frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 16 September 2025
DOI 10.3389/fsufs.2025.1649753

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OPEN ACCESS

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RECEIVED 18 June 2025
ACCEPTED 18 August 2025
PUBLISHED 16 September 2025

CITATION
Lu Z, Gou D, Wu Q and Feng H (2025) Does the rural digital economy promote shared prosperity among farmers? Evidence from China. *Front. Sustain. Food Syst.* 9:1649753.
doi: 10.3389/fsufs.2025.1649753

Does the rural digital economy promote shared prosperity among farmers? Evidence from China

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Introduction: Ensuring shared prosperity among rural populations remains a central challenge in achieving inclusive and sustainable development. New opportunities for rural development have been created by the growth of the digital economy, yet empirical evidence on its capacity to promote shared prosperity among farmers remains limited. This study examines the connection between the growth of the rural digital economy and shared prosperity, highlighting the function of high-quality agricultural development as a moderating factor.

Methods: This study uses a fixed effects regression approach to evaluate how the development of the rural digital economy affects farmers' shared prosperity using balanced provincial panel data from 2013 to 2022. To investigate the influence of high-quality agricultural development, the mediation model is constructed. Multiple robustness tests, including lagged variables, alternative indicators, and sub-sample analyses, are carried out to guarantee the validity of the findings.

Results: The results of the study indicate that the development of the digital economy in rural areas significantly promotes farmers' shared prosperity. The mediating role of high-quality agricultural development is confirmed, highlighting its importance in channeling digital economic benefits. Regional heterogeneity is observed, with stronger effects found in western provinces compared to eastern ones. Furthermore, the impact follows a U-shaped trajectory, indicating that as digital infrastructure matures, its capacity to promote shared rural prosperity increases.

Discussion: The findings suggest that advancing rural digital infrastructure and services, alongside improvements in agricultural quality, is essential for fostering equitable development outcomes. The evidence underscores the need for context-specific strategies, particularly in underdeveloped regions where digital integration can yield the greatest marginal benefits. This study adds to the expanding discussion about digital inclusion and rural revitalization in the global effort toward sustainable and inclusive food systems.

KEYWORDS

rural digital economy, shared prosperity among farmers, digital economy, shared prosperity, rural digital transformation, global south evidence

1 Introduction

The concept of "shared prosperity" originated in the mid-20th century amid growing attention to agricultural modernization and equitable development (Xing and Wang, 2025; Xu C. et al., 2025). It has since evolved into a broader framework encompassing social justice and inclusive growth (Yang et al., 2025; Zhao et al., 2025). As absolute poverty declines globally, shared prosperity has become a key objective for nations pursuing sustainable modernization (Ma et al., 2025), particularly in rural areas, which remain marked by inequality, exclusion, and limited access to opportunities (Zhang J. et al., 2025). Empirical evidence from countries like India also echoes the significance of institutional design and incentive mechanisms in achieving inclusive rural development goals (Bahinipati et al., 2024), while land policy reforms and tribal resettlement experiences further emphasize the importance of localized approaches to ensuring food security and livelihood sustainability in marginalized regions (Marowa et al., 2024). Achieving shared prosperity requires rural communities' equitable participation in national and global development (Hou et al., 2024; Hu et al., 2024; Zhang and Fan, 2024). The rise of digital technologies presents new opportunities to reshape rural production, empower smallholders, and improve social inclusion (Hou and Gao, 2025; Liu K. et al., 2025; Lyu et al., 2025; Qiao et al., 2025). Therefore, it is crucial to comprehend how rural digital economic development promotes farmers' shared wealth to help global efforts toward justice and sustainable growth, as well as in developing countries.

The digital economy's potential to foster equitable development and narrow the urban-rural divide has garnered growing academic interest (Park and Mercado, 2016; Corrado et al., 2017; Demertzis et al., 2018). In China, research on its role in advancing shared prosperity has expanded alongside national priorities (Dunford, 2022; Fang and Zhou, 2022; Limna et al., 2022). While concerns persist over algorithmic bias, digital inequality, and platform monopolies (Chen and Zhang, 2023; Zhao et al., 2023), other scholars emphasize its ability to improve resource efficiency and broaden market access for vulnerable groups (Luo and Xiong, 2024; Ross, 2022). Furthermore, the digital economy influences income distribution by enhancing agricultural productivity, stimulating rural entrepreneurship, and facilitating industrial upgrading (Wang et al., 2022a; Liu W. et al., 2023; Yu and Chen, 2023). Cross-national findings also suggest that globalization and sectoral restructuring interact significantly with rural income dynamics and digital integration (Behera and Karthiayani, 2022), which underscores the need to contextualize rural digital development within broader macroeconomic transitions. The rural digital economy has become an increasingly important focus (Xin et al., 2025; Ye, 2025; Zhang L. et al., 2025). Zhan et al. (2025) demonstrated that by encouraging non-agricultural employment, digital finance positively influences rural household income. Shi et al. (2025) found that the effects of digital inclusive finance are stronger in central and western China, with region-specific patterns of marginal returns. Xing and Wang (2025) revealed spatial spillover effects in shared prosperity, particularly from population density and education. Zhang and Zhao (2025) highlighted how rural e-commerce policies have significantly boosted digital financial inclusion in underdeveloped areas. Mechanism-wise, existing research has considered high-quality agricultural development, green finance, public fiscal support, and digital literacy as potential mediating or moderating variables (Fu et al., 2024; Hong et al., 2024; Luo and Hu, 2024; Liu Y. et al., 2025). However, systematic empirical evidence that there are currently few obvious proofs linking the shared prosperity of farmers with the rural digital economy. Additionally, few studies explore both intermediary mechanisms and regional heterogeneity in depth.

Despite the growing body of literature, three key gaps remain. First, prior research rarely focuses specifically on the shared prosperity of farmers, and existing rural digital economy indicators are often simplistic, failing to capture nuanced regional dynamics. Second, there is a lack of empirical research on the transmission mechanisms through which the rural digital economy may affect farmers' prosperity, such as through high-quality agricultural development. Third, the relationship's non-linear consequences and geographical differences have received less attention, with most studies emphasizing average impacts and overlooking differences across income levels and geographic regions.

In three significant aspects, this study adds to the existing literature: first, it offers a fresh framework for analysis that systematically integrates the growth of the rural digital economy with the attainment of shared prosperity among farmers—a subject that hasn't gotten enough attention in the literature on digital economy and sustainable agriculture. The study enriches existing theoretical models of rural sustainability by shifting the analytical focus toward equitable rural development and explicitly integrating the rural population into the larger conversation on common prosperity. Second, by creating multi-dimensional, empirically supported composite indices for both farmers' shared prosperity and the development of the rural digital economy, this study tackles the measurement issues that have hampered earlier research. Based on panel data from 31 Chinese provinces between 2013 and 2022, these indices include a variety of indicators, such as the overall prosperity of farmers, farmers' shared wellbeing, the rural digital economy environment, the digitalization of the agricultural industry, and the digitalization of rural life services, among others. This method increases the validity of cross-regional comparisons while simultaneously improving measurement precision. Third, Significant non-linear and geographically heterogeneous impacts that have received little attention in the literature so far are shown by the investigation. It shows a U-shaped relationship between farmers' shared prosperity and the development of the rural digital economy, suggesting threshold effects and perhaps declining rewards in the early phases of digital deployment. The significance of adjusting digital policy initiatives to particular geographical settings and developmental phases is highlighted by these findings. In sum, this research enriches theoretical perspectives on the relationship between shared prosperity and the digital economy, while providing a scientific foundation for evidence-based policy formulation in rural digital development.

