
Digital financial inclusion coverage breadth	LnWid	372	226.01	110.70	1.96	455.93
Depth of digital financial inclusion use	LnDep	372	235.60	107.40	6.76	510.69
Degree of digitization of digital financial inclusion	LnDig	372	311.79	117.83	7.58	467.17
Level of economic development	Pgdp	372	58029.43	30419.28	16024	189988
Fiscal expenditure level	Fex	372	0.2905	0.2054	0.1050	1.3538
Social Security levels	Sse	372	0.0380	0.0220	0.0092	0.1777
Rural-urban income gap	Uri	372	20087.55	6659.87	9317	49269
The level of rural human capital	Edu	372	7.6895	0.8244	3.8038	9.9150

on the high-quality development of the rural economy in China. While the mean and standard deviation provide a basic summary of the data, a deeper discussion can enhance our understanding of how these variables relate to each other and to the hypotheses. The average value of high-quality development of the rural economy (Chqd) is 0.1754, with a standard deviation of 0.0862. This indicates that there is considerable variability in the level of rural economic development across the sample. The minimum value of 0.0643 and maximum value of 0.5657 further highlight the wide range of development levels observed. This variability suggests that different regions may face unique challenges and opportunities in achieving high-quality rural economic development. The average value of the DIF index (Dfi) is 242.88, with a standard deviation of 107.64. This indicates that the level of DIF varies significantly across regions. The range from 16.22 to 460.69 underscores the vast differences in the adoption and implementation of DIF across China. The components of DIF, including coverage breadth (Wid), depth of use (Dep), and degree of digitization (Dig), also show substantial variability. The standard deviations for these variables (110.70, 107.40, and 117.83, respectively) suggest that regions differ greatly in terms of their access to and utilization of digital financial services. The average per capita GDP (Pgdp) is 58,029.43 yuan, with a standard deviation of 30,419.28 yuan. This indicates that there are significant economic disparities among the regions studied. The fiscal expenditure level (Fex) has an average value of 0.2905 and a standard deviation of 0.2054, suggesting that government spending also varies considerably across regions. The social security levels (Sse) show relatively low average expendi-

ture (0.0380) with a standard deviation of 0.0220, indicating limited but variable investment in social welfare programs. The rural-urban income gap (Uri) has an average value of 20,087.55 yuan, with a significant standard deviation of 6,659.87 yuan. This indicates that income disparities between rural and urban areas are substantial and vary widely across regions. The level of rural human capital (Edu), measured in years of education, has an average of 7.6895 years, with a standard deviation of 0.8244. This suggests that while there is some variation in educational attainment among rural residents, overall education levels are relatively consistent across regions. The variability observed in the descriptive statistics is crucial for contextualizing the study's findings. For example, the significant positive impact of DIF on rural economic development (as indicated by the regression results) is likely to be more pronounced in regions with lower baseline levels of development (i.e., those with lower Chqd values). Similarly, regions with higher levels of DIF (as indicated by higher Dfi, Wid, Dep, and Dig values) may experience greater benefits from digital financial inclusion, further accelerating their economic growth.

4.3. Measurement Model

$$\text{Ch}qd_{it} = a_0 + a_1 LnDfi + a_c Control_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (9)$$

where $\text{Ch}qd_{it}$ denotes the level of the high-quality development of rural economy for the i-th province in the t-th year; $LnDfi_{it}$ represents the level of the DIF's development in the i-th province in the t-th year; $Control_{it}$ represents the control variable; μ_i denotes the fixed effect of provinces; δ_t is the time fixed effect; ε means the er-

ror term. We Use the linear regression method in Stata software to estimate the Equation (9).

