Digitalization of Rural Industry and Rural Technology Acceptance Driving Comprehensive Rural Revitalization in China

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Abstract: Agriculture and rural areas are heavily impacted by digital technology, and the digitization of rural industry reorganizes the rural production system through the spread and use of new technologies and gives comprehensive rural revitalization a boost. A thorough assessment system for the digitization of rural industry, comprehensive rural revitalization, rural technology adoption, and rural policy interventions is built using the entropy technique and panel data from 30 Chinese provinces between 2010 and 2023. This study empirically evaluates the moderating influence of rural policy interventions and the mediating role of rural technology acceptance between digitization of rural industry and comprehensive rural revitalization by building a mediation effect model with a moderating effect.

The study found (1) the direct effect shows that the digitization of rural industries can promote rural revitalization through digital facilities, applications, management and industries, forming a systematic drive for comprehensive rural revitalization. (2) The mediating effect shows that the digitization of rural industry can significantly enhance farmers' technology acceptance and thus promote comprehensive rural revitalization through paths of digital facilities, applications, management and industries. (3) The moderating variables show rural policy interventions can strengthen the promotional effect of technology acceptance on comprehensive rural revitalization and have a significant positive moderating effect on the relationship between rural technology acceptance and comprehensive rural revitalization. This study suggests to provide a theoretical foundation and a practical route for the rural digital transformation path, practical insights are gained from this, including enhancing technical training, optimizing rural infrastructure, and conducting stable policy assessments.

Keywords: Digitization of rural industry, Comprehensive rural revitalization, rural technology acceptance, rural policy interventions, Entropy technique

INTRODUCTION

Since China's rural revitalization strategy was put into effect in 2017, it has emerged as the primary means of advancing the development and enhancement of agriculture and rural areas. This has created a "five-in-one"[1] framework for development (Chen & Kong, 2022), whereby industrialization thrives, ecology is balanced, culture thrives, governance improves, and life is better. A major contributor to rural revitalization, the significance of digital transformation in agriculture and rural economic and social development has gained prominence in recent years. The conventional rural industrial landscape is being restructured by the rapid adoption of digital technologies, and policy interventions' diminishing effects on the diffusion of technology have made this a crucial practical suggestion for fostering rural revitalization (Maythu et al., 2024). Rural areas continue to struggle with issues such delayed industrialization, unequal resource distribution, poor technology uptake, inadequate infrastructure, and inadequate technology application, despite the government's increased investment and policy support (Suhrab et al., 2024). The digital divide is still noticeable, indicating that the connection between technological dissemination and digital transformation is still crucial. In 2024, the Internet penetration rate in rural areas was 63.8%, significantly lower than that of urban areas (85.3%). This illustrates the total inconsistency between the cooperative processes[2] of governmental intervention and technology dissemination (Bi, 2024). To speed up the overall revitalization of rural areas, it is crucial to thoroughly examine the roles that technology diffusion and policy interventions play in the digital transformation of rural industries.

The term "industrial digital transformation" describes how information technology, particularly the internet, big data, the Internet of Things (IoT), artificial intelligence (AI), and other technologies, can be used to convert traditional industries into a digitally driven industrial structure (Zhang et al., 2024). Industrial digital transformation in rural areas encompasses aspects

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[1] Rural revitalization covers five main dimensions: industrial prosperity, green living, rural civilization, effective governance, and prosperous living. Industrial development increases income and sustains the economy, while green living emphasizes environmental protection and quality of life. Promoting rural civilization promotes cultural pride and social cohesion. Effective governance ensures the grassroots legal system, while prosperous living emphasizes the provision of public services and well-being. Together, these five dimensions form a scheme for rural revitalization.