Building on the preceding discussion of the significance and challenges associated with promoting shared prosperity among farmers, this study systematically investigates whether and how this goal is supported by the growth of the rural digital economy. This is the structure of the rest of the paper. The theoretical foundation is established, and the research hypotheses are presented in Section 2, focusing on the direct effects, mediating mechanisms, and potential threshold characteristics of rural digital economy development. The data sources, key variables, and empirical models used in the study are all mentioned in Section 3. The primary empirical findings are presented in Section 4, including Panel data stationarity test, baseline regression results, endogeneity treatment, robustness checks, heterogeneity analyses across regions and development levels, threshold effect testing, mechanism identification, and dynamic effect analysis. Main findings, practical policy recommendations, and a discussion of limitations and

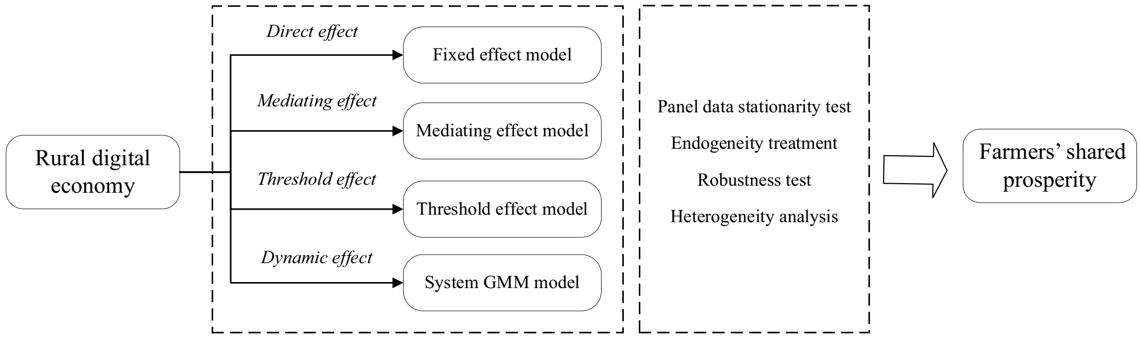

FIGURE 1
Research design.

potential future research are included in Section 5. Figure 1 shows the Research Design of the study.

2 Theoretical framework and hypotheses development

This study defines the "rural digital economy" as a key part of the broader digital economy, centered on using data-driven resources to boost productivity and achieve goals such as strong agriculture, vibrant rural areas, and improved farmer livelihoods (Philip et al., 2017; Salemink et al., 2017; Li et al., 2019). It includes new business models driven by modern technologies in agriculture. Likewise, "shared prosperity among farmers" refers to rural populations attaining decent living standards through honest work, legal business, and mutual support, with farmers and rural areas as the core focus (Ferreira and Ravallion, 2011; Jolliffe, 2014; World Bank, 2016). The growth of the rural digital economy contributes to this prosperity through direct, mediated, and threshold effects.

2.1 The direct effects of the development of the rural digital economy on fostering farmers' shared prosperity

The expansion of the rural digital economy not only drives local economic growth but also introduces frameworks for fairer benefit distribution (OECD, 2018; Li et al., 2019). It enhances resource allocation, boosts farmer incomes, narrows urban-rural gaps, and supports the goal of shared prosperity (Wang et al., 2022b; Chen et al., 2025; Wang J. et al., 2025).

First, the inclusive nature of the rural digital economy improves access to public services and addresses rural resource limitations (Gai et al., 2025; Han et al., 2024; Lu Y. et al., 2025). With the help of inclusive digital projects, rural residents can adopt technologies and services in both daily life and agricultural production (Xu and Tao, 2025; Zhang Q. et al., 2025). Programs like "Broadband China," "Internet Plus Education," and "Internet Plus Healthcare" offer more accessible and comprehensive services in governance, education, and healthcare (Perisic et al., 2023). In addition to offering diversified financial support for the growth of modern agriculture through smart agriculture and rural tourism, rural inclusive digital finance can successfully control the disparity of financial resources between urban and rural areas, improving the convenience and rationality of rural financial services (Liu and Huang, 2025; Lu D. et al., 2025). Additionally, it may provide important components to rural communities, such as financial professionals and financial technology, addressing the deficiencies in rural financial talent and technological elements (Jiang, 2022; Zhang et al., 2024).

Second, the innovation effect promotes farmers' innovation and entrepreneurship, enhancing rural resource development and utilization (Goldfarb and Tucker, 2019; Masoud, 2025). On the one hand, the agricultural industries' integration of information and communication technology and the Internet gives rise to new models and industries, sparking entrepreneurial and employment vigor in rural areas (Yao et al., 2025; Yi et al., 2025). Projects such as "Internet Plus Agriculture," "Internet Plus Planting," "Internet Plus Fresh Produce," and "Internet Plus Rural Tourism" provide rural women and impoverished individuals with independent and flexible employment opportunities, stimulating the participation of surplus rural labor in value creation (Gao et al., 2024; Sun and Yu, 2025; Yang and Wang, 2025; Zhang et al., 2025b). On the other hand, digital economy models exhibit significant characteristics, such as differentiation, interconnectedness, and agility (Ansong and Boateng, 2019; Wang and Zhao, 2022; Shafik, 2024; Xu and Lu, 2025). Thanks to abundant land resources, rich cultural heritage, and beautiful natural scenery in rural areas, rural residents can innovate rural economic activities using cost-effective, distinctive products and green farming practices (Wolfert et al., 2017; Klerkx et al., 2019; Fielke et al., 2020). Moreover, they can also leverage the characteristics of "small-scale agriculture" to highlight personalized and customized service advantages, thereby exploring new opportunities for rural development (Shen et al., 2022; Hong et al., 2023).

Third, platform effects enhance market efficiency, reduce agricultural costs, and help farmers increase income and achieve shared prosperity (Fielt et al., 2008; Zheng et al., 2023; Popiel, 2024). The rural land transfer market, long hampered by low participation and inefficiencies (Deininger and Jin, 2005; Deininger et al., 2009; Jin and Deininger, 2009), benefits from digital platforms that offer integrated land data systems for buyers and sellers (Eastwood et al., 2019; Klerkx et al., 2019). Tools like "Diya Cloud Loan" provide online transaction solutions, overcoming spatial and informational barriers in land deals (Aker, 2011; Zhang G. et al., 2023). This reduces information asymmetry and increases market premiums (Zhou et al., 2024).

Fourth, digital technologies hasten the transition from traditional to modern agriculture, boosting productivity (Wu et al., 2020; Liu J. et al., 2023). The adoption of advanced technologies enhances labor methods and raises production quality and efficiency (Ayenew et al., 2020; Feyisa, 2020). Digital tools improve seed breeding, irrigation, fertilization, and pest control (Gebbers and Adamchuk, 2010; Wolfert et al., 2017; Shen et al., 2022), mitigating external risks and improving both yield and product quality (Xie et al., 2024; Musajan et al., 2024). Moreover, technologies enhance every stage of the agricultural value chain—from marketing and logistics to transportation and operations—raising total efficiency (Bowen and Morris, 2019; Poti and Joy, 2022; Bustamante, 2023). As a result, total agricultural production efficiency improves significantly. The following theory was put out in light of these considerations:

H1: The development of the rural digital economy helps promote farmers' shared prosperity.

2.2 The mediating effects of the influence of the development of the rural digital economy on fostering farmers' shared prosperity

High-quality development is fundamental to achieving shared prosperity (Kakwani et al., 2022; Hong et al., 2023; Xu and Li, 2023; Zhang et al., 2025a). Promoting high-quality agricultural growth is therefore vital for realizing shared prosperity among farmers (Liu and Li, 2017; Peng et al., 2022; Lin et al., 2024). This study explores how the rural digital economy supports this goal by driving innovation, optimizing agricultural structures, and enabling equitable distribution of development outcomes (Cao, 2022; Zhang and Wang, 2023).

