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Has Digital Village Construction Improved Rural Family Resilience in China? Evidence Based on China Household Finance Survey

Zheng Cai, Shengsheng Li and Di Cheng *

School of Public Administration and Law, Northeast Agricultural University, Harbin 150030, China; tyrealcz@neau.edu.cn (Z.C.); li_shengsheng@yeah.net (S.L.)
* Correspondence: chengdineau@yeah.net

Abstract: The development of digital village construction to improve rural family resilience (RFR) is emerging as a key focus area and target of China's rural revitalization strategy. However, there is limited evidence available on the impacts of digital village construction on RFR measures. This paper aimed to examine the effect and mechanism of digital village construction on rural family resilience based on the micro panel data of the China Household Finance Survey (CHFS) from 2015 to 2019 to empirically test the effect and mechanism of targeted digital village construction on the resilience of rural family. This research also examined the role of farmers' entrepreneurial dynamism in the process. Unlike previous studies, we included family welfare into the measurement framework of RFR. Therefore, RFR was represented by the probability that household welfare exceeds a certain standard. The research found that rural communities quickly transformed from one stable state to another when the external shocks exceeded the threshold of rural resilience. The development of digital village construction can effectively reduce the probability of changing the existing steady state when rural families face shocks. At the national level, farmers' entrepreneurial dynamism had a positive moderating effect on the RFR of the digital village. In the more developed eastern region, digital village construction was relatively advanced and had a significant effect on farmers' income growth. Conversely, the digital village construction in the central, northeastern, and western regions was less developed; moreover, it had a weaker impact than that in the eastern area. Therefore, the regional reality and gap should be fully considered when constructing a digital village.

Keywords: digital village; rural family resilience; farmers' entrepreneurial dynamism; China

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1. Introduction

Social science research on digital village construction exploded over the past decade, with topics ranging from digital countryside and rural revitalization to digital agriculture and rural governance [1,2]. However, rural areas continued to experience significant digital disparities and lags [3–7]. This emphasis increased rural communities' digital marginalization because urban-based conceptions of digital appropriation, empowerment, and politics may not apply to rural settings [8]. As Salemink contended that more place-based studies on digital construction in rural areas were needed to understand how rural communities mobilize to benefit from technology [6]. Previous studies showed that, with China's ongoing popularization of the rural network infrastructure and diffusion of digital technology information dividends, e-commerce and rural-inclusive financial policies provided new references for farmers' entrepreneurial dynamism, injected new impetus into the agricultural industrial organization system and agricultural-development model, and provided new research directions for rural revitalization and decline [9–12].

Owing to the global phenomenon of rural decline, rural resilience has been attracting much academic attention recently [13,14]. Narrow rural community resilience was defined as an area's adaptive ability to maintain its original state when under external attack

from events such as climate change and environmental disasters. Rural communities with high resilience were active and dynamic and can maintain or update their functions by adapting to environmental changes and maintaining a satisfactory standard of living [15]. Low rural resilience can lead to a decline in or even disappearance of rural communities. As the smallest unit of rural society, the rural family engages in multiple functions of farm production and life, which is important in the rural governance system. Scholars believed that rural family resilience (RFR) introduced risks and uncertainties into the analytical framework of family welfare, which dynamically reflected the process of families alleviating poverty or maintaining their nonpoverty status and predicted the families' long-term development in multiple dimensions, provided new ideas for studying and designing a rural digital policy for long-term poverty alleviation [16]. The study on RFR contributed to a resource-based thesis, which highlighted the importance of digital connection in rural economies. Moreover, local players in rural resilience, such as companies and entrepreneurs, contributed to rural diversification [17–20]. Therefore, research on the resilience of rural families deserved attention. However, few scholars have investigated the impact of the construction of a digital village and the farmers' entrepreneurial dynamism on the resilience of rural families [21].

Currently, China is rapidly becoming a world leader in digital village building. Research on the digital village is growing in recent years but lags significantly in its degree of growth. Few studies have focused on the digital village's effect on resilience and its occurrence. As a result, China lacks corresponding theoretical guidance and systematic evaluation and feedback on the construction and development of digital village at a time when the development potential of digital economy is huge. In order to make up for the lack of relevant research, this study built a regression model based on the micro panel data of the China Household Finance Survey (CHFS) in 2015, 2017, and 2019 to empirically test the effect and mechanism of targeted digital village construction on RFR resilience, and examine the role of farmers' entrepreneurial dynamism in the process. It verified the effect of digital village construction on RFR and the role of farmers' entrepreneurial dynamism in this process. Unlike previous studies, we identified the traits of RFR by computing the likelihood of family welfare exceeding a certain threshold. This study expanded on the work by Henderson by evaluating whether digital village construction has improved rural family welfare, its effect on farmers' entrepreneurial dynamism, and the role of inclusive digital finance [22]. Therefore, this study focused on answering these key questions:

- What are the regional differences in digital village construction?
- How does farmers' entrepreneurship involve digital resources?
- How would enhance the digital village impact farmers' welfare?

Thus, this paper is presented as follows. Section 2 presents a literature review on digital village in the context of rural China. Section 3 provides the methodology and explains the rationale behind the quantitative approaches used in this study. Section 4 provides descriptive findings, a regression model, and a balanced panel estimation, followed by a discussion and conclusions intended to stimulate policy proposals for addressing digital village construction concerns.

2. Literature Review and Research Hypothesis

2.1. Family Resilience Theories and the Situation in Rural China

This study developed a research framework for a digital village to improve the resilience of rural families with a focus on conceptual and quantitative resilience studies. However, we must first define resilience. It was not a new concept, as ecologists and psychologists began investigating the meaning and scope of resilience in the 1970s [23–26]. Owing to frequent political conflicts between some developing countries and regions, as well as the impact of the climate, economy, and health, many international relief organizations recognized the problem of regional development in terms of (ex-ante) pressure and (ex-post) impact, and the discussion of resilience expanded from natural systems to social development systems [27,28]. Considerable efforts were made in the past decade

to understand and quantify resilience. Several other studies provided comprehensive reviews of this body of literature. This study adopted the definition of resilience proposed by Barrett and Constas with reference to Amartya Sen's poverty trap theory [29]. This definition stated that RFR was the ability of an individual, household, or other organization to avoid falling into poverty when faced with various stresses or multiple shocks, and it was assumed that the subject recovers after a shock if and only if this ability remains high over time. However, there was no consensus among earlier studies on the definition of this concept.

Generally, in the literature, the conceptualization and measurement of resilience can be classified into three major categories [30]: (1) resilience as a return to equilibrium; (2) resilience as the ability to tolerate negative stresses or shocks; and (3) resilience as a normative condition (i.e., the sustained capacity of an entity to avoid falling below some normative threshold of living standards).