[1] It is an action taken to bridge this gap of disparities in access to online resources, information and opportunities. While governments may be involved in promoting technology, such efforts may not be effective in reaching rural communities. This digitalization has significant implications, potentially hindering economic development, educational opportunities and access to essential services in rural areas. Bridging this gap requires targeted government interventions, including infrastructure development, affordable internet solutions and digital literacy programs specifically designed for rural populations.

including agricultural product distribution, rural services, and rural management in addition to agricultural production data (Javaid et al., 2024). In addition to increasing the market distribution and consumption efficiency of agricultural products through digital platforms to increase farmers' income, digital technologies can boost agricultural production efficiency and encourage the growth of the agricultural industrial chain (Abiri et al., 2023). The country's rural internet retail sales in 2024 totaled 2.47 trillion yuan, increasing 5.1% year over year, according to the Ministry of Agriculture and Rural Development (MARD), indicating a notable push for digitalization in the rural economy. Rural revitalization is significantly impacted by the industry's digitalization. First, by employing smart tools and technologies, it encourages the development of better agricultural production techniques, maximizes the distribution of production resources, and boosts production efficiency (Abbasi et al., 2022). Second, the digitalization of farmers' lives enhances their quality of life and encourages the broad use of digital payments, rural e-commerce, and other services (Ahmed et al., 2025). Third, digitalization is also crucial for ecological environmental protection and rural governance. For example, big data analysis can be used to increase the effectiveness of rural governance, and digital technology can be used to monitor and enhance the ecological environment's quality (Bulkis et al., 2025).

The majority of the research that has been done on rural digitization and revitalization has been on how digital technology affects agriculture and income, frequently ignoring its wider benefits (Deng et al., 2024). Although it has an impact on farmers' attitudes, few research look at rural technology acceptance as a mediating factor (Cattaneo et al., 2025; Liu et al., 2024). Furthermore, little is known about how policies influence the use of technology and aid in rural revitalization.

The literature has provided the framework for investigation of this study, but the most of these previous researches have only looked at the topic generally and at a broad view, without a detailed examination of the precise connection between the digitization of rural industry and all-comprehensive rural revitalization thorough examination. Therefore, to build the relationship between rural industry digitization, rural technology adoption, the comprehensive rural revitalization research model, and propose the moderating variable rural policy interventions based on the appropriate data of 30 Chinese provinces from 2010 to 2023.

This study aims to:

(1) Investigate how to support comprehensive rural revitalization by examining the digitization of rural industry through digital facilities, digital applications, digital management, and digital industry four elements (digital facilities, digital applications, digital management, and digital industry),

(2) Investigate how the relationship between digitization of rural industry and comprehensive rural revitalization is influenced by rural technology acceptability as a mediating variable, and

(3) Examine the ways in which the relationship between rural technology adoption and comprehensive rural revitalization is mediated by local government policy action.

By examining the effects of rural industry digitization, rural technology adoption, and local government policy interventions on comprehensive rural revitalization, it will be possible to identify the mechanisms underlying these factors' interactions, provide empirical support for the government's development of more focused rural revitalization policies, and offer theoretical justification for the digitization of rural industry and its transformation. Additionally, this study also provides a reference guideline to promote inclusive rural development and theoretical support for sustainable rural industrial transformation.

LITERATURE REVIEW

The Resource-Based View (RBV) for China's Digitalization of Rural Industry and Revitalization