First, the innovative development of agriculture is supported by the rural digital economy's technological impacts (Shen et al., 2022; Dai et al., 2023; Zhang Q. et al., 2023). Through big data, the Internet, and AI, digitalization drives innovation in technology, marketing, and agricultural science, facilitating quality and efficiency upgrades in agriculture (Kamilaris et al., 2017; Yao et al., 2025). Digital platforms also enhance the flow and integration of agricultural resources, promoting the merging of primary, secondary, and tertiary sectors (Lin and Li, 2023; Li et al., 2024; Wen et al., 2024). This spurs new industries such as integrated crop-livestock systems, rural tourism, and academic-industry collaboration (Gretzel et al., 2015; Yan et al., 2022; Lu et al., 2025c). Additionally, digital expansion attracts skilled talent and young people proficient in technology and management, stimulating rural innovation and entrepreneurship (Zang et al., 2023; Gao et al., 2025; Chu et al., 2025).

Second, the digital economy optimizes agricultural structures by promoting high-tech, high-value-added, and coordinated development, thus driving structural upgrading and sustainability (Costa et al., 2023; Liu and Li, 2024; Zhao et al., 2024; Shen et al., 2025). Digital tools like farmland data systems and smart machinery reduce labor input and improve productivity (Abbasi et al., 2022). Precision agriculture allows real-time monitoring of crop and environmental conditions, enhancing resource management while minimizing waste and environmental impact (Achour et al., 2021; Aarif et al., 2025; Xu et al., 2025a).

Finally, the rural digital economy's platform and inclusiveness promote the equitable sharing of development benefits (Njuguna et al., 2025). On the production side, economies of scale reduce costs and mitigate risks, overcoming long-standing inefficiencies in rural production and raising farmer incomes (Jiang et al., 2025; Xu et al., 2025b). On the sales side, digital platforms improve communication between producers and consumers, closing information gaps and reducing transaction and matching costs (Wang and Huang, 2025). These improvements enhance agricultural operational efficiency and increase returns for farmers. Moreover, digital inclusive finance offers accessible financing for rural investment and entrepreneurship (Chen et al., 2025; Wei et al., 2025). Digital inclusive project plans offer high-quality services, such as remote education, technical consultation, and market analysis, to rural areas, ensuring that farmers have access to more equal entrepreneurial and employment resources, as well as to an open and fair market trading environment (Lu et al., 2025b; Orkoh and Teh, 2025). The following hypothesis was put out in light of these considerations:

H2: Rural digital economy fosters shared prosperity among rural residents through the mediating effect of high-quality agricultural development.

2.3 The influence of the development of the rural digital economy on fostering farmers' shared prosperity at a threshold

Because of differences in resource endowments, the degree of growth of the digital economy differs greatly among Chinese areas (Wang Q. J. et al., 2025). There are differences across areas in terms of how well they can absorb and use the components of the digital economy (Feng et al., 2025). Accordingly, the beneficial knock-on effects of the growth of the rural digital economy can take diverse forms (Wang C. et al., 2025). Although most previous research has suggested that the digital economy contributes to the economic growth of rural areas, some scholars have also raised concerns about negative effects, such as the "digital divide" and the "crowding-out effect" (Wang H. et al., 2025). Furthermore, the "capability gap" of farmers is a crucial factor constraining the effectiveness of the process of promoting shared prosperity among farmers (Meng et al., 2023). Urban-rural integration is encouraged by the digital economy, but it may also impede the equalization of public services in urban and rural regions, which might ultimately impede the shared prosperity of both (Li et al., 2022; Lu et al., 2025a).

Additionally, the rural digital economy's impact demonstrates a threshold effect in certain domains. For instance, its influence on the urban-rural income gap follows a "reverse U-shaped" trend—initially widening before eventually narrowing the disparity (Wang S. et al., 2025). This supports the argument by Jiang et al. (2022) and Zhang et al. (2023) that the digital economy plays a significant threshold role in narrowing income gaps. Similar patterns are observed in urban-rural consumption differences. The effect of digital finance on agricultural economic growth also displays threshold characteristics. When development is below a critical point, expanding rural financial elements may hinder growth; once it exceeds the threshold, the positive contribution becomes evident (Wang J. et al., 2025).

Therefore, the relationship between the development level of the rural digital economy and its effectiveness in promoting farmers' shared prosperity is likely to exhibit similar threshold-driven dynamics. First, it varies across different regions and development stages. Second, its positive effect may be constrained by its low level of development. Third, as the rural digital economy develops, several problems might lead to certain negative impacts on the promotion of shared prosperity among farmers. As such, the relationship between these two elements does not adhere to a traditional linear pattern. Consequently, the following hypothesis was put forward:

> *H3: There are variability and threshold effects in the way that the rural digital economy promotes shared prosperity among farmers.*

3 Materials and methods

3.1 Data source

According to data availability, this study examined 31 Chinese provincial-level entities between 2013 and 2022. When there were gaps in the data, linear interpolation was used to fill them in. Moreover, monetary unit-denominated data were adjusted using the GDP deflator to account for changes in prices between years. The initial data came from the statistical yearbooks of the relevant provinces and cities for each year, as well as from publications like the "China Statistical Yearbook," "China Rural Statistical Yearbook," "China Urban-Rural Statistical Yearbook," "China Population and Employment Statistical Yearbook," "China Education Statistical Yearbook," "China Rural Management Statistical Yearbook," "Peking University Digital Inclusive Finance Index," and data published on the official websites of the Ministry of Agriculture and Rural Affairs, the National Bureau of Statistics, and Alibaba.

3.2 Variable construction and definitions

This study's explained variable was shared prosperity among farmers (*FCP*). The achievement of shared prosperity involves two main aspects: the continuous advancement of productive forces to enhance overall economic levels; and the upholding of the principles of socialist fairness and justice, to prevent the emergence of wealth disparities and polarization (Borjigin et al., 2025; Lyu et al., 2025; Mao and Chen, 2025; Nga and Kesumo, 2025). To achieve shared prosperity in rural areas, it is essential to address residents' material, cultural, and environmental needs by improving infrastructure, public services, and living conditions. Emphasizing spiritual and cultural development—such as promoting traditional agrarian values—also helps enhance rural cultural soft power (Wang et al., 2022b; Wang, 2023).

Accordingly, this study constructs a comprehensive evaluation index system with two dimensions: overall prosperity and shared prosperity among farmers, which is quantitatively assessed using the entropy method, as presented in Table 1. According to the method of entropy weight, we standardized the data of sub-indicators and calculated the proportion, entropy value, difference coefficient, and weight of each indicator. Among them, the positive and negative values of each sub-indicator are shown in the table, and the standardized formula is shown in Equations 1, 2. The explained variables, explanatory variables, and mediating variables in this paper are all calculated by the entropy weight method, and the subsequent calculation steps will not be repeated. To avoid the potential collinearity problem among the sub-indicators, we conduct the variance inflation factor (VIF) test on all the second-level sub-indicators used to construct the composite index. The results show that: the average VIF value of variable FCP is 3.654 (<5), and the maximum VIF is 4.85 ("Per capita consumer level ratio between urban and rural areas"). The VIF values of each sub-indicator are fully listed in the last column of Table 1.

$$X_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (1)$$

$$X_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})} \quad (2)$$

Digital economy development in rural areas is the key explanatory variable (*RDE*). An overview of the "Key Priorities for Digital Rural Development" published in the past 4 years highlighted key aspects of the rural digital economy, including the development of digital industries in rural regions, the digitalization of rural government, the supply of intelligent services for rural citizens, and rural digital infrastructure. A digital economic environment, digital infrastructure, digital agricultural transformation, and digital lifestyle enhancement are the four main components that make up the idea of the rural digital economy (Feng et al., 2025; Lin and Peng, 2025; Wang and Zhang, 2025; Xing et al., 2025). Economic development is based on the digital economic environment. Digital infrastructure is crucial for upgrading industries, while digital agricultural transformation is key to industrial advancement, and digital lifestyle services ensure quality of life. On this basis, this study developed a methodology for measuring the growth of the rural digital economy that includes three dimensions: the digitization of the agricultural sector, the digitalization of rural life services, and the rural digital economic environment. Table 2 shows the quantitative evaluation of these aspects using the entropy method. Each second-level sub-index has also been tested by the variance inflation factor (VIF) and is listed in the last column of Table 2.