The first category considers that resilience was the actors' ability to ensure that pressure and impact do not have long-term adverse consequences [29,31]. Resilience was viewed as the capacity to adapt, following the development of coping skills by people, families, communities, or other collective entities to reduce the short- or long-term negative repercussions of earlier risk exposure or shocks [29,30]. Typically, resilience, which was often viewed as an integrated ability, required a collection of multidimensional indicators and traits that were believed to capture diverse characteristics and types of capacity [31–34]. Therefore, scholars included resilience analysis in the framework of sustainable livelihoods, considering welfare as a function of five kinds of capital, namely, finance, human, nature, material, and social, to investigate the role of RFR in coping with external shocks [34].

The second category of measuring and demonstrating resilience considered the notion of resilience proposed by Barrett and Costas. This concept of resilience integrated welfare standards, combined the theory of poverty vulnerability and the poverty trap and transformed the problem of poverty from static analysis to dynamic identification. Essentially, it comprehensively viewed family development from three perspectives, pre-prevention, in-process response, and post-recovery; thus, reflecting the families' efforts to avoid falling into poverty. Therefore, research on families' long-term development was often based on this concept [29,35,36]. While these two methods had advantages in conceptualizing and measuring resilience [37,38], they also had obvious drawbacks, particularly in terms of estimating the results of interventions needed to improve resilience. These methods emphasized resilience as a latent variable that amplified or explained variances in how shocks and stressors affected people, rather than as a way of quantifying the effectiveness of resilience-building strategies.

The third category, resilience as a normative condition, added a crucial benchmark and grounded the idea of resilience in normative standards of living, such as poverty thresholds, minimum daily caloric intake, and similar benchmarks. Such benchmarking can ensure that resilience was assessed relative to some useful standards and normative criteria [37]. In terms of index measurement, Cissé and Barrett transformed this concept of resilience into an econometric method and added the nonlinear dynamic analysis path [16]. Through the estimation of conditional expectations and the variance of welfare function, along with a two-parameter distribution hypothesis, resilience was estimated as the conditional probability that meets a certain welfare standard. It did not conceptually link the measure of resilience to the incidence of particular shocks. Therefore, it accurately captured the danger of dropping below a certain threshold than the explicit capacity to respond to a particular shock. However, in a stochastic environment characterized by recurrent shocks, families' ability to meet normative standards over a longer duration was probably highly connected with their resilience to shocks and stresses. This method compensated for the neglect of heteroscedasticity and other nonconstant high-order central moments in poverty-trap-related studies and the neglect of nonlinear expectations when estimating conditional expectations and variance in poverty vulnerability. It can comprehensively describe and predict family development and prospects [16].

Our study followed the conceptualization of resilience proposed by Barrett and Constas and the econometric method proposed by Cissé and Barrett to evaluate the implications of a digital village for rural households' resilience in China [16,29]. However, in studies on China, resilience was not considered a systematic function among most families but rather as family relationships that existed under certain circumstances, such as families with teenagers, families in need of support for their elderly members, and families dealing with health issues [39–42]. Walsh's concept of family resilience considers both static and dynamic aspects of a family's ability to adjust when faced with change and uncertainty, such as the rapid urbanization and emigration [43]. Family members in modern rural China were less likely to address difficulties without consulting one another or considering their resources and dynamics. As rural households had fewer members who can work and earn, they needed more support in saving up for economic and health crises such as unemployment, natural disasters, and expensive medical care [44]. New family structures emerged because of declining birth rates and labor sharing, with members maintaining close relationships with each other through frequent mutual assistance within their social networks, including parents, children, and siblings [45]. Consequently, families prepared better to face economic storms as they had more control over their physical capital, which included their homes and production infrastructure [46]. This showed that the resources, structures, and social relationships within and outside of the family all contributed to the resilience of rural Chinese families [39,45].

2.2. Impacts of Rural Digital Construction on Rural Families in China

Digital technologies, such as the Internet of things, big data, cloud computing, and artificial intelligence, created unprecedented opportunities for global change. While supporting the development of new rural business models, they can effectively accelerate the process of rural digital transformation and improve rural governance efficiency, and China's inclusive growth, especially for rural low-income groups [47]. In this regard, the Chinese government issued the Outline of Digital Village Development Strategy in May 2019, which clearly outlined the goals and overall requirements of digital rural construction and committed to improving the performance of rural revitalization by actively playing out the advantages of modern technology. In May 2020, the Central Cyberspace Office, the Ministry of Agriculture and Rural Affairs, and four other departments of the Chinese government jointly issued the Key Points of Digital Village Development, the further strategic objectives, key measures, and institutional guarantees of digital rural construction. These strategic goals highlighted rural families' ability to access broadband and suggested that "Broadband China" influenced the growth of the rural internet in several ways. First, the policy increased rural access to high-speed internet. The policy was implemented mainly by increasing rural broadband coverage once the required level of urban network coverage has been attained. Rural China's internet penetration rate reached 46.2% by the end of 2020. Compared with the 28.1% penetration level before the "Digital Village Development Strategy," this represented an increase of approximately 20%. Second, the speed with which rural regions can transmit broadband improved. Broadband transmission rates in rural regions had grown from 4 Mbps to 8 Mbps and, finally, to 12 Mbps during the past few years. All rural regions had attained 4 Mbps of internet transmission speed, with most reaching 8 Mbps and some locations reaching 12 Mbps. Therefore, the execution of the digital village program significantly affected the breadth and depth of internet growth in China's rural areas.

After reaching a certain threshold of urban informatization, the digital revolution will spur the development of rural informatization. The degree of informatization helped in the growth of digital finance and to reduce employment information search costs [48,49]. Increased use of the internet was the most obvious indicator of this trend. Farmers can find more work owing to the information asymmetry in the rural labor market enabled by the digital revolution. Additionally, the growth of the digital economy and finance in the region will accelerate alongside the development of the information infrastructure. On one

hand, advancements in digital finance will increase employment opportunities, such as flexible employment for courier delivery workers, takeout and takeaway delivery, and drip drivers. On the other hand, they will also encourage innovation and entrepreneurship by reducing barriers to obtaining capital. The employment landscape will shift because of these two factors: encouragement of innovation and entrepreneurialism and production of new jobs.