Various resources are the primary source of competitive advantage for organizations or regions, according to resource-based view (RBV) theory, which was first put forth by Penrose in 1959 and subsequently extended and developed by Wernerfelt in 1984 and Barney in 1991 (Hoopes et al., 2003). Digitization of rural industries re-configures the rural resource endowment system through technological embedding, and access to and effective use of key resources, such as digital technologies, directly affects the competitiveness of rural industries (Bi, 2024). The digital facilities such as 5G base stations and smart sensors act as physical resources, breaking through the geographical constraints of traditional agriculture, to achieve inter-temporal integration of production factors (Jiang et al., 2022); digital applications such as agricultural big data platforms and rural live e-commerce as technological resources to enhance the marginal output efficiency of land and labor (Deichmann et al., 2016); digital management such as rural cloud-based government system and agricultural products block-chain traceability as organizational resources to optimize the decision-making mechanism of resource allocation (Wang et al., 2021);digital industries such as rural digital cultural tourism and rural smart logistics as innovation resources to generate new rural economic forms (Zhang et al., 2023). This process shows itself as a leaping path from resource digitization to capability integration to value networking in China, where the digital economy is growing quickly (Zhang et al., 2021). Through digital infrastructure investment and industrial policy support, the government transforms traditional production factors into digital capital, which fits the transformation chain of “resource-capability-performance” in the RBV, and provides an endogenous impetus for the comprehensive revitalization of the countryside (Mao et al., 2021).

Technology Acceptance Model (TAM) for China’s Rural Digital Transformation

Davis (1989) developed the Technology Acceptance Model (TAM) to identify and explain users' adoption of new technologies. Perceived Utility (PU) and Perceived Ease of Use (PEOU) influence how people accept new technologies. In rural digital transformation, the application of TAM needs to be adapted and expanded with the characteristics of the rural society (Davis et al., 2024). Perceived usefulness is reflected in the practical utility of the technology in production and life, such as smart irrigation systems that directly improve farmers' income by saving water and increasing production; level of computer literacy limits perceived ease of usage (Elijah et al., 2018), and simplified operation design can significantly reduce the threshold of use (Elijah et al., 2018); the unique acquaintance social network in rural China further strengthens the diffusion of technology, and the acquaintance social network can further enhance the diffusion of technology, and the social network of the rural population is more and more important. Social network further strengthens technology diffusion, and the demonstration effect of acquaintances can enhance group adoption willingness (Chu & Choi, 2011). It is significant to recognize that rural technology adoption is influenced by social networks and group synergy in addition to individual behavioural choices (Xue et al., 2021). The transmission mechanism of "cognition-behavior-result" in the TAM model is established when technology adoption reaches a scale, as digital applications become deeply ingrained in rural production and life scenes, supporting the achievement of comprehensive rural revitalization goals like industry thrives and ecological governance (Ferrari et al., 2022).

Innovation Diffusion and Policy Determinant in Rural Development

In development economics, the diffusion of innovation theory was first developed by Rogers (1962) to explain how innovations spread through social systems over time (Rodríguez-Pose & Crescenzi, 2008). Diffusion of innovations has been widely used to explain the relationship between technological progress and economic development, revealing that the diffusion of technologies necessarily crosses the gap between “early adopters” and “laggards” (Geels, 2004). Rural areas often face barriers to innovation diffusion due to poor infrastructure and human capital, and policy interventions regulate the diffusion process through a number of mechanisms. First, demand-side incentives, agricultural machinery purchase subsidies to reduce the cost of technology adoption digital skills training to enhance farmers' operational capabilities (Sun & Wu, 2004); second, supply-side support, government-led construction of village-level e-commerce service stations and agricultural Internet of Things bases to make up for the lack of market supply (Liu et al., 2018); Third, the institutional environment optimization, which is a key factor in the diffusion process, through the “People’s Republic of China Data Security Law” to regulate the boundaries of technology application, balancing efficiency and risk (F. Zhang et al., 2024). China's practice shows that the combination of “government-led and market synergy” policy tools has a significant moderating effect. For example, the digital village pilot policy has not only accelerated the speed of technology diffusion through financial subsidies, talent stationing and regulatory support, but also reshaped the rural governance structure through the adjustment of the benefit distribution mechanism such as the digitization of land transfer (Chao & Biao, 2021). This intervention strategy verifies the central role of policy as a “diffusion catalyst” in innovation diffusion theory.