High-quality agricultural development (*HQA*) is the mediating variable. According to the findings of previous research, high-quality agricultural development is a broad term with many contributing variables and a rich meaning (Zhang et al., 2022; Wu and Shi, 2023). This study constructed a measurement

TABLE 1 Measurement indicator system for shared prosperity among farmers.

Dimension	Primary indicator	Secondary indicator	Measurement indicator	Direction	VIF
Overall prosperity of farmers	Material prosperity	Income level of farmers	Rural individuals' per capita disposable income	+	-
		Property income level of farmers	Rural inhabitants' asset income per capita	+	2.14
		Consumption structure of farmers	Rural Engel coefficient ratio	-	1.99
	Spiritual wellbeing	The spiritual civilization of farmers	Rural dwellers' per capita spending on culture, education, and leisure	+	2.83
		Rural cultural and educational development	Number of cultural stations in townships and villages per ten thousand people	+	4.93
		Rural ecological environment	Average agricultural carbon emissions	-	1.76
		Entertainment of farmers	Rural TV program's coverage rate	+	2.52
Farmers' shared wellbeing	Distribution	Urban-rural income gap	The ratio of per capita income in urban and rural areas	-	4.59
		Urban-rural consumption gap	Per capita consumer level ratio between urban and rural areas	-	4.58
		Group distribution gap	The proportion of residents receiving minimum living security	-	3.16
	Public services	Rural infrastructure	Penetration rate of rural sanitary toilets	+	1.64
		Rural health care	The number of rural health clinics for every 10,000 rural dwellers	+	2.80
		Rural education level	Rural dwellers' average number of years of schooling	+	3.72
		Rural social welfare	Rural dwellers' average per capita transfer income	+	1.94

TABLE 2 Measurement indicator system for rural digital economy development.

Primary indicator	Secondary indicator	Measurement indicator	Direction	VIF
Rural digital economy environment	Digitally skilled workforce	The proportion of information technology professionals to the total rural workforce	+	-
	Digital inclusive finance	Development Index for Digital Inclusive Finance	+	2.08
	Digital agricultural technology	Number of agrometeorological stations	+	1.82
Agricultural industry digitalization	Digital agricultural investment	Agricultural R&D investment	+	1.63
	Agricultural e-commerce development	Number of Alibaba-constructed villages	+	2.06
	Digital agricultural production power	Total power of agricultural machinery	+	2.29
Digitalization of Rural Life Services	Construction of rural logistics	Rural express delivery routes	+	3.78
	Rural internet usage	The proportion of rural households with broadband access	+	2.13
	Rural digital service consumption	Rural dwellers' per capita spending on communication and transportation	+	2.65

index system based on five dimensions: innovation, coordination, output, environment, and openness. Specifically, the dimension of innovation relates to agricultural innovation investment, whereby both financial investment and agricultural professional technology investment help improve the yield quantity and quality. The dimension of coordination emphasizes the coordinated development of three industries and between urban and rural regions. The dimension of output is the purpose of development, as agricultural high-quality development must ensure the sharing of the benefits of high-quality development among all farmers. The dimension of environment emphasizes sustainable development and the fact that agricultural high-quality development must be low-carbon. Finally, the dimension of openness relates to the long-term coordination of resources both at home and abroad, and to expanding the foreign market. The specific indicators of these five dimensions of high-quality agricultural development are presented in Table 3. Similarly, each second-level sub-index has also been tested by the variance inflation factor (VIF) and is listed in the last column of Table 3.

Control variables are other factors influencing shared prosperity among farmers. The variables listed below were chosen for this study: (1) Marketization Level (*market*): represented by

TABLE 3 A system of indicators for measuring the degree of high-quality agricultural development.

Dimension	Primary indicator	Secondary indicator	Measurement indicator	Direction	VIF
Innovation	Innovation support	Agricultural fiscal support	The percentage of municipal funds allocated to research and technology	+	-
	Innovation outcomes	Agricultural entrepreneurship and innovation	The proportion of "One Village One Product" demonstration villages	+	1.64
Coordination	Industry coordination	Agricultural industry structure adjustment	1-(Total output value of farm output / total output value of agriculture, forestry, animal husbandry, and fishery)	+	1.52
	Urban-rural coordination	Urban-rural dual comparison coefficient	Primary industry output value ratio divided by the secondary and tertiary industry output value ratio	+	1.07
Output	Land output	Agricultural land productivity	Increased value of primary industry per total crop sown area	+	2.77
	Labor output	Agricultural labor productivity	Increased value of primary industry per rural population	+	2.72
	Grain output	Agricultural grain output rate	Food yield per grain crop sown area	+	1.89
Environment	Resource consumption	Per capita electricity consumption	The amount of power used by per rural population	-	1.41
	Environmental protection	Agricultural pollution control	Discharge of ammonia nitrogen in agricultural wastewater	-	1.49
		Living environment management	Harmless treatment rate of domestic waste	+	1.23
Openness	Resource optimization	Rural households contract land transfer	The total amount of farmland contracted by the family divided by the total area contracted by the household management	+	2.26
		Agricultural fixed asset investment	Percentage of fixed assets invested in agriculture by rural households	+	3.00
	Market optimization	Agricultural market openness	Total agricultural product imports and exports	+	2.03

the marketization index; (2) Foreign Investment Level (*invest*): determined by dividing the total value of imports and exports from businesses with foreign investments by the regional GDP; (3) Population Labor Structure (*labor*): represented by the total population dependency ratio (i.e., support rate of the working population); and (4) Local Fiscal Support (*gov*): determined by the local spending on forestry, agricultural, and water issues to GDP. In general, industrial structures with different economic types and different market levels may have effects on rural economic development. To a certain extent, labor structure may also affect how the local agricultural economy develops and how successful farmers are. Moreover, from the standpoint of capital supply, local fiscal assistance and foreign investment have an impact on how different aspects of the regional economy develop. Table 4 displays the descriptive statistics for each variable.

3.3 Model specification

The study developed the following benchmark regression model based on this analysis:

$$FCP_{i,t} = \beta_0 + \beta_1 RDE_{i,t} + \beta_2 COT_{i,t} + \mu_i + \varepsilon_{i,t} \tag{3}$$

In Model (1), i and t represent the province and time, respectively; β is the coefficient to be estimated; *FCP* denotes the level of shared prosperity among farmers; *RDE* represents the level of rural digital economy development; *COT* indicates the set of control variables; and μ and ε denote the province fixed effects and the random disturbance term, respectively.

To further examine the authenticity of the theoretical mechanism, we constructed a mediating effects model using rural high-quality development level (*HQA*) as the mediating variable. The mediating effects model is as follows:

$$HQA_{i,t} = \alpha_0 + \alpha_1 RDE_{i,t} + \alpha_2 COT_{i,t} + \mu_i + \varepsilon_{i,t} \tag{4}$$

$$FCP_{i,t} = \gamma_0 + \gamma_1 RDE_{i,t} + \gamma_2 HQA_{i,t} + \gamma_3 COT_{i,t} + \mu_i + \varepsilon_{i,t} \tag{5}$$

In Model (2) and Model (3), $HQA_{i,t}$ indicates the high-quality agricultural development, and the meaning of other variables are the same as that in Model (1).