However, high levels of aspiration and entrepreneurship did not translate into comparable growth and income levels in rural areas. Rural enterprises frequently failed to collaborate successfully on the challenges they encounter. Thus, how does China fully utilize farmers' entrepreneurial dynamism to increase rural residents' income? Can the RFR be improved by the construction of a digital village? Understanding these problems will not only help further elucidate the relationship between the construction of a digital village and RFR but also provide a theoretical and practical basis for the decision-making and practical aspects of the construction of the digital village and the rural revitalization strategy. This study would be a reference for improving the construction of the digital village; thus, promoting the development of RFR policies and supporting agriculture, rural areas, and farmers to keep pace with social digital development.

2.3. Rural Digital Construction in Farmer Entrepreneurship—Its Role in RFR

Since the mid-1990s, several studies conducted on the topic of digital divide. Salemink comprehensively assessed the literature on rural digital research, considered several problems that arose and persisted over the years, and concluded that everyone needs to access the internet [6]. Furthermore, they supported the claims of Townsend that everyone should have access to high-speed internet and mobile data services [50]. However, they also recognized that rural communities face unique challenges because of digital connectivity issues, which adversely affected the rural economy and their ability to compete. Although these problems were first recognized around the turn of the millennium [51,52], studies showed that these problems still persist [22,53]. According to the resource-based view [54,55], effective resource utilization lent a company its competitive advantage. Barney categorized a company's resources as physical, human, and organizational capital, and the most important material resources include technology and geographic location, and they may be supplemented by online connections [54]. Based on this research, Morone suggested that successful businesses engage in superior technology management [56]. An organization's knowledge base was a valuable human capital asset that was often linked to the pioneering spirit of business owners and provides a strategic edge in the current market [57]. Enterprises located in rural regions had less access to resources, including technology such as digital connections, than their urban counterparts, which implied that conventional knowledge economy cannot function in the countryside. This cast doubt on the rural firms' capacity to face economic storms and uncertainty, as they were less likely to use pertinent resources and show fewer signs of entrepreneurial vigor. However, in an increasingly globalized market, a company's ability to capitalize on valuable, uncommon, unique, or no substitutable resources might be enhanced by access to digital connection resources [54]. This depended on the quality of local digital connections and how well the government policy works to expand people's ability to obtain stable internet service. Accordingly, this study examined how the rise of digital technologies in rural areas affected the entrepreneurial spirit among farmers.

Consistent with the principles of resource-based theory, researchers highlighted the value of access to high-speed internet for rural regions' creative economies and the role of local stakeholders in ensuring stable connectivity. Actors such as local companies aided rural diversification [17,18], and innovative practitioners helped strengthen community resilience [19,20]. Smart farming, which uses technology and big data to create more productive methods and enhance sustainable agricultural operations, was one-way people and the economy can benefit from increased access to the internet in rural areas. Better social involvement within rural areas, such as those in China, had further positive effects [58].

Although rural e-commerce was not only an effective interpretation of "internet plus agriculture" but also an important part of digital rural construction, few empirical studies accurately evaluated the relationship of the digital village with farmer–e-commerce entrepreneurship and the resilience of rural families. Furthermore, limited studies focused on the qualitative description of the importance of the digital village and provided suggestions on how to encourage the construction of a digital village [59–61].

Thus, this study evaluated China's RFR based on the abovementioned theories. Unlike existing studies, this study included family welfare into RFR's evaluation system and calculated the probability that family welfare exceeded a certain threshold determined the characteristics of RFR. This study also explored the moderating relationship between farmers' entrepreneurial dynamism and RFR.

2.4. Research Hypothesis

The digital village strategy can help implement the rural revitalization strategy. In the digital village process, empowering the RFR, popularization of the rural internet, the rise and development of rural e-commerce, and the improvement of the rural-inclusive financial system played vital roles.

The internet laid a solid foundation for the rapid development of China's digital economy. As a representative product of technological progress, popularizing the internet helped in the rapid development of rural economy. Using the internet, farmers broadened their income channels and increased their income from agricultural operation, wage, and property; thus, enhancing RFR [62]. Most farmers had no higher education and worked in the agricultural field almost all their lives. The internet offered them the opportunity to learn how to apply certain technologies, create value, broaden their income channels, and even gain employment in the nonfarming sector. Farmers with entrepreneurial plans benefited from the growth of the internet. Through the internet, farmers can learn more about the relevance of their agricultural products. For example, they can identify which agricultural products consumers are more willing to consume and which agricultural products have higher nutritional value. Using the internet, they can gather more information on agricultural products, continuously improve the quality of their agricultural products, and enhance the competitiveness of these products, expand their sales, and increase their income. Farmers can also obtain important information about agriculture through the internet, access relevant agricultural policies, quickly search for information, reduce the degree of information asymmetry, and reduce agricultural production costs while improving agricultural production efficiency [63].

Therefore, H1a was proposed:

H1a: *Digital village construction enhanced RFR by increasing the rural internet infrastructure.*

The digital village was inseparable from e-commerce empowerment. The rise of e-commerce platforms and live streaming created unprecedented opportunities for developing China's digital village. On the one hand, the rise in e-commerce platforms increased the sale of local rural agricultural products and reduced the losses caused by large inventory backlogs. Online shopping became widely popular among consumers, and rural e-commerce was a promising online marketing model. Consumers can purchase agricultural products through online shopping. Consumers can view all production processes of agricultural products and the stories behind the products, thus increasing the sale of agricultural products. Traditional physical, offline stores cannot perform these functions [64]. On the other hand, some youth lived far away from their hometown, moved to major cities such as Beijing, Shanghai, Guangzhou, and Shenzhen to seek better job opportunities. While gaining business experience, they also bore high living costs; the elderly and children at home were left unattended. With the development of e-commerce platforms and the support of government policies, some youths returned home to start businesses. With unique opportunities and characteristic local advantages, they began to learn the online business model and sell their agricultural products across the country's e-commerce

platforms. Therefore, e-commerce platforms considerably increased the opportunities for entrepreneurship and agricultural products' sales and operating income [65]. Additionally, e-commerce platforms encouraged the development of live streaming. The unemployed in rural areas relied on live streaming and short videos to attract more supporters and traffic income. They can not only publicize rural areas but also increase their income through various key topics related to rural areas. E-commerce opened a new channel through which economic growth can be increased in economically underdeveloped areas [66].