HYPOTHESIS DEVELOPMENT

Effects of digitization of rural industry

The digital transformation of rural industries is the main driving force of rural revitalization in the digital economy era. Through the digital technology embedded in the entire agricultural production, administration and service chain, it redefines the allocation of rural production factors (Wen et al., 2024). Rural digital facilities, the coordinated development of digital applications, digital management and digital industries can lower the threshold for technology application, increase the willingness of rural subjects to adopt technology, and then systematically affect the industrial prosperity, ecological livability, cultural prosperity, state administration and the richness of livelihood resources of rural revitalization (Salemink et al., 2017). In particular, the construction of digital facilities can improve the level of infrastructure, especially the digitalization of transportation, communication and energy (Di Silvestre et al., 2018). Promoting digitalization can make agricultural production more efficient and the application of agricultural technologies more widespread, resulting in better competitiveness and industrial development in rural areas. Digital management can improve rural governance capabilities, make resource allocation more efficient, and promote the ecological living and cultural prosperity of rural areas (Zambon et al., 2019). The rapid development of digital industries promotes industrial restructuring and promotes rural development. Restructuring the industry and enhancing the innovation capability of rural industries promote rural economic growth and livelihood prosperity (Zhou et al., 2023), thus proposing the following hypotheses as:

H1: Digitization of rural industry can promote comprehensive rural revitalization.

H1a: Digital facilities can promote comprehensive rural revitalization.

H1b: Digital applications can promote comprehensive rural revitalization.

H1c: Digital management can promote comprehensive rural revitalization.

H1d: Digital industry can promote comprehensive rural revitalization.

In the new digital era, the impact of the digital transformation of rural industries on agricultural technology adoption is becoming more and more obvious. The advancing role of rural digital facilities, digital applications, digital management, and digital industries has greatly increased the opportunities for farmers to access and use new technologies (Zhou et al., 2023). The construction of digital facilities can further intelligentize rural infrastructure, improve farmers' access to advanced technologies, and smooth the circulation of information and technology promotion (Liu & Liu, 2024). Promoting digital applications through smart agricultural equipment and technological tools can improve the efficiency and productivity of agricultural production, and the adoption of this technology encourages farmers to be more interested in new technologies (Walter et al., 2017). Digital management improves farmers' level of knowledge and understanding of scientific and technological management, and encourages them to participate more in learning and practicing modern agricultural technologies (Klerkx et al., 2019). The development of digital industries not only increases farmers' acceptance of new agricultural industries, but also positively promotes farmers' acceptance of digital technologies (Fabregas et al., 2019). Therefore, the following hypotheses are proposed:

H2: Digitization of rural industry can promote rural technology acceptance.

H2a: Digital facilities can promote rural technology acceptance.

H2b: Digital applications can promote rural technology acceptance.

H2c: Digital management can promote rural technology acceptance.

H2d: Digital industry can promote rural technology acceptance.

Mediating effects of rural technology acceptance

Rural technology acceptance directly affects farmers' motivation to adopt new technologies, and the promotion and adoption of new technologies is an important driving force for comprehensive rural revitalization. Improving rural technology acceptance can increase the efficiency and quality of agricultural production, promote rural economic development, and contribute to overall rural revitalization, including ecological well-being and cultural prosperity. Verma & Sinha (2018) have shown that there is a significant positive relationship between rural technology acceptance and economic income, production efficiency, and living standards high technology adoption can effectively improve agricultural production capacity and income levels, which promotes industrial prosperity and facilitates rural revitalization (Han et al., 2022). In addition, rural areas with high technology adoption can better allocate resources, promote the modernization of rural governance, and promote the development of ecological well-being, cultural

prosperity, and other areas (Ribot et al., 2006). Therefore, the following hypothesis is proposed:
H3: Rural technology acceptance can promote comprehensive rural revitalization.