In light of the intricate relationship between the rural digital economy and shared prosperity, we built a regime-dependent panel threshold regression model using the rural digital economy as the threshold variable to investigate the non-linear relationship between these two variables preliminarily, citing Hansen (1999):

$$\begin{aligned} FCP_{i,t} &= \delta_0 + \delta_1 RDE_{i,t} I(RDE \le \lambda_1) + \delta_2 RDE_{i,t} I(\lambda_2 < RDE \le \lambda_2) \\ &+ ... + \delta_m RDE_{i,t} I(\lambda_{n-1} < RDE \le \lambda_n) + \lambda_{n+1} RDE_{i,t} I(RDE > \lambda_n) + \\ &\lambda_{n+2} COT_{i,t} + \mu_i + \varepsilon_{i,t} \end{aligned} \tag{6}$$

In Model (4), *RDE* functions as the threshold variable as well as the key explanatory variable; δ is the coefficient to be estimated; λ represents the threshold value to be estimated; and $I(\cdot)$ is the restriction function; if the expression included in parenthesis is

TABLE 4 Descriptive statistical results.

Variable	Sample	Mean value	Standard error	Minimum	Maximum
FCP	310	0.3398	0.0861	0.1162	0.6365
RDE	310	0.1091	0.0855	0.0191	0.4683
HQA	310	0.2159	0.0944	0.0651	0.4876
Market	310	8.1402	2.1931	−0.1610	12.8640
Invest	310	9.9995	14.1884	0.0005	75.4850
Labor	310	39.5694	7.0428	22.7000	56.7000
Gov	310	3.7515	3.6663	0.6762	26.2110

true, I equals 1, if otherwise, it equals 0. Other variables have the same meaning as Model (1).

To capture the dynamic nature of shared prosperity and potential endogeneity concerns, we employ the system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). The model is as follows:

$$FCP_{i,t} = \eta_0 + \eta_1 FCP_{i,t-1} + \eta_2 RDE_{i,t} + \eta_3 COT_{i,t} + \mu_i + \varepsilon_{i,t} \quad (7)$$

In Model (5), $FCP_{i,t-1}$ represents the one-period lag of the explained variable, common prosperity of farmers, and the remaining variables are consistent with Model (1).

4 Results

4.1 Panel data stationarity test

4.1.1 Stationarity test of the series

To minimize the possibility of spurious regressions in the empirical analysis, it is essential to conduct unit-root tests on the variables. In this study, two methods were employed for the unit root test: the Levin–Lin–Chu (LLC) test and the Fisher-Augmented Dickey-Fuller (Fisher-ADF) test. These tests help determine whether the time-series data used in the analysis are stationary, which is a critical precondition for reliable regression analyses in panel data studies. Table 5 presents the test results. The results show that in the LLC test, the original values of all variables pass the unit root test. In the ADF-Fisher test, the original values of the three variables: FCP, market, and gov, pass the unit root test and are considered to be stationary time series. However, variables RDE, labor, and invest cannot reject the null hypothesis of the existence of a unit root. Therefore, these variables are non-stationary in their original form but become stationary after first-order differencing.

4.1.2 Testing for cointegration

Cointegration tests are typically conducted when a model has multiple variables; the prerequisite for cointegration testing is that the highest order of differencing among the variables is at least 2. In this case, after the unit-root tests, some variables were found to be stationary, but not the other variables. The variables RDE, labor, and invest were all first-order integrated, resulting in the highest order of differencing at 1. Therefore, it was possible to perform cointegration tests on these variables. The results of the Pedroni cointegration test in Table 6 indicated that at a 1% significance level, the null hypothesis of "no cointegration relationship exists in the model" was rejected. This finding suggests a long-term equilibrium relationship among the variables, allowing for further empirical regression analyses. The presence of cointegration implies that the variables are linked by a stable long-term relationship, and deviations from this relationship are corrected in the long run. This is an important condition for conducting panel data regression analysis.

4.2 Baseline regression results

Based on Model (1), we explore the direct effect between rural digital economy and farmers' shared prosperity. Table 7's Columns (1) and (2) provide the results of the benchmark regression; Column (1) displays the findings without adjusting for additional variables, while Column (2) displays the results following such control. The rural digital economy's coefficient was consistently positive and statistically significant in both instances, suggesting that it plays a part in fostering farmers' shared prosperity. Following the addition of control variables, the rural digital economy coefficient's size slightly decreased. This suggests that even after considering variations in the influence of economic development status, marketization level, foreign investment level, and the structure of the labor force, the rural digital economy still significantly promotes shared prosperity among farmers.

Specifically, a 1% increase in rural digital economy development may lead to an increase of ~0.3326% in shared prosperity among farmers. In those rural areas where the digital economy penetrates, the unique advantages of digitization, interconnection, and information technology efficiently propel the agriculture sector's growth. The advancement of digital technology raises rural populations' quality of life and encourages regional economic growth. According to the study of the control variables, farmers' progress and shared prosperity are facilitated by increased marketization and labor force structure adjustments. In several rural areas of China, the agricultural industry is predominantly characterized by small-scale farming and low levels of specialization. This implies that there is a significant chance to improve the effectiveness and caliber of agricultural development. Additionally, it clearly illustrates the necessity to enhance the high efficiency and high quality of agricultural development as well as

TABLE 5 Panel unit root test results.

Variables and testing methods	Raw value		First order difference
	LLC	ADF-fisher	ADF-fisher
FCP	−6.2830***	3.4304***	-
RDE	−9.7403***	1.0234	1.4087*
Market	−14.0441***	9.4109***	-
Labor	−8.1443***	0.9563	18.4802***
Invest	−6.5607***	−1.2248	15.1939***
Gov	−11.9342***	6.1656***	-

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

TABLE 6 Results of the sequence cointegration relationship test.

Pedroni test	Statistic	*p*-value
Modified Phillips–Perron test	7.6315	0.0000
Phillips–Perron test	−18.3407	0.0000
Augmented Dickey-Fuller test	−11.3984	0.0000

Note: With trend terms, the lag order was automatically chosen as 1, and Bartlett kernel estimation was used.

the significance of creating a rural digital economy to support the high caliber, high degree of innovation, and effective growth of the agricultural sector.

4.3 Endogeneity treatment and robustness test

4.3.1 Endogeneity treatment

Potential endogeneity concerns were included in the regression analysis. First, the explained variable and the core explanatory variable may have a bi-directional causal relationship. This implies that the development of a rural digital economy could be influenced by the level of shared prosperity among farmers, while also exerting a reverse influence on the latter during the process. Second, there is the issue of omitted variables, whereby the regression may fail to include some crucial variables that affect the explanatory variable, leading to a correlation between the error term and the explanatory variable. Therefore, to address endogeneity issues, this study used the Instrumental Variables (IV) Two-Stage Least Squares (2SLS) method, using the lagged one-period rural digital economy development level as the instrument.

The examination of the data revealed that the first-stage F-statistic was 845.48, significantly exceeding the critical value according to the empirical rule. The C-Donald F-statistic of 2,926.02 was significantly greater than the critical 10% significance level, indicating the absence of weak instrument problems. The K-Paaprk LM statistic, equal to 23.69 and with a corresponding *P*-value of 0.000, suggests that the instrument variables are not subject to identification issues. Columns (3) and (4) of Table 7 illustrate the results of the instrumental variable regression. Overall, the significance increased, although the direction, size, and significance of the coefficients stayed mostly the same in comparison to the benchmark regression. This suggests that the encouraging impact of the rural digital economy on farmers' shared prosperity is further reinforced when endogeneity issues are resolved, hence validating H1.