Therefore, H1b was proposed:

H1b: *Digital village construction improved RFR by developing e-commerce platforms.*

The World Bank defined "inclusive finance" as a financial system that provided convenient access to financial services for all sectors and groups of society [67]. Using the theory of entrepreneurship, Banerjee and Newman first established a causal chain linking financial development, entrepreneurship, and income distribution. Subsequently, they showed how an imperfect financial market affects income distribution [68]. Digital inclusive finance was of great significance for building the resilience of rural families. Building a reasonable and effective digital inclusive financial system played a positive role in better implementing agricultural support policies and supporting the effective implementation of the rural revitalization strategy [69]. The resilience of rural households in China gradually improved due to the improvements in inclusive financial coverage. Continuous improvements in rural financial institutions played a positive role in promoting rural economic development and narrowing the income gap between urban and rural areas [70]. However, small and micro businesses struggled to acquire credit support because they frequently lack company documents and face more acute information asymmetry [71,72]. Digital technologies, such as big data and cloud computing, were used by inclusive digital finance, unlike traditional financial institutions, to effectively extract useful information from users' social networks and transaction data. The range of feasible transactions increased and information asymmetry reduced by the capacity to define a user's credit image without complex data, such as assets and income. This lowered the barrier to venture capital restrictions and simplified financing small and microbusinesses, thus boosting entrepreneurship [73]. In the development of the digital village, incorporating digital economy into the rural financial service system can help the system to improve service to farmers, especially those in remote areas, thus making it simpler for these farmers to borrow from banks and meet their own production and living needs. Simultaneously, continuous improvements in the inclusive financial system can reduce the service costs and increase the financial institutions' incomes. Financial institutions' increasing enthusiasm to support farmers would help in improving their agricultural production.

Therefore, H1c was proposed:

H1c: *Digital village construction improved RFR through the development of rural-inclusive finance.*

Several factors affected farmers' willingness to start businesses, including personal and family reasons, personal education levels and experience, policy support, funds, rural facilities and environment, and the availability of resources [74]. With the promotion of the digital village strategy, the degree of networking, modernization, and informatization in rural areas was increasing. Internet technology, e-commerce promotion platforms, and rural financial institutions were widely used. These resources provided farmers with excellent entrepreneurial conditions and motivated their entrepreneurial will. If farmers have entrepreneurial dynamism, they may adopt these advanced modern information technologies in time to invest in their own agricultural production and management activities. Consequently, more farmers are engaging in entrepreneurship, which can encourage more farmers to achieve employment, broaden the source of family income, and improve income stability, which prompts the RFR. This idea was supported by Cai, who found that digital financial inclusion significantly promoted entrepreneurship and had a stronger incentive effect on small and micro businesses [12]. Guihe also claimed that the development of

digital-inclusion finance greatly stimulated farmer entrepreneurship, especially for those with poor social, material, and human capital [75]. Therefore, this study considered farmers' entrepreneurial dynamism as a regulating variable.

The following assumptions regarding farmers' entrepreneurial dynamism were proposed:

H2a: *Farmers' entrepreneurial dynamism enhanced the positive impact of the rural internet access on RFR.*

H2b: *Farmers' entrepreneurial dynamism enhanced the positive impact of e-commerce platforms on RFR.*

H2c: *Farmers' entrepreneurial dynamism enhanced the positive impact of rural-inclusive finance on RFR.*

Entrepreneurial dynamism of farmers varied across regions because of the differences in the levels of economic development. Thus, combining with the geographical locations and the different levels of regional economic development, and referring to the earlier regional division method [76], this study divided the study area into four regions: eastern, northeastern, central, and western.

Therefore, H3 was proposed as follows:

H3: *There was regional heterogeneity in the effect of the digital village on RFR.*

Briefly, the research hypotheses are shown in Table 1, and the internal logical relationship and mechanism through which a digital village fosters RFR is presented in Figure 1. The construction of a digital village transformed and upgraded the original rural economic and social development model by popularizing the construction of internet infrastructure in rural areas and developing e-commerce platforms and inclusive financial services; thus, allowing farmers to gain employment and increasing income by relying on the digital-industry system. The widespread use of the rural internet fairly reduced the negative effect of information inequality and provided farmers with more skill choices, agricultural product information, and employment opportunities. The e-commerce platform introduced online sales of agricultural products, and the increasing number of e-commerce transactions of agricultural products encouraged the development of agricultural product logistics, live broadcasts, and short videos; thus, creating a significant job market. Rural-inclusive finance provided farmers with more convenient and comprehensive financial services and reduced the resistance caused by the lack of financial services in agricultural production and life in general. Utilizing the facilities, platforms, and policies that digital rural construction offers, farmers engaged in entrepreneurship, which enriched their employment and expands their sources of income. Therefore, digital rural construction would improve agricultural operations and farming life and deliver a high-quality rural economic model and social development model, which in turn enhances the RFR.

Table 1. Research hypotheses.

Hypothesis	Content
H1a	Digital village construction enhanced RFR by increasing the rural internet infrastructure.
H1b	Digital village construction improved RFR by developing e-commerce platforms.
H1c	Digital village construction improved RFR through the development of rural-inclusive finance.
H2a	Farmers' entrepreneurial dynamism enhanced the positive impact of the rural internet access on RFR.
H2b	Farmers' entrepreneurial dynamism enhanced the positive impact of e-commerce platforms on RFR.
H2c	Farmers' entrepreneurial dynamism enhanced the positive impact of rural-inclusive finance on RFR.
H3	There was regional heterogeneity in the effect of the digital village on RFR.

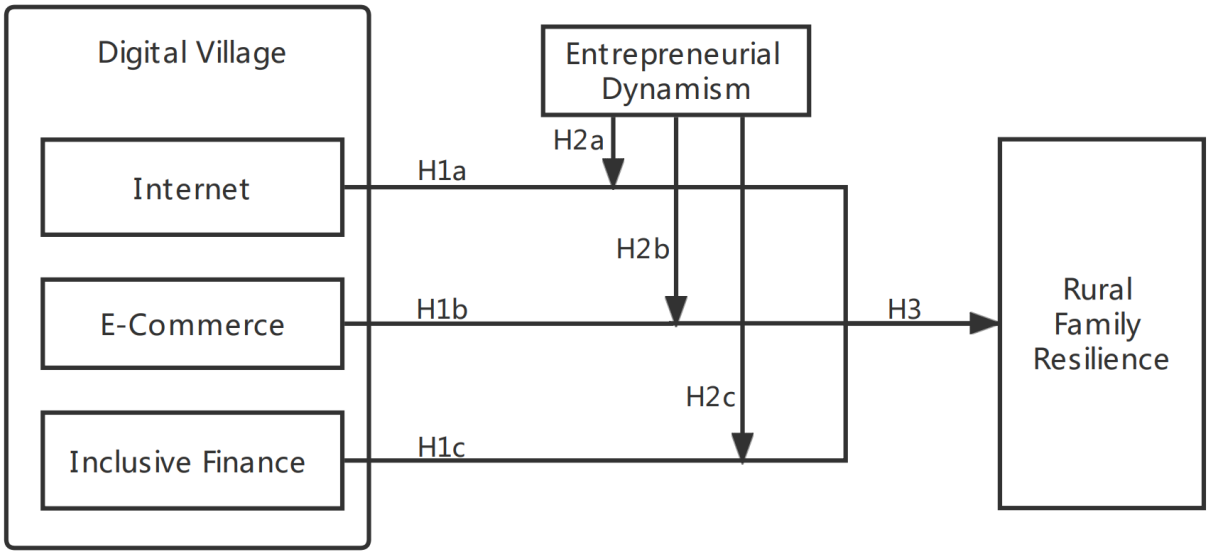

Figure 1. Theoretical framework.