The mediating role of rural technology acceptance between the digital transformation of rural industries and the comprehensive revitalization of rural areas is becoming more significant. Digital transformation not only promotes rural revitalization by directly improving the efficiency and economic benefits of agricultural production, but also indirectly promotes the development of rural enterprises by increasing rural technology acceptance (Yang et al., 2023). In particular, digital facilities accelerate the process of agricultural modernization by popularizing smart farm machinery and other equipment, lowering the threshold for technology adoption, and enhancing farmers' confidence in technologies (Zhu et al., 2024). Digital applications, with the help of e-commerce platforms and other tools, through user-friendly convenient experiences, can increase farmers' willingness to adopt technologies, stimulate rural innovation and entrepreneurial vitality (Wang et al., 2023). Digital governance relies on e-government systems and agricultural traceability platforms to increase data transparency, enhance farmers' sense of participation, and promote the modernization of rural governance systems (Abdelkhalek et al., 2021). Digital industries, through big data analysis and other technologies, help farmers understand market rules and the returns from technologies, and drive the expansion of the industrial chain and ecological agriculture (Pan et al., 2024). Therefore, the following hypotheses are proposed:

H4: Rural technology acceptance plays a mediating role between digitalization of rural industry and comprehensive rural revitalization.

H4a: Rural technology acceptance plays a mediating role between digital facilities and comprehensive rural revitalization。

H4b: Rural technology acceptance plays a mediating role between digital applications and comprehensive rural revitalization。

H4c: Rural technology acceptance plays a mediating role between digital management and comprehensive rural revitalization。

H4d: Rural technology acceptance plays a mediating role between digital industry and comprehensive rural revitalization

The moderating effect of rural policy interventions

Rural policy interventions present as a moderating role between rural technology acceptance and comprehensive rural revitalization. Local governments’ fiscal spending, tax incentives and innovation policies provide financial support and technical guidance for rural digital transformation (Dong et al., 2023). Policy-led digital demonstration projects enhance farmers' perceived usefulness of technology through the “bench-marking effect”, while accurate digital management training enhances farmers’ ability to participate in data decision-making, thereby increasing the effectiveness of technology-enabled governance (Rijswijk et al., 2019). Rural policy interventions can also increase farmers' motivation to participate in digital transformation through incentives, which will enhance the facilitation effect of technology adoption on comprehensive rural revitalization, diversity of policy interventions, and diversity of policy interventions (Khanna, 2021). Therefore, long-term stable policy support is more conducive to the sustainability of technology adoption, whereas "campaign-style" intervention may lead to resource mismatch. Therefore, the following hypothesis is proposed:

H5: Rural policy interventions have a moderating role between rural technology acceptance and comprehensive rural revitalization.

The conceptual framework is presented in figure 1.