5. Empirical Analysis and Discussions

5.1. Benchmark Regression Analysis

The benchmark regression results indicate that DIF exerts a significant promoting impact on rural economic high-quality development in China and prove that Hypothesis 1 and 2 are correct. The DIF positively correlates with the high-quality development of the rural economy. This finding suggests that DIF, with its low threshold, high efficiency, and low-cost advantages, contributes to improving agricultural economic development, social living standards, and other aspects of rural development. **Table 4** presents the relevant estimated results based on the Equation (1). Overall, based on double fixed effects that consider time and space model, the DIF (Dfi) was only introduced as the control variable in Column (1). Obviously, without adding control variables, the results show that the regression coefficient of the DIF on the Quality Development Index of Rural Economy (Chqd) is significantly positive, indicating that the development of the DIF can motivate the quality of economic development. While a series of control variables are introduced in Column (2), our results reveal that the DIF's coefficient remains positive and has passed the 1% statistical significance test. These results indicate that the DIF can effectively facilitate rural economic growth in China. Furthermore, according to the estimated results given in the mentioned above, the levels of fiscal expenditure (Fex) and rural human capital (Edu) in each region exert a significant positive effect on improving rural economic development. In other words, the higher the overall level of fiscal expenditure in each region, the greater the investment in infrastructure construction such as transportation and communication. The higher the level of agricultural modernization, the more conducive it is to promoting the development of rural economy and the improvement of productivity. Therefore, the stronger the promotion effect on rural development; The higher the education level of farmers in a region, the greater the promotion effect on the basic infrastructure construc-

tion and foreign investment introduction in that area. Effective financial support is conducive to driving rural economic development. The positive impact of social security level (Sse) on the high-quality development of rural economy is not significant, but it shows a positive significance in the inclusive finance's digitalization, indicating that social security can improve people's lives to a certain extent and promote the digital development of the DIF. However, if the level of social security is too high, it will enhance enterprises' and individuals' burden, lighten market vitality and efficiency, and thus cannot promote the improvement of rural economic quality and efficiency. The urban-rural income gap (Uri) exerts a certain significant effect on rural economic high-quality development in China, indicating that as the income gap increases, the high-quality development of rural economy in China would be affected to some extent.

Columns (3), (4), and (5) in Table 4 all exhibit the impacts of different dimensions of the DIF on the high-quality development of rural economy in China. Overall, the effects of different dimensions of the DIF on rural economic development vary, while the breadth of coverage (Wid), depth of use (Dep), and degree of digitization (Dig) all have significant positive influences on rural economic development. This means that more rural areas can obtain credit supply, and rural residents can conveniently access financial products and services, which helps to broaden the channels for rural residents to increase income and inject momentum into the high-quality development of rural economy. Especially with the deepening of digitalization, rural areas have increased the use of network resources, increased the popularity of mobile finance and online finance, enlarged the coverage of financial products and services, and further enriched their accessibility.

In real-world terms, the effects of DIF are significant. By improving product innovation and quality in rural areas, DIF contributes to regional innovation and development. It facilitates the inter-regional flow of factors such as capital and human resources, aiding in the integration of the tertiary industry and achieving coordinated rural development. Furthermore, DIF promotes the transformation of production methods and the development of a circular economy, leading to green devel-

Table 4. Results regarding the DIF affecting rural economic development in the benchmark regression model.

Variables	Chqd				
	(1)	(2)	(3)	(4)	(5)
Dfi	0.234 *** (0.0150)	0.215 *** (0.0158)	-	-	-
Wid	-	-	0.0660 ** (0.0276)	-	-
Dep	-	-	-	0.108 *** (0.0087)	-
Dig	-	-	-	-	0.0689 *** (0.0061)
LnPgdp	-	0.0487 ** (0.0231)	00498 * (0.0302)	0.00302 (0.0239)	0.0252 (0.0244)
Fex	-	0.121 ** (0.0480)	0.253 *** (0.0597)	0.177 *** (0.0488)	0.222 *** (0.0496)
Sse	-	0.129 (0.1825)	0.391 * (0.2302)	0.231 (0.1878)	0.515 *** (0.1917)
LnUri	-	0.0587 (0.0366)	0.178 *** (0.0444)	0.0621 (0.0380)	0.147 *** (0.0377)
Edu	-	0.0299 *** (0.0062)	0.0400 *** (0.0076)	0.0271 *** (0.0064)	0.0374 *** (0.0065)
Constant term	0.0509 *** (0.0070)	0.242 (0.3638)	1.395 *** (0.4614)	0.768 ** (0.589)	1.334 *** (0.3694)
Fixed time	YES	YES	YES	YES	YES
Province fixed	YES	YES	YES	YES	YES
N	372	372	372	372	372
adj.R^2	0.209	0.816	0.809	0.79	0.796

Note: *, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with robust standard error in brackets. The same is true below.

opment in rural areas. It also augments rural residents' earnings and helps to lessen the inter-regional income gap, contributing to shared development.