3. Data and Methodology

This study constructed a balanced panel estimation of the effect of farmers' entrepreneurial dynamism and the digital village, and their intersections in regression, on the resilience of rural families. It also tested the moderating effect of the farmers' entrepreneurial dynamism across the country, eastern, northeastern, central, and western regions, on the relationship between the digital village and rural families through the significance of the interactive term coefficient. The data used in this study were from the CHFS organized and managed by China Household Financial Survey and Research Center, Southwestern University of Finance and Economics. Finally, considering the data availability and the actual situation in the region, after data cleaning and sorting, we selected 3749 observation samples from 29 provincial administrative units in 2015, 2017, and 2019. In this paper, STATA 15 was used to process the data and build the difference-in-difference (DID) model. To facilitate further understanding of the study area, Table 2 shows details about the study area, including the area of cultivated land, number of villages, number of rural population, number of internet users, disposable income of farmers and consumption of farmers.

To explore the RFR supported by digital villages, this paper constructed a DID model based on panel data:

$$RFR_{it} = \alpha_1 IA_{it} + \alpha_2 IM_{it} + \alpha_3 IF_{it} + \vartheta COND_{it} + C_{it} + \varepsilon_{it} \quad (1)$$

After adding the regulating variable of farmers' entrepreneurial dynamism, the model can be expressed as follows:

$$RFR_{it} = \alpha_1 IA_{it} + \alpha_2 IM_{it} + \alpha_3 IF_{it} + \alpha_4 IA_{it} \times FED_{it} + \alpha_5 IM_{it} \times FED_{it} + \alpha_6 IF_{it} \times FED_{it} + \vartheta COND_{it} + C_{it} + \varepsilon_{it} \quad (2)$$

In the above model, i represented the household, t represented the time, $COND$ was the control variable, C was the constant term, and ε was a random disturbance term.

Explained Variable: Based on the framework of Barrett and Costas [29], RFR was defined as the probability that the welfare of family (i) in time (t) was higher than a certain standard threshold. Based on the experience of measuring farmers' entrepreneurship, this paper considered the per capita income of households (logarithm) as the measurement index of welfare. This paper referred to the moment estimation method proposed by Cissé and Barrett to measure development resilience and expand it along with the development

characteristics of Chinese families [16]. First, it was assumed that family welfare depended on the first-order Markov process, which was specified as follows:

$$W_{it} = \sum_{j=1}^{k} \beta_{Mj} W_{i,t-1}^{j} + \gamma_M X_{it} + \varepsilon_{Mit} \quad (3)$$

Here, in Formula (3), W_{it} represented the welfare index, $W_{i,t-1}^{j}$ was the welfare lag term, and j represented the order of high-order center distance. Considering the classical S-shaped dynamic characteristics of the poverty trap, k was set as 3 in the study [29]. X_{it} was the other characteristic variables that affect family welfare, including family population, economy, society, and other characteristics. ε_{Mit} was a random perturbation term. β_{Mj} and γ_M were the coefficients to be estimated. The subscript M represented the expectation equation, and i and t represented the family and year, respectively.

Table 2. Basic facts about the study area.

Region	Province	Area of Cultivated Land (Hectares)	Number of Villages	Number of Rural Population (Thousand)	Number of Internet Users (Thousand)	Disposable Income of Farmers (RMB)	Consumption of Farmers (RMB)
Eastern region	Hebei	8089.4	44,048	29,793.7	10,389	16,467	12,201.1
	Fujian	1631.3	13,344	12,982.8	5776	20,880.3	16,338.9
	Hainan	676.9	2788	4005.3	1112	16,278.8	13,169.3
	Tianjin	419.2	2949	2121.6	528	25,690.6	16,844.1
	Beijing	98.2	3542	2726.7	944	30,125.7	20,912.7
	Jiangsu	7478.4	13,933	22,505.6	14,164	24,198.5	17,021.7
	Zhejiang	2014.5	17,090	17,969.1	8927	31,930.5	21,555.4
	Shanghai	255.2	1577	2661.5	27	34,911.3	22,095.5
	Shandong	10,889.1	66,086	37,513.2	10,709	18,753.2	12,660.4
	Guangdong	4451.8	18,439	32,576.4	10,170	20,143.4	17,132.3
Central region	Anhui	8818	15,041	25,432.1	8021	16,620.2	15,023.5
	Henan	14,688	41,727	44,287.0	9017	16,107.9	12,644.2
	Hubei	7974.4	22,683	21,432.2	5703	16,305.9	14,472.5
	Hunan	8400.1	23,000	27,398.7	7016	16,584.6	14,974.0
	Jiangxi	5644.4	16,833	17,878.0	5185	16,980.8	13,579.4
	Shanxi	3541.5	24,190	13,084.1	2336	13,878.0	10,290.1
Northeastern region	Jilin	6151	9113	8994.4	1126	16,067.0	11,863.6
	Liaoning	4287.8	10,739	11,865.4	770	17,450.3	12,311.2
	Heilongjiang	14,910.1	8857	10,952.4	1642	16,168.4	12,360.0
Western region	Gansu	3931.8	15,946	11,952.5	3360	10,344.3	9922.9
	Ningxia	1174.2	2268	2524.0	617	13,889.4	11,724.3
	Qinghai	571.4	4132	2364.6	501	12,342.5	12,134.2
	Shaanxi	4160.8	16,236	14,759.3	3466	13,316.5	11,375.7
	Sichuan	9849.9	44,003	36,209.0	11,092	15,929.1	14,952.6
	Yunnan	6989.7	13,442	23,580.7	4040	12,841.9	11,069.5
	Guizhou	5475.3	14,009	18,066.2	2243	11,642.3	10,817.6
	Guangxi	6107.3	14,223	22,955.8	7007	14,814.9	12,431.1
	Chongqing	3372.5	8375	9790.1	2530	16,361.4	14,139.5
	Inner Mongolia	8882.8	11,000	7821.7	873	16,566.9	13,593.7