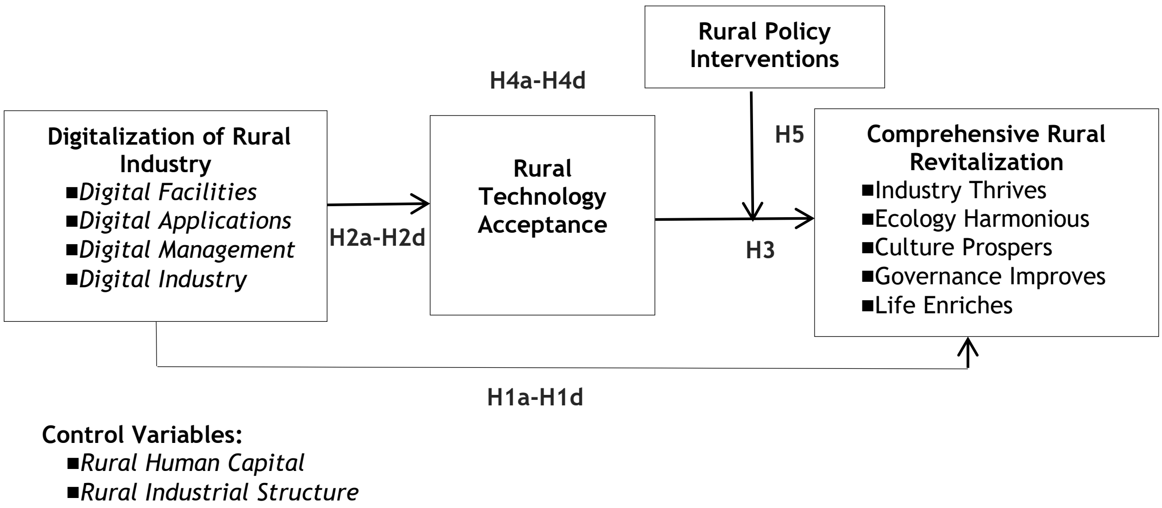

Figure 1 Conceptual Framework

RESEARCH DESIGN

Data sources

This study uses the agricultural and rural development statistics of 30 Chinese provinces, except Xizang, Hong Kong, Macao, and Taiwan, from 2010 to 2023 as its primary research target to approve the readiness and steadiness of the entire data. The primary sources of the data are the China Rural Statistics Yearbook, reports from the Ali Research Institute, statistics from the National Bureau of Statistics, the Ministry of Industry and Information Technology, and information found on the Ministry of Agriculture and Rural Development of China's official website. In some places, linear interpolation was used to fill in the missing indicators of specific years in the data collection and statistics. To analyze the data of indicators such as the degree of digitization of rural industry and the degree of comprehensive rural revitalization, the study also uses the entropy value approach. The composite indices are then obtained as the data for the empirical study.

Model Formulation

Based on the theoretical model in figure 1, this study is being done on the effects of rural industry digitization on comprehensive rural revitalization, on the effects of rural industry digitization on comprehensive rural revitalization, and on the transmission path of rural industry digitization - rural technology acceptance - comprehensive rural revitalization. This is developed to support the existence of the transmission path of digitization of rural industry and rural technology acceptance. Furthermore, this study is conducted whether rural policy interventions have a major effect on rural revitalization. And whether the transmission pattern of digitization of rural industry - rural technology acceptance - comprehensive rural revitalization exists. The existence of the transmission path "rural technology acceptance-comprehensive rural revitalization", as the regulating mechanism of rural policy interventions (rural policy interventions), is based on the theoretical model in figure 1. Based on the research results of Tang & Chen (2022), Arion et al. (2024), and Zhang et al. (2024), hypotheses, selected time, 30 provinces around China, fixed effects model (FEM) were constructed, respectively, with direct effects, mediation effects, and lag effects logit regression models to systematically test the hypothesized relationship between the variables. The main equations of the model are as follows:

A direct effect models (1) and (2) were constructed to test hypotheses H1, H1a-H1d, H2, and H2a-H2d to examine the direct effect of digitization of rural industry.

$$\mathbf{lnCrr_{it}=\alpha_0+\alpha_1 lnDri_{it}+\alpha_2 lnRhc_{it}+\alpha_3 lnRis_{it}+\mu_i+\delta_t+\varepsilon_{it}} \quad (1)$$

$$\mathbf{lnRTA_{it}=\beta_0+\beta_1 lnDri_{it}+\beta_2 lnRhc_{it}+\beta_3 lnRis_{it}+\mu_i+\delta_t+\varepsilon_{it}} \quad (2)$$

Construct a mediated effects models (3) and (4) for testing hypotheses H3, H4, and H4a-H4d to explore the mediated effects of rural technology acceptance.

$$\mathbf{lnCrr_{it}=\lambda_0+\lambda_1 lnRta_{it}+\lambda_2 lnRhc_{it}+\lambda_3 lnRis_{it}+\mu_i+\delta_t+\varepsilon_{it}} \quad (3)$$

$$\mathbf{lnCrr_{it}=\gamma_0+\gamma_1 lnDri_{it}+\gamma_2 lnRta_{it}+\gamma_3 lnRhc_{it}+\gamma_4 lnRis_{it}+\mu_i+\delta_t+\varepsilon_{it}} \quad (4)$$