4.3.2 Robustness test

First, a separate regression analysis was performed by period. For ease of comparison, Column (1) of Table 8 corresponds to Column (2) of Table 7. The sample was split up into two periods in consideration of the different phased features of digital economic development: an early stage of digital economy, from 2013 to 2017, and a later stage, from 2018 to 2022. The findings mainly agreed with the baseline regression results, as seen in Table 8's Columns (2) and (3). It was discovered that both the early and late phases of the development of the rural digital economy supported farmers' collective development. The coefficient size of the early stage was slightly greater than that of the later stage.

The second was the exclusion of the four municipalities that were immediately under the central government. Due to their differences in economic scale, development base, and digital infrastructure, these provinces may have an impact on how the rural digital economy promotes farmers' shared prosperity generally. The regression results are shown in Column (4) of Table 8 following the removal of data from the four municipalities that are directly under the federal government. Although the regression coefficient was somewhat lower, the effect was still substantial, which further confirms the results' dependability. These results are also in line with the baseline regression results.

Third, the core variables were replaced. To avoid measurement errors in the core variables, principal component analysis was conducted to re-measure the core variables while keeping the indicator system unchanged. First, the Kaiser-Meyer-Olkin (KMO) test was performed, yielding KMO values of 0.751 for the RDE indicator system and 0.692 for the FCP indicator system, both of which were above the threshold of 0.6. Additionally, the corresponding *P*-values passed the 1% significance test, indicating the appropriateness of the indicator systems for principal component analysis. Therefore, the RDE and the FCP were recalculated and, on this basis, the results of the re-estimation of the benchmark model are displayed in Table 8's Column (5). The reliability of the baseline regression findings was confirmed by the calculated coefficients for the influence of the rural digital

TABLE 7 Benchmark regression results and endogeneity treatment results.

Variable	(1)	(2)	(3)	(4)
	FCP	FCP	FCP	FCP
RDE	0.9233*** (0.1447)	0.3326*** (0.1060)	0.8931*** (0.0651)	0.4091*** (0.0605)
Market		0.0127* (0.0063)		0.0089* (0.0052)
Labor		0.0070*** (0.0011)		0.0063*** (0.0007)
Invest		−0.0003 (0.0012)		0.0004 (0.0008)
Gov		0.0027 (0.0037)		−0.0005 (0.0036)
Constant term	0.2391*** (0.0158)	−0.0833** (0.0353)		
Provincial effects	Yes	Yes	Yes	Yes
Control variables	No	Yes	No	Yes
Sample size	310	310	279	279
Coefficient of determination	0.5042	0.7571	0.4482	0.7127

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust.

TABLE 8 Results of the robustness test.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	FCP	FCP	FCP	FCP	FCP	FCP
RDE	0.3326*** (0.1060)	0.6446** (0.2519)	0.4671*** (0.1049)	0.2619** (0.1083)	0.2924*** (0.0856)	1.0652* (0.5333)
RDE^2						−1.2739 (0.9451)
Constant term	−0.0833** (0.0353)	−0.0650 (0.0525)	0.1461*** (0.0394)	−0.1167*** (0.0307)	0.3351* (0.1819)	−0.0863** (0.0329)
Provincial effects	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	310	155	155	270	310	310
Coefficient of determination	0.7571	0.6501	0.6614	0.7383	0.5795	0.7723

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust.

economy on farmers' shared prosperity, which continued to be considerably positive.

Fourth, the regression model was replaced. To avoid problems in the construction of the benchmark model, this study innovatively developed a robustness test benchmark model, as follows:

$$FCP_{i,t} = \gamma_0 + \gamma_1 RDE_{i,t} + \gamma_2 RDE_{i,t}^2 + \gamma_3 COT_{i,t} + \mu_i + \varepsilon_{i,t} \quad (8)$$

Table 8's Column (6) displays the regression results of model 6. There were no notable variations from the baseline regression results, and the regression coefficient was considerably positive, thus validating the conclusion that rural digital economy development promotes shared prosperity among farmers.

4.4 Heterogeneity analysis

4.4.1 Regional heterogeneity

The sample data was divided into three areas (i.e., eastern, central, and western China) to conduct independent regression estimates due to the possible regional heterogeneity in the influence of the rural digital economy on the shared prosperity among farmers; the outcomes are shown in Table 9. All three of these locations had positive regression coefficients, and the eastern and western regions' regression coefficients passed the significance test. This suggests that the shared prosperity of farmers in the three regions under consideration is positively impacted by the rural digital economy. Regarding the magnitude of the coefficient, significant variations were shown by the coefficients of the eastern area (0.4066), the middle region (1.4857), and the

TABLE 9 Results of the regional heterogeneity analysis.

Variable	Eastern region	Central region	Western region
	FCP	FCP	FCP
RDE	0.4066*** (0.1126)	1.4857 (0.9689)	2.9840*** (0.8427)
Constant term	0.2106** (0.0665)	−0.1757** (0.0669)	0.0325 (0.0615)
Provincial effects	Yes	Yes	Yes
Control variables	Yes	Yes	Yes
Sample size	110	80	120
Coefficient of determination	0.9048	0.8805	0.7750

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust.

western region (2.9840). This regional gradient may reflect several underlying dynamics.

First, the marginal utility of digitalization is higher in less developed regions, where the digital economy is still in the early diffusion stage. Even modest technological improvements can yield substantial returns by bridging information gaps, enhancing market access, and improving agricultural productivity. Second, the western region benefits from stronger policy support and institutional readiness, as national strategies have prioritized rural digital infrastructure and investment in lagging areas. These policies have strengthened local capacity to absorb digital tools, thereby amplifying their developmental impact. Third, the wider urban–rural divide in western China means that rural residents are more sensitive to improvements in digital connectivity and services, which serve to reduce transaction costs, improve income channels, and enable more inclusive access to e-commerce and public platforms. In contrast, eastern regions may suffer from a saturation effect, where digital infrastructure is already mature, and further digitalization yields diminishing returns. Moreover, digital resources in the East may be disproportionately concentrated in urban or commercial sectors, detaching digital infrastructure from farmers' actual needs—a phenomenon that limits the inclusiveness of digital dividends in rural areas.

4.4.2 Analysis of heterogeneity at the development level

To further investigate the differentiated impact of the rural digital economy across varying levels of farmers' shared prosperity, panel quantile regression was employed. The results, presented in Table 10, reveal a clear upward trend in the estimated coefficients from the 10th to the 90th percentile. While the effect at the 10th percentile is statistically insignificant, the impact becomes increasingly significant and stronger at higher quantiles, with the largest coefficient observed at the 90th percentile. This pattern suggests a heterogeneous impact of the rural digital economy depending on farmers' prosperity levels, reflecting what may be described as a "digital empowerment gradient."

Specifically, farmers at lower levels of prosperity may lack sufficient digital literacy, financial capital, or infrastructural access, limiting their ability to leverage digital technologies for economic gains. This aligns with the "digital divide" literature, which emphasizes structural barriers in the initial phases of digital diffusion. In contrast, farmers at higher levels of prosperity are more likely to possess the absorptive capacity necessary to integrate digital tools into their livelihoods, such as engaging in online sales, accessing digital credit, or adopting precision agriculture. As a result, the returns to digital participation increase with development level, reinforcing the observed upward trajectory in the quantile regression coefficients.