Second, using the random error term zero mean hypotheses, we estimated the family welfare state of conditional expectation $\check{\mu}_{1it}$, which was expressed as follows:

$$\check{\mu}_{1it} = E[W_{it}|W_{i,t-1}X_{ii}] = \sum_{j=1}^{k} \check{\beta}_{Mj} W_{i,t-1}^{j} + \check{\gamma}_M X_{it} \quad (4)$$

Third, with V said variance equation, the second-order center distance available first-order center distance square residual predicted $\check{\varepsilon}^2_{Mit}$ to express, setting as follows:

$$\check{\varepsilon}^2_{Mit} = \sum_{j=1}^{k} \beta_{Vj} W^j_{i,t-1} + \gamma_j X_{it} + \varepsilon_{Vit} \tag{5}$$

Similarly, following the random error term zero mean hypothesis, at time t we can estimate the family welfare state of conditional variance $\check{\mu}_{2it}$.as follows:

$$\check{\mu}_{2it} = \sum_{j=1}^{k} \check{\beta}_{Vj} W^j_{i,t-1} + \check{\gamma}_V X_{it} \tag{6}$$

Finally, following the analytical framework of Barrett and Constas, this study assumed the distribution form of family welfare and estimated the conditional probability density function and cumulative probability density function of family welfare according to the conditional mean and variance [29]. Thus, will RFR ($\check{\rho}_{it}$) is defined as the welfare of the family (i) at time (t) was higher than the probability of a standard threshold ($\bar{W}$), the specific setting was as follows:

$$\check{\rho}_{it} \equiv p(W_{it} \geq \bar{W}) = \bar{F}_{W_{it}}[\bar{W}; \check{\mu}_{1it}(W_{it}, X_{it}), \check{\mu}_{2it}(W_{it}, X_{it})] \tag{7}$$

In the Formula (7), $\bar{F}$ was the cumulative probability density function. Specifically, in this study, per capita household consumption (logarithm) was used to measure welfare. As the amount of household consumption must be kept non-negative, this study assumed that family welfare followed the Poisson distribution and used the generalized linear model to estimate the maximum likelihood of Equations (3)–(6). Threshold ($\bar{W}$) was set with reference to the World Bank poverty line of $1.9, per capita consumption, according to the corresponding period of the exchange rate and consumer price index for processing. Finally, this study measured family resilience by the probability that the family's welfare level remains above the poverty line.

Explanatory variable: Scholars at home and abroad evaluated the digital village differently [77]; however, no generally recognized evaluation-index system of the digital village has been formed. Combined with the existing literature, relevant government policies, and social practices, the orderly and healthy development of a digital village was encouraged by building rural network facilities, developing rural e-commerce platforms, and improving the coverage of inclusive finance; thus, bringing in more benefits to the farmers. Therefore, this study selected various indicators, including internet access (IA), internet management (IM), and inclusive finance (IF).

Regulating Variable: The farmers' entrepreneurial dynamism (FED) often affected the relationship between the digital village and RFR, and the development of a digital village in rural areas benefited farmers with high entrepreneurial dynamism. They can quickly start their businesses with the help of digital platforms and increase their income. Farmers with low entrepreneurial dynamism were not much affected by the digital village. Although the construction of the digital countryside offered great development opportunities for rural areas, these farmers were unwilling to innovate and experiment with new methods. Therefore, this study took the FED as the regulating variable, draws lessons from research on rural statistical data by Aisaiti, and measures the FED by taking independent management as the standard [69].

Control Variable: Referring to studies on family developmental resilience, this study mainly controlled for variables of individual and family characteristics [78]. Individual characteristics variables mainly included respondents' age, marital status, gender, and years of education; moreover, household characteristics mainly included household consumption,

household health, household income, and household size. Additionally, to reduce the influence of the differences in macro-regional characteristics on the empirical results, we included regional dummy variables. An explanation of the variables is shown in Table 3. Due to the difference in the data units of each variable, all variables were standardized.

Table 3. Variables used in the models.

Variable	Definition	Mean	Std. Dev.
Explained variable			
RFR	Measured by formula (G)	0.576	0.093
Explanatory variable			
IA	Whether to use phones with internet access (yes = 1, no = 0)	0.156	0.363
IM	Whether to use the Internet for business (yes = 1, no = 0)	0.094	0.292
IF	Whether there are outstanding bank loans (yes = 1, no = 0)	0.137	0.344
Regulating variable			
FED	Whether or not self-employed (yes = 1, no = 0)	0.106	0.308
Control variable			
Householder's gender	Male = 1, female = 0	0.559	0.497
Householder's age	Difference between the year of survey and year of birth	54.667	13.628
Householder's marital status	Married = 1, unmarried = 0	0.875	0.331
Householder's educational level	Length of schooling	8.795	3.859
Household's health	Self-evaluation (health = 1, other = 0)	0.411	0.492
Household scale	The number of people in a household	4.256	1.758
Household income	Natural logarithm of annual household income	10.357	1.127
Household consumption	Natural logarithm of annual household consumption	9.569	1.476

4. Results

4.1. Empirical Test: Benchmark Regression

The panel data test typically addressed the selection problem of the random effect or the fixed effect model. The Hausmann test results showed that the *p*-value was 0.0000, strongly refuting the original hypothesis; therefore, the fixed effects model was used to analyze the panel data. The regression results are depicted in Table 4. In Model A, IA was significant at the 5% level, the IM and IF were significant at the 1% level, and the regression coefficients were positive, which conformed to expectations. In addition, studies used cluster standard errors to reduce the impact of endogenous issues on study results. The regression coefficient of IA was 0.026, which showed that for every one standard deviation increase in IA, the RFR increased by 2.6%, which was mainly due to the growth in the number of rural broadband users. The regression coefficient of the IM was 0.076, which indicates that for every one standard deviation increase in the e-commerce development level, the RFR increased by 7.6%. Thus, H1a and H1b were confirmed.

Table 4. Basic regression results.

	RFR	
	Model A	**Model B**
Constant	0.372 ***	0.375 ***
IA	0.026 **	0.043 **
IM	0.076 ***	0.048 *
IF	0.012 ***	0.009 ***
FED × IA		0.012 *
FED × IM		0.135 **
FED × IF		0.011 ***
COND	Yes	Yes
N	3749	3749
Adjusted R^2	0.855	0.864

***, **, and * are significant at the 1%, 5%, and 10% levels, respectively.

The coefficient of rural-inclusive finance was only 0.012, far lower than the values of the earlier variables, which showed that the increase in IF in the development of the digital countryside was not optimal. Thus, H1c was verified. However, we should consider whether vulnerable groups, such as rural small and microenterprises, farmers, and low-income urban inhabitants, can access effective financial services.