The results of both robustness test and endogeneity test are reported in **Appendix A**.

5.2. Heterogeneity Test

Considering that China's 31 provinces and regions in rural areas have significant differences in economic development, years of schooling and resource endowments, this article divides these 31 provinces studied here into three regions in mainland China, namely, the East, Central, and West region, to further examine the possible inter-regional heterogeneity regarding the effect of the DIF on rural economic development. As shown in **Table 5**, it exerts a markedly positive effect in the eastern, central, and western regions. Moreover, it can be seen that due to the differences in economic development level, infrastructure construction, the income gap, and the impact of threshold effects and digital divide, the difference regarding the impact of the DIF on the high-quality development of rural economy in the eastern, central, and western regions varies. Additionally, although the economic development levels in these three regions are different, for the eastern region, the level of overall economic development remains relatively high, and the agricultural foundation of the central region is more profound, the emergence of the DIF can enable rural subjects to effectively and conveniently access financial services. Although the digital divide prob-

ably exist in rural areas, with the acceleration of digital transformation in various regions, the popularity of digital facilities is also deepening, and farmers are increasingly accepting the use of mobile devices and the Internet. Therefore, the popularity of the DIF would play a strong role in facilitating the high-quality development of regional economy in rural areas, which is consistent with the research results of the impact of the DIF dimensions on high-quality development of rural economy in **Table 4** above.

5.3. Conclusions and Policy Implications

On the basis of in-depth discussion on the mechanism of the DIF promoting the high-quality rural economic development, this article empirically explores the effect and regional heterogeneity of the DIF based on panel datasets covering China's 31 provinces from 2011 to 2022. In general, our results indicate that, first, the DIF can remarkably facilitate the high-quality development of rural economy in rural areas. With its penetrating advantages, the DIF could play an increasingly important role in promoting innovation, coordination, green, openness, and shared development, greatly improving the economic quality and efficiency of rural areas, and providing financial support and digital paths for promoting common prosperity of rural residents. In addition, on basis of dividing the DIF into three dimensions, our results also reveal that the DIF can facilitate regional economic growth. Second, the heterogeneity analysis indicates that, for these three regions in mainland China, the

Table 5. Heterogeneity test regarding the digital financial inclusion affecting rural economic development.

Variable Name	Eastern	Middle Part	West
Dfi	0.239 *** (0.0387)	0.0973 *** (0.0256)	0.0411 *** (0.0131)
Constant term	2.446 * (1.2651)	1.117 ** (0.4842)	0.0728 (0.1944)
Control variables	YES	YES	YES
Fixed time	YES	YES	YES
Province fixed	YES	YES	YES
N	156	72	144
adj.R^2	0.7457	0.8965	0.7510

*, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with robust standard error in brackets.

DIF all exerts a remarkable positive impact on promoting rural economic growth.

Based on the empirical findings and theoretical contributions of this study, several policy implications can be derived to address the identified issues and promote the high-quality development of the rural economy through DIF.

(1) Accelerate Rural Digital Infrastructure Construction

The development of digital infrastructure is crucial for promoting financial inclusion in rural areas. As of December 2022, the Internet penetration rate in rural China was 61.9%, which is 21.2% lower than that in urban areas. To bridge this gap, policymakers should prioritize the construction and upgrading of rural digital infrastructure, including broadband networks, mobile communications, and intelligent financial equipment. This will ensure that rural residents can effectively and conveniently access financial services through digital channels.