A moderating effects model (5) was constructed using the interaction effect (rural policy interventions×rural technology acceptance) and used to test hypothesis H5 to investigate the moderating effect of rural policy interventions.

$$\mathbf{lnCrr_{it}=\theta_0+\theta_1 lnRta_{it}+\theta_2 lnRpi_{it}+\theta_3 ln(Rta_{it}\times Rpi_{it})+\theta_4 lnRhc_{it}+\theta_5 lnRis_{it}+\mu_i+\delta_t+\varepsilon_{it}} \quad (5)$$

These include: Crr_{it}, Dri_{it}, Rta_{it}, Rpi_{it}, are the level of comprehensive rural revitalization, the level of digitization of rural industry, the level of rural technology acceptance and rural policy interventions in year t of province i, respectively. The Rhc_{it} and Ris_{it}re are control variables of rural human capital level and industrial structure level. The μ_i and δ_t denote area and time fixed effects, respectively. The ε_{it} is an error term.

VARIABLE SELECTION

Dependent variable: Comprehensive rural revitalization (CRR)

The implementation of the rural revitalization strategy has led to the steady strengthening and improvement of the evaluation index system for the development level of rural revitalization, which has shown a trend. Generally, this study selects five first-level indicators (flourishing industry, ecological livability, prosperous countryside, effective governance, and rich life) to build a consistent indicator system based on the overall requirements of the 20-word guideline for rural revitalization. This study refers to the indicator system listed in the research report on the rural revitalization strategy, integrates the requirements of rural digital industry development, and draws on the construction methods of Geng et al. (2023) and Pan et al. (2025). The modified indicators of 18 specific indicators of this study as shown in table 1.

Table 1 Comprehensive rural revitalization indicators definition

<table>
<tr><th>Element</th><th>Indicator</th><th>Definition</th><th>Reference</th></tr>
<tr><td rowspan="4">Industry Thrives</td><td>Labor productivity (yuan/person)</td><td>Added value of primary industry/total rural population</td><td rowspan="4">Liu, Gong, & Gong (2022); Geng, Liu, & Chen (2023); Cheng, Yang, Li, Xu, & Cao (2024)</td></tr>
<tr><td>Land productivity (CNY yuan/mu)</td><td>Added value of primary industry/total crop sown area</td></tr>
<tr><td>Total mechanical power per capita (kW/person)</td><td>Agricultural machinery total power/primary industry employees</td></tr>
<tr><td>Proportion of added value of primary industry (%)</td><td>Added value of primary industry/CDP</td></tr>
<tr><td rowspan="4">Ecology Harmoni-ous</td><td>Tap water penetration rate (%)</td><td>Number of farmers using tap water/total number of farmers</td><td rowspan="4">Liu, Gong, & Gong (2022); Geng, Liu, & Chen (2023)</td></tr>
<tr><td>Hygienic toilet penetration rate (%)</td><td>Number of farmers using sanitary toilets/total number of farmers</td></tr>
<tr><td>Green coverage (%)</td><td>Green coverage area/total rural area</td></tr>
<tr><td>Forest coverage (%)</td><td>Forest area/total land area</td></tr>
<tr><td rowspan="3">Culture Prospers</td><td>Public library collections per capita (book/person)</td><td>Public library collection/total rural population</td><td rowspan="3">Sun, Zheng, Ye, & Lin (2023); Liu, Gong, & Gong (2022); Geng, Liu, & Chen (2023)</td></tr>
<tr><td>Cultural station coverage (%)</td><td>Number of cultural stations in townships/total number of townships</td></tr>
<tr><td>Culture and education expenditure ratio (%)</td><td>Culture and education expenditure/total consumption</td></tr>
<tr><td rowspan="3">Governa n-ce Improves</td><td>General public budget expenditure (CNY billion)</td><td>Wages and benefits, goods and services, capital expenditures and other expenditures</td><td rowspan="3">Liu, Gong, & Gong (2022); Geng, Liu, & Chen (2023)</td></tr>
<tr><td>Proportion of village improvement carried out (%)</td><td>Number of villages carrying out sanitary toilet penetration rate improvement/total number of administrative villages</td></tr>
<tr><td>Village committee coverage rate (%)</td><td>Number of village committees/total number of administrative villages</td></tr>
<tr><td>Life Enriches</td><td>Elderly care service institutions</td><td>Number of elderly care service institutions/total rural population</td><td>Zhang, Huang, Chen, Zhu, & Gan</td></tr>
</table>