To prove that FED has a positive moderating effect on the development of the digital village, an interactive term multiplied by FED was added to Model B. The final regression results of Model B showed that the three explanatory variables of IA, IM, and IF moderated by FED were significant and the coefficients were positive, which met our expectations. Therefore, H2a, H2b, and H2c were confirmed, indicating that FED had a significant positive moderating effect on improving the RFR in the digital countryside. The development of a digital village significantly increased the RFR; moreover, FED, which had the highest improvement value, moderates IA. This may have been because the internet's popularity helped farmers to effectively use various technology platforms and increased the number of available technology-learning channels. Simultaneously, farmers can start businesses in the form of rural e-commerce. The two variables supported each other and played an obvious role in enhancing RFR.

4.2. Heterogeneity Analysis

The development of the digital village differed in different regions of China. Based on earlier studies, this study examined the regional heterogeneity of the digital village's support for RFR in four regions: eastern, northeastern, central, and western. Thus, H3 was confirmed. Similarly, the p-value of the Hausmann test was 0.0000, strongly refuted the original hypothesis. Therefore, this study used the fixed effect model to study regional heterogeneity of consumption growth of digital village-enabled RFR. The results are shown in Table 5.

Table 5. Heterogeneity analysis.

	RFR							
	Eastern		**Northeastern**		**Central**		**Western**	
	A-1	**B-1**	**A-2**	**B-2**	**A-3**	**B-3**	**A-4**	**B-4**
Constant	0.308 ***	0.327 ***	0.503 **	0.469 *	0.136 **	0.147 **	0.429 ***	0.421 ***
IA	0.026 *	0.034 *	0.029	0.022	0.041 *	0.042 *	0.036 **	0.024 *
IM	0.107 **	0.108 *	0.003	0.006	0.062 *	0.065 *	0.039 **	0.027 *
IF	0.011 ***	0.012 ***	0.002 ***	0.002 ***	0.012 ***	0.012 ***	0.012 ***	0.012 ***
FED × IA		0.025 *		0.028		0.043		0.042
FED × IM		0.212 **		0.054		0.046		0.057
FED × IF		0.112 ***		0.001		0.002		0.003
COND	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1463	1463	501	501	1157	1157	628	628
Adjusted R^2	0.861	0.874	0.868	0.874	0.954	0.914	0.849	0.807

***, **, and * are significant at the 1%, 5%, and 10% levels, respectively.

In Model A-1, the regression coefficient of IA in the eastern region was significant at the 10% level; however, its value was lower than that of the national average. This was probably because the eastern region began popularizing the internet in rural areas earlier than in other regions and the dividend earned from network infrastructure construction declined. The regression coefficient of the IM was significant at the 5% level, which was higher than that of the national average level, showing that the RFR increased in the eastern region by 10.7% for every standard deviation of the IF. The IM in the eastern region was ahead of that of the whole country. Beijing constantly optimized the development environment of e-commerce through policies and had many well-known e-commerce enterprises. In addition to providing jobs to the rural working population, e-commerce enterprises support farmers' entrepreneurship with their efficient and convenient trading

platforms. In Model B-1, the regression coefficients of IA and IM were significantly higher than the data in Model A-1 after adding the adjusting variable of FED, indicating that the farmer entrepreneurs in the eastern region were more active and that the construction of internet infrastructure and the development of e-commerce provided a foundation for farmers' entrepreneurship. Simultaneously, FED positively influenced the growth of the digital countryside and regulated RFR in the eastern region.

Models A-2 and B-2 demonstrated the impact of digital village construction in northeastern China on the RFR. Unlike the results of the whole country and other regions, the regression coefficients of IA and IM were not significant, and the coefficients of IF were small, showed that the digital village strategy had no significant impact on RFR. After introducing the adjustment variable of FED, the result showed no obvious change. Research by Cai can be used to explain this phenomenon [79]. Northeastern China, an important grain production base, had vast plains and black soil resources. Most farmers in this region were engaged in planting and breeding, and demonstrate low entrepreneurial dynamism. Furthermore, vast land and scattered houses increased the cost of network infrastructure construction and logistics transportation. The region also lacked the necessary conditions for developing e-commerce. Therefore, the farmers adjusted their planting schedule according to the changes in policy to gain government's financial support. Moreover, the natural conditions made this area suitable for developing mechanized planting methods. Agricultural financial support and the level of agricultural mechanization were the main factors that improve RFR in this area.

The central and western regions experienced a similar situation. The three explanatory variables representing the construction of the digital countryside significantly promoted the improvement in the RFR. While the regression coefficient of the interaction between the moderating variables and the explanatory variables was not significant, it showed the current situation of rural areas in central and western China. The digital village strategy brought more extensive network coverage and more convenient e-commerce platforms to rural areas, widened farmers' access to information, and improved farmers' living standards. However, FED in the central and western regions was not high, and the digital entrepreneurship represented by e-commerce was still underdeveloped.

5. Discussion

This study found the significant role of digital rural construction in increasing RFR. This was apparent when external shocks exceed the threshold of rural resilience, and rural communities begin transforming from one stable state to another. Further investigation was conducted through regression analysis, with the location-area variables showing statistical significance. Different regions of China had different levels of digital village development. Based on earlier studies, this study examined the regional heterogeneous ways in which the digital village enables RFR in four regions: eastern, northeastern, central, and western. Observations on the distances of enterprises from metropolitan areas and the variable returns on digital building in rural areas with varying degrees of development in China corroborated these results. According to Townsend, this contradicted the idea of reliable connectivity levels for everyone, but it agreed with their observations of Wales's levels of digital connectivity [22,50]. These results substantiated the claims that poor digital connectivity impedes rural progress [80,81].

This suggests the need for additional investment in digital infrastructure, which, as shown by studies, can help increase GDP and productivity levels [82,83]. Rural regions must quickly become aware of new digital connectivity technologies as these advances, for example, by creating ultra-fast internet or 5G mobile communication. As the number of people who work from home continues to rise, businesses and individuals rely heavily on dependable digital connection. The bulk of commercial activities are now conducted online, including emailing, video conferencing, and e-retail. Rural firms face a competitive disadvantage compared with urban-based enterprises in their efforts to adapt despite this new scenario because of the different levels of connectivity between urban and rural locations.