(2) Promote the Integration of Urban and Rural Digitalization

To further narrow the digital divide between urban and rural areas, policymakers should promote the integration of urban and rural digitalization. This can be achieved by encouraging the sharing of digital resources and technologies between urban and rural regions, as well as by facilitating the flow of information and knowledge. By doing so, rural areas can leverage the advantages of digital technology to accelerate their economic development.

(3) Strengthen Data Integration and Sharing

Efficient data integration and sharing are essential for the effective implementation of DIF in rural areas. To achieve this, policymakers should establish a unified data platform that supports the development of digital technology in rural regions. This platform should enable seamless data connectivity between different departments, breaking down data barriers and facilitating the sharing of information. This will help in providing comprehensive financial services to rural residents while ensuring data security and privacy.

(4) Enhance Regulatory Systems for DIF

As the application of big data and digital technology increases, rural residents may face certain difficulties and concerns about information security issues and loan risks. To address these concerns, policymakers should strengthen the regulatory systems for DIF in rural areas. This includes establishing clear rules and regulations for digital financial services, ensuring the security of transaction data, and providing protection for rural residents' financial information.

(5) Implement Differentiated Policies for Different Regions

The impact of DIF on the high-quality development of the rural economy varies across different regions due to differences in economic development levels, infrastructure construction, and the income gap. Therefore, policymakers should implement differentiated policies for different regions based on their specific circumstances. For instance, in the eastern region, where the overall economic development level is relatively high, policymakers can focus on promoting innovative financial products and services to further enhance rural economic vitality. In contrast, in the central and western regions, where the agricultural foundation is more profound, policymakers should prioritize improving access to financial services for rural residents and supporting

agricultural development through DIF.

6. Limitations

While this study contributes to the understanding of the impact of DIF on the high-quality development of the rural economy in China, several limitations should be noted.

Firstly, the study uses panel datasets covering 31 provinces in China from 2011 to 2022. While these data provide a comprehensive view of rural economic development across the country, they may not capture all the nuances and variations that exist within each province. Local-level variations in DIF adoption, implementation, and impact could be more pronounced and might not be fully reflected in the provincial-level data.

Secondly, the evaluation indicators used in this study, while comprehensive, may not cover all aspects of high-quality rural economic development. For instance, indicators related to social capital, cultural preservation, and community cohesion, which are crucial for sustainable rural development, are not included in the analysis. The exclusion of these indicators may limit the study's ability to capture the full extent of DIF's impact on rural economic development.

Finally, the study assumes that the impact of DIF on rural economic development is linear and homogeneous across different regions. However, in reality, the impact may be non-linear and influenced by various factors such as local economic conditions, policy environments, and cultural practices. The study's findings may, therefore, have limited generalizability across different contexts and regions.

Author Contributions

Each author of this article has taken on specific roles and responsibilities in the research, and provided intellectual support for the writing of the entire article. Conceptualization, L.Z. and J.T.; Methodology, L.Z. and S.M.F.A.; Validation, L.Z., S.M.F.A. and J.T.; formal analysis, L.Z.; Resources, L.Z.; Data curation, S.M.F.A., L.Z.; Project administration, L.Z. All authors have read and agreed to the published version of the manuscript.

Funding

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The datasets adopted here were obtained from the China National Bureau of Statistics and the CSMAR database. After obtaining permission from the Chinese government, these data can be available at https://www.stats.gov.cn or obtained from the corresponding author. Readers are required to comply with the Chinese government's regulations on the use of publicly available data when applying for data.

Acknowledgments

Conflicts of Interest

The authors declare no conflict of interest.

Appendix A

1. Robustness Test
The benchmark regression results indicate that the

Table A1. Robustness results regarding the DIF affecting rural economic development.