4.5 Analysis of the mechanism

The previous Sections presented the results of the theoretical analysis of the mechanism through which the rural digital economy promotes shared prosperity among farmers. Based on Models (2) and (3), this section tested the reliability of this mechanism using sample data. First, we looked into how high-quality agricultural development affects farmers' shared wealth. The regression coefficients of high-quality agricultural development were considerably positive at the 1% level, according to Table 11's column (1). This suggests that high-quality agricultural development indeed promotes shared prosperity among farmers, thus confirming H2.

Next, mediation model regressions were performed. The three-stage estimated findings of the mediation effect are shown in Columns (2), (3), and (4) of Table 11, which presents the results. In particular, the findings in Column (3) confirm that the rural digital economy and high-quality agricultural development are positively correlated. When high-quality agricultural development was employed as a mediator, Table 11's column (4) demonstrates that the estimated coefficients of the relationship between the rural digital economy and high-quality agricultural development on shared prosperity among farmers were 0.1949 and 0.5232, respectively, both passing the significance level test.

Although the rural digital economy's coefficient remained considerably positive, its magnitude was lower than that of the direct effect. This research suggests that the process of advancing the rural digital economy is significantly mediated by high-quality agricultural development. The mediating effect of high-quality agricultural development was around 41.41% of the entire effect in terms of magnitude. Sobel and Bootstrap tests were used to confirm the regression results. The results, shown in Table 11, confirmed the existence of this mediating effect, suggesting that high-quality agricultural development has a significant mediation role in the promotion, thereby reconfirming hypothesis H2.

4.6 Threshold effect analysis

The positive impact of the development of the rural digital economy on shared prosperity among farmers may not adhere to a traditional linear relationship. To verify this, we first employed the Hansen bootstrap test to determine whether a significant threshold

TABLE 10 Results of the analysis of heterogeneity in development level.

Variable	(0.10)	(0.25)	(0.50)	(0.75)	(0.90)
	FCP	FCP	FCP	FCP	FCP
RDE	0.2709 (0.2294)	0.3001* (0.1594)	0.3370*** (0.1009)	0.3664*** (0.1152)	0.3865** (0.1522)
Market	0.0123 (0.0170)	0.0125 (0.0118)	0.0128* (0.0075)	0.0130 (0.0085)	0.0131 (0.0113)
Labor	0.0075*** (0.0026)	0.0072*** (0.0018)	0.0069*** (0.0011)	0.0067*** (0.0013)	0.0065*** (0.0017)
Invest	−0.0005 (0.0026)	−0.0004 (0.0018)	−0.0003 (0.0011)	−0.0003 (0.0013)	−0.0002 (0.0017)
Gov	0.0134 (0.0137)	0.0084 (0.0096)	0.0020 (0.0061)	−0.0031 (0.0069)	−0.0066 (0.0091)
Provincial effects	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes
Sample size	310	310	310	310	310

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust.

TABLE 11 Results of the mediating effect.

Variable	(1)	(2)	(3)	(4)
	FCP	FCP	HQA	FCP
RDE		0.3326*** (0.1060)	0.2632*** (0.0677)	0.1949* (0.1114)
HQA	0.5968** (0.2350)			0.5232** (0.2524)
Constant term	−0.0983*** (0.0298)	−0.0833** (0.0353)	0.0099 (0.0300)	−0.0885*** (0.0304)
Provincial effects	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes
Sample size	310	310	310	310
Coefficient of determination	0.7878	0.7571	0.7509	0.7948
Sobel test				4.3590 (0.0000)
Bootstrap test				[0.0013, 0.2741]

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust. The Sobel test reports z-values and p-values, while the Bootstrap test reports confidence intervals at the 95% level.

effect exists. According to the results, which are shown in Table 12, the bootstrap computation produced a *P*-value of 0.000 under the null hypothesis I condition, suggesting the existence of a threshold effect at the 1% confidence level with a threshold value of 0.1527. Similarly, the test results under the null hypothesis II condition, at the 1% confidence level, two threshold values were accepted, equal to 0.0332 and 0.0549. The hypothesis III test yielded an F-value of 26.29 and a *P*-value of 0.6270. The rejection of this null hypothesis suggests the existence of only two threshold values, in which rural digital economic development promotes shared prosperity among farmers.

Building upon this result, Model (4)'s threshold model was used to do a regression; Table 13 displays the findings. When the development of the rural digital economy was <0.0332, its impact on shared prosperity among farmers was significantly negative.

TABLE 12 Results of the threshold effect test.

Null hypothesis	Threshold value		P-value	F-value
I	Th1	0.1527	0.0000	43.85***
II	Th2-1	0.0332	0.0000	41.50**
	Th2-2	0.0549		
III	Th3		0.6270	26.29

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; Null hypotheses I, II, and III indicate the presence of one, two, and three threshold values, respectively.

When it was between 0.0332 and 0.0549, it still played an inhibiting role, although the size of the inhibiting coefficient decreased sharply. This suggests that shared prosperity might be negatively

TABLE 13 Results of the threshold regression analysis.

Variable	FCP	lnFCP
RDE	0.3326*** (0.1060)	
RDE (RDE≤0.0332)		−2.1179*** (0.3010)
RDE (0.0332<RDE≤0.0549)		−0.2375** (0.1088)
RDE (RDE>0.0549)		0.4202*** (0.0565)
Constant term	−0.0833** (0.0353)	−0.0205 (0.0215)
Provincial effects	Yes	Yes
Control variables	Yes	Yes
Sample size	310	310
Coefficient of determination	0.7571	0.7901

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust.

impacted by an excessively low level of the rural digital economy. When rural digital economy development exceeded 0.0549, with the coefficient rising to 0.4202, its encouraging impact on farmers' shared prosperity began to manifest. These findings show how the development of the rural digital economy affects shared prosperity and exhibits a "U-shaped" pattern, initially inhibiting it and then promoting it.

Insufficient construction of digital infrastructure and severe information asymmetry in the early stage may worsen the imbalance of resource allocation. This is evident in the first stage, when the development level of the rural digital economy has not yet reached the threshold value (<0.0332). At this point, the digital economy has not yet developed a structured, durable, and usable pattern, and it is challenging to genuinely benefit the large rural populations. Even while the inhibitory impact is lessened in the second stage (0.0332–0.0549), the "delayed release" of the digital dividend is still not a major positive driving factor. The crucial transition from "quantitative laying" to "qualitative transformation" occurs at this developmental stage. It might result in the "useless network" and "idle technology" problems if there is no support structure or advancement in digital literacy.

The impact of the rural digital economy on farmers' shared prosperity starts to significantly improve when its development level surpasses the second threshold value of 0.0549. This suggests that digitalization has essentially finished the shift from "accessibility" to "availability" and "availability." At this point, farmers were able to take part more actively and reap significant benefits from the digital economy, genuinely experiencing the increase in income and the leveling of public services brought about by technological empowerment. Mechanisms like information matching, upgrading agricultural products, online skills training, and rural financial inclusion were all gradually improved. This implies further that there isn't a straightforward linear connection between them. The development of the rural digital economy has a real impact on farmers' shared prosperity once it reaches a certain point.

4.7 Dynamic effect analysis

The system GMM method incorporates the lagged dependent variable to account for temporal inertia, thereby, Model (5) can effectively identify the dynamic effects of rural digital economy development on farmers' shared prosperity. Table 14 shows the results. The AR (1) test is significant ($p = 0.004$), while AR (2) is not significant ($p = 0.110$), indicating that the model has no serial correlation problem. Hansen test $p = 0.130$, >0.1, does not reject the null hypothesis, and the instrumental variables are generally valid. The results show that the model setting is reasonable, the instrumental variables are effective, and the dynamic estimation results have statistical explanatory power and robustness.

TABLE 14 System GMM regression results.