This study emphasizes how crucial it is for farmer entrepreneurs to develop a digital village as it enables businesses to conduct critical daily tasks. An interactive term amplified by FED was introduced in Model B to demonstrate how farmers' entrepreneurship positively moderates the development of the digital countryside. As expected, the final regression findings in Model B showed that the three explanatory variables of IA, IM, and IF moderated by FED were significant and the coefficients were positive. Any firm must perform these basic tasks to function; a lack of inclusive rural financing would adversely influence a company's capacity to do so. These actions align with Henderson's study on Welsh SMEs' use of digital technology, which identified related activities [22].

Digital villages are crucial for diversifying and expanding entrepreneurial activity [84]. Digital technology is also valuable for companies aiming to grow or diversify their business to become more resilient in the current challenging economic climate. The findings of this study demonstrate that lower rural digitalization levels may affect a company's capacity to engage in various activities, especially in northeastern China, where the level of rural digitization is much lower than in China's more rural regions in the east and south. Typically, the rural economy consists of small businesses that operate in sectors with distinctly rural features, such as agriculture, food production, cultural industries, and public service. Thus, farmers must display greater entrepreneurial abilities to broaden their range of operations by allocating resources to maximize the financial potential of their farms [14]. In the framework of China's digital village program, the advantages of digital connection may also be observed in more effective agricultural techniques, such as big data or smart farming [85]. However, the agricultural sector is often seen to be resistant to change as farmers are usually older and less inclined to accept new technology. Moreover, despite the potential for agricultural diversification and worldwide expansion of SMEs in the food production industry, SMEs in the agriculture and food sectors were seen to be more receptive to business-growth opportunities in rural regions owing to the difficulties of digital divide [84]. Through digital connection, which allows small- and medium-sized enterprises to be "born global" and participate in global activities from the beginning, the potential for internationalization becomes increasingly obvious [86]. This is especially challenging for businesses with limited internet connectivity, such as those in northeast China.

Our findings emphasize that, as shown in rural locations with low digital connectivity and fewer human capital resources, limited resources hinder the ability to exploit competitive advantages. This is related to lower levels of entrepreneurship because firms are less proactive in pursuing development prospects, which influences the resilience of rural enterprises. Owing to a shortage of resources, "brain drain" occurs when educated and young individuals leave peripheral rural regions for core urban centers to find work. Internet infrastructure upgrades might inspire the youth to remain in rural areas and reduce the phenomenon of "brain drain". Digital connection may attract creative workers who can use local resources and engage with the community in rural areas [87]. Rural China has a scattered population. This study found a large regional digital connection gap. Farmers' entrepreneurial spirit might boost rural diversification and resilience, along with other small businesses [20]. Local government efforts or current legislation promoting digital villages and regional prosperity may help. These local networks need reliable digital connection to link individuals and companies within areas for growth opportunities.

Thus, identifying factors that restrict rural resilience is important for stabilizing rural communities. However, this study of China's rural resilience at a provincial level has several limitations and problems: (1) Rural resilience covers many aspects, such as economic, social, and ecological resilience, and a general evaluation fails to reveal the specifics of rural resilience. (2) Rural communities are not homogeneous groups of entities; thus, they differ in many aspects, such as resource endowments, economy, geographical conditions, and social issues. The results of an evaluation of rural resilience at a provincial level may not necessarily be replicated at the community level. Therefore, further studies should focus on a specific rural community and reveal its economic, social, and ecological resilience when

facing different external challenges. (3) The resilience of rural households is vulnerable to the impact of sudden practice. Vicious natural disasters such as earthquakes and tsunamis, as well as widespread public safety hazards such as the coronavirus pandemic, can affect a family's ability to cope with risks. This article does not directly consider these factors. Follow-up studies should focus on these factors.

Despite these limitations, the general pattern and constitution of rural resilience in this study could serve as a reference point for further studies of rural resilience in China. Among possible topics for future research, we suggest studies of rural resilience for different geographical conditions, such as plains, mountainous areas, and intermediate and remote locations. Future studies could also address the following questions: What are the restrictions on rural resilience for different communities? What are the thresholds of rural resilience for these rural communities?

6. Conclusions and Policy Recommendations

It is crucial to improve the resilience of rural families for rural revitalization in the new era. The data show that, the digital countryside drives farmers' development at the national level in all aspects through different forms and connection mechanisms, supporting the RFR. However, this effect is heterogeneous owing to the differences in the digital village construction environment between different regions of China. The results show that in the more developed eastern region, digital village construction is relatively well developed and has a significant impact on farmers' income growth, while that in the central, northeastern, and western regions is less developed and its impact is also weaker. After introducing the adjustment variable of FED, the results showed that the overall level of country FED has a positive moderating effect on a digital village's RFR. However, owing to the differences in resource endowment, geographical conditions, and economic development levels among the regions, the digital level of rural areas also differs and there are significant differences between farmers' entrepreneurial paths and conditions. Based on these conclusions, we should give full play to the role of the digital village in increasing farmers' income. This study makes the following suggestions.

First, improve the construction of digital facilities in the central and western regions, broaden nonagricultural entrepreneurship channels, and increase farmers' entrepreneurship enthusiasm. The level of economic development in the central and western regions is relatively low. Limited by their regions' conditions, most farmers are engaged in agricultural activities, and there are relatively few agricultural entrepreneurship projects. Agricultural resources are not fully developed or used. Even if farmers desire to start a business, they do not have the necessary conditions to support it. Therefore, the central and western regions should focus on developing and constructing basic resources, providing basic material guarantees and various forms of entrepreneurship guidance for more farmers, broadening farmers' employment channels, compensating for the shortages of basic elements, and actively learning from various advanced digital village planning experiences in developed regions, such as the eastern region.

Second, rapid transformation and advancement of rural industrial structures in the eastern region should be ensured by the government to help farmers start their businesses. The level of economic development in the eastern region is relatively high; the rural transportation, communication, and other infrastructural features are relatively well developed, and farmers' education levels and personal qualities are high, which provide the preconditions for entrepreneurship. Therefore, farmers in these regions can be encouraged to seize the opportunity offered by industrial upgrades, start a business, optimize their agricultural production mode, and significantly increase their income.

Third, it is necessary to actively support the construction of the digital countryside in northeastern China and apply digital technology to the process of agricultural production according to the natural conditions and the actual situation in northeastern China. The Agricultural Industrial Park built in northeastern China recently conducted real-time monitoring of crop production, automatic irrigation, and fertilization using innovative

new-generation technologies, such as big data, the Internet of things, artificial intelligence, blockchain, and 5G.

Thus, from the long-term development perspective of various regions, the construction of the digital countryside is central to promoting the growth of the RFR. Strengthening the investment in digital technology facilities in various regions and improving various necessary conditions for farmers to engage in entrepreneurial activities are important measures to improve RFR and change the income growth model.

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