Variable Name	Chqd		
	(1)	(2)	(3)
Dfi	0.136 *** (0.0113)	-	-
L.Dfi	—	0.217 *** (0.0182)	-
LL.Dfi	—	-	0.203 *** (0.0214)
Constant term	−0.32 (0.2275)	0.227 (0.4154)	0.662 (0.4675)
Control variables	YES	YES	YES
Fixed time	YES	YES	YES
Provincial fixation	YES	YES	YES
N	324	341	310
adj.R^2	0.74	0.6453	0.6037

DIF exerts a significant promoting impact on rural economic high-quality development in China. To test the robustness of the benchmark regression results, robustness tests will be conducted from the following two aspects: first, removing major cities. Considering that the economic development of four municipalities such as Beijing, Tianjin, Shanghai, and Chongqing is relatively developed and their financial development level is generally higher than other provinces, which has its particularity, this article refers to the approach of Li Muchen et al.[32] to exclude the data of Beijing, Tianjin, Shanghai, and Chongqing from the original sample and re regress. The results are shown in column (1) of Table A1. Secondly, we replace the explanatory variable here. Specifically, the first-order lagged term (namely, L.lnDfi) and the second-order lagged term (namely, LL. lnDfi) of the DIF are introduced as explanatory variables to conducted the further discussions, and the relevant estimated results are exhibited in columns (2) and (3). We introduced the first-order lagged term and the second-order lagged term of Digital Inclusive Finance (DIF) as explanatory variables, mainly based on the consideration that the impact of DIF on rural economic development may exhibit a certain time lag effect. The development of DIF requires a certain amount of time to penetrate rural areas and influence the local economic structure and production mode. Therefore, the current state of rural economic development may not only be influenced by the current level of DIF but also by the continued influence of past DIF levels. By introducing lagged terms, we can more comprehensively capture the dynamic impact of DIF on rural economic development, thereby making the model more closely aligned with re-

ality. Lagged terms also helps to alleviate potential autocorrelation and multicollinearity issues in the model, enhancing its stability and predictive ability. Through the above robustness tests, it was found that the promotion effect of the DIF on rural economy is still significant, therefore the benchmark regression results have strong robustness.

2. Endogeneity Discussion

In order to solve the endogeneity problem, this paper introduces the relevant instrumental variables and re-estimate the benchmark results based on two-stage least squares method. Endogeneity is a common and crucial issue in economic research. In our study, DIF, serving as the core explanatory variable, may exhibit a bidirectional causal relationship with rural economic development. That is, the development of DIF may drive rural economic growth, while rural economic growth may, in turn, promote the popularization and enhancement of DIF. This bidirectional causal relationship can lead to endogeneity issues, resulting in biased regression results. To address this issue, we introduce instrumental variables. An IV is a variable that is correlated with the endogenous explanatory variable but uncorrelated with the error term. In this paper, we select the first-order and second-order lagged terms of DIF as IVs because they can reflect the historical changes in DIF, are related to the current level of DIF, but are unlikely to be directly influenced by the current state of rural economic development. We also adopt the number of Internet broadband borrowing users as a new instrumental variable to represent the core explanatory variable. Investigating its reason, the popularization and use of the Internet is an essential condition for promoting the DIF, which is

Table A2. Endogeneity test regarding the digital financial inclusion affecting rural economic development.

Variables	(1) L.fi Is an Instrumental Variable	(2) LL.Dfi Is an Instrumental Variable	(3) LnNibau Is the Tool Tariable
Dfi	0.287 *** (0.0247)	0.405 *** (0.0491)	0.402 *** (0.0447)
Anderson canon.corr.LM statistics	189.799	286.288	95.724
Cragg-Donald Wald	369.053	3658.274	126.465
Control variables	YES	YES	YES
Fixed time	YES	YES	YES
Province fixed	YES	YES	YES
N	341	310	372
adj.R^2	0.3357	0.0924	0.1525

*, **, and *** indicate significant at the 10%, 5%, and 1% levels, respectively, with robust standard error in brackets.

closely related to its development. After controlling for other related variables such as fiscal expenditure and rural education level, this article has no other channels of influence on the high-quality development of rural economy. Based on the above analysis, the number of Internet broadband borrowing users can be used as an effective tool variable for the DIF. According to Table A2, after introducing these two endogeneity treatment methods, the DIF still exerts a markedly positive impact on rural economic development. Thus, we can conclude that the benchmark regression results have strong robustness.

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