Variables	FCP
L.FCP	0.9321*** (0.0229)
RDE	0.0645** (0.0294)
Constant term	0.0300*** (0.0083)
AR (1)	0.004
AR (2)	0.110
Hasen	0.130
Control variables	Yes
Sample size	279
Number of provinces	31

Note: *, **, *** denote significance at the 10%, 5%, and 1% level, respectively; the standard errors in parentheses are robust.

The regression results show that the lagged term of FCP is significantly positive at the 1% level (coefficient = 0.9321), indicating that the current level of farmers' shared prosperity is significantly affected by the previous state to a large extent. This confirms that shared prosperity is characterized by distinct dynamic persistence. Even after controlling for this dynamic effect, the rural digital economy (RDE) remains a significant positive contributor (coefficient = 0.0645), indicating that after controlling for the previous state, the digital economy still has an independent and positive role in promoting farmers' shared prosperity. These findings confirm that the rural digital economy plays an increasingly important and sustainable role in advancing farmers' shared prosperity over time. The dynamic effect observed in the empirical results reflects not only the path-dependent nature of shared prosperity but also the structural inertia embedded in institutional, behavioral, and spatial dimensions. The accumulation of digital infrastructure, the gradual formation of rural digital capabilities, and the delayed policy feedback jointly contribute to a persistent and self-reinforcing process.

5 Conclusion and policy recommendations

5.1 Conclusion

This study investigated whether and how the development of the rural digital economy promotes shared prosperity among farmers. It defined the concepts of the rural digital economy and shared prosperity, clarified the intrinsic mechanisms by which the development of the rural digital economy fosters shared prosperity among farmers, and created an index system for evaluation of both. To explore the underlying mechanisms between the two, this study introduced high-quality agricultural development as a mediating variable and empirically analyzed the impact of rural digital economy development on shared prosperity among farmers using data from 31 provincial-level units in China between 2013 and 2022.

The findings revealed that rural digital economy development can facilitate the shared prosperity of farmers. This promoting effect is further enhanced after addressing endogeneity issues. The validity of this finding was validated by several robustness tests. The growth of the rural digital economy had a greater positive impact on farmers' shared prosperity in China's western and eastern regions than in the country's central area. Rural digital economy development contributes positively to the shared prosperity among farmers at various levels of development. Additionally, the extent of this promoting effect increases with higher percentile levels. This suggests that the improvement in the level of shared prosperity among farmers is accompanied by an increase in the efficiency of the rural digital economy's contribution to this promotion. The impact of the development of the rural digital economy in promoting shared prosperity among farmers exhibited a "U-shaped" pattern, whereby its promoting effect on shared prosperity among farmers begins to appear following a particular developmental stage. Furthermore, this study found that high-quality agricultural development serves as a crucial mediating factor in the rural digital economy's promotion of shared prosperity among farmers.

5.2 Policy implications

The following policy suggestions are provided by this study. First, there has to be a steady advancement in the rural digital economy, and its capabilities must be directed toward empowering shared prosperity among farmers. The government should take a holistic approach to building a rural digital economy, consciously directing digital technology to serve rural economic development. This entails the creation of a conducive environment for the incorporation of the digital economy into rural production and living, seizing the opportunities presented by digital development, and empowering rural economic growth. Local governments should boost investment in rural digital infrastructure, directing digital economy elements to rural areas to strengthen the foundations for shared prosperity among farmers. Special focus should be placed on upgrading information infrastructure across isolated parts of China's central and western provinces to connect the digital, resource, and information divides in underdeveloped areas, thereby building a solid digital foundation to advance shared prosperity among farmers.

Second, the pathways and mechanisms through which the digital economy empowers shared prosperity among farmers must be facilitated, fully leveraging the role and functions of the rural digital economy. Local governments should support and guide the high-quality development of local agricultural industries, incorporating rural industries into regional economic development and transformation plans. The modernization and restructuring of traditional agricultural sectors in China's central and western rural areas should get particular emphasis. Local governments should encourage and support farmers in utilizing digital technologies to develop precision agriculture and smart agriculture, respond to farmers' urgent needs for high-tech agricultural technologies and equipment, promote high-quality development in agriculture, and ultimately, enable farmers and rural communities to achieve prosperity together.

Third, relevant policy measures that strengthen the foundations for the achievement of shared prosperity among farmers must be enhanced. Local governments should encourage and guide the movement of commercial and industrial capital into rural regions, intentionally directing capital to support underdeveloped rural regions. They should also encourage financial institutions to leverage digital inclusive finance to better serve rural markets, strengthen agricultural finance, and effectively meet the investment and financing needs of various new agricultural enterprises. Local governments should seize the opportunities presented by rural digitalization, supporting and guiding agricultural industries in utilizing digital and intelligent tools to enhance their overall production capacity. Those regions where agriculture is a significant part of the economy must expend focused effort on improving agricultural productivity and development levels, to expedite China's transition from a large agricultural nation to a strong nation. Local governments should keep pushing for the growth of rural market systems, the modernization and transformation of traditional rural business models, the bidirectional movement of industrial goods into rural areas and agricultural products into urban areas, the removal of obstacles to the economic development of both urban and rural areas, and the advancement of rural market expansion and modernization. Finally, the coordinated regional development strategy should be gradually advanced by the national government, fostering a leapfrog development in the underdeveloped areas of the central and western parts of China. This entails addressing issues including income inequality and promoting balanced development between regions, better facilitating the achievement of shared prosperity among farmers.

5.3 Limitations and future research

This study has several limitations that should be noted. First, due to data availability, the growth of the rural digital economy is constrained to provincial-level indicators, which may mask intra-provincial variations and village-level dynamics. Second, although the study introduces agricultural high-quality development as a mediating variable, other potentially important mechanisms—such as digital literacy, institutional support, or market integration—were not fully examined. Third, the cross-sectional heterogeneity across different farmer groups, particularly in terms of gender, age, or education, remains underexplored. Future research could address these gaps by employing more granular data, such as household or village-level surveys, to better capture micro-level effects. It is also worth exploring how combinations of digital infrastructure, policy environments, and social capital jointly determine the impact of the digital economy on the prosperity of society. In sum, whereas this study provides fresh perspectives on how shared prosperity is supported by the rural digital economy, further empirical exploration is needed to refine the mechanisms and assess long-term effects in broader contexts.

Data availability statement

The data that support the findings of this study are openly available in Figshare at https://doi.org/10.6084/m9.figshare.29802209.v2. The dataset includes panel data from 2013 to 2022 across Chinese provinces, covering indicators of rural digital economy development, income distribution, high-quality agriculture, and control variables used in the fixed effects and mediation models.

Author contributions

ZL: Formal analysis, Writing – review & editing, Supervision, Writing – original draft, Funding acquisition, Conceptualization. DG: Data curation, Methodology, Writing – review & editing, Conceptualization, Validation, Formal analysis, Resources, Visualization, Writing – original draft. QW: Data curation, Writing – original draft, Conceptualization, Writing – review & editing, Investigation, Methodology, Software. HF: Conceptualization, Writing – review & editing, Resources, Supervision, Software, Writing – original draft, Data curation, Formal analysis, Methodology, Visualization.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was supported by the General Project of the National Social Science Foundation of China (Grant No. 23BGL203), the General Project of Humanities and Social Sciences of Chongqing Municipal Education Commission (Grant Nos. 23SKGH011; 23SKJD122), and the Key Scientific and Technological Research Project of Chongqing Municipal Education Commission (Grant Nos. KJZD-K202400302; KJQN202100314).

Acknowledgments

Zhaoyang Lu gratefully acknowledges Professor Jingang Zhao of the University of Saskatchewan for his valuable guidance, and the Department of Economics at the University of Saskatchewan for their hospitality during his visit from January 2024 to September 2025.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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