	(individuals/10,000 people)		(2022); Liu, Gong, & Gong (2022); Geng, Liu, & Chen (2023)
	Comparison of income between urban and rural residents (%)	Urban residents income/rural residents income	
	Engel coefficient (%)	Total food expenditure/total consumer expenditure	
	Per capita disposable income (CNY yuan)	Disposable income of rural residents/permanent household population	

Independent variable: Digitization of rural industry (DRI)

To create a corresponding evaluation index system for the digitization of rural industry in four dimensions (digital facilities, digital applications, digital management, digital industry), this study combines the attribute characteristics of rural industry development with the index system of industrial digitization development level developed by Nhamo et al. (2020) and Li et al. (2024). Digital facilities, digital applications, digital management, digital industry are four elements to build a matching assessment index system for rural industry digitization. The specific indicators include (1) digital facilities, such as the rural internet penetration rate (%) and other four indicators to measure to construct a corresponding evaluation index system to explain the digitization of rural industry. (2) Digital applications, such as testing scenarios for agricultural production environments (number) and other three metrics to gauge the extent of digital technology's use in agricultural production. (3) The rural postal communication service level (individual/person) is one of three indicators used to quantify digital management. (4) Digital industry, which is measured by four indicators, including online sales of rural agricultural products (CNY100 million yuan). Table 2 displays the digitalization of rural industry indicator definition with references.

Table 2 Digitalization of rural industry indicator definition

Element	Indicator	Definition	Reference
Digital Facilities	Internet penetration rate（%）	Number of regional Internet users/regional population	Maja, Meyer, & Von Solms (2020); Muhammad et al. (2021); Li & Wen (2023)
	Mobile phone coverage (department)	Number of mobile phones owned by rural residents per 100 households	
	Optical cable line coverage (department)	Length of optical cable line per square kilometer	
	Rural delivery routes (km)	The length of the delivery route to rural users	
Digital Applic -ations	Agricultural production environment testing situation (number)	Number of environmental and agricultural meteorological observation service stations	Stankulova, Barreca, Rebaudengo, & Rolando (2024); Muhammad et al. (2021); Li & Wen (2023)
	Rural mechanization level (CNY10,000 kilowatts/1,000 hectares)	Total agricultural machinery power per unit sown area in rural areas	
	Degree of electrification of agricultural production (CNY yuan/kWh)	Added value of agriculture, forestry, animal husbandry and fishery/total rural electricity consumption	

Digital Manage-ment	Rural postal communication service level (individual/person)	The average population served by each postal business outlet in rural areas	Pavlov & Palatkin (2021); Danica et al. (2020); Muhammad et al. (2021); Li & Wen (2023)
	Rural digitalization base	Number of Taobao villages	
	Fixed investment in social digital services (CNY10,000 yuan)	Fixed asset investment in transportation, warehousing and postal industries	
Digital Industry	Online sales of rural agricultural products (CNY100 million yuan)	Online sales of rural agricultural products	Min et al. (2022); Muhammad et al. (2021); Li & Wen (2023); Memo & Pieńkowski (2023)
	Number of corporate websites (number)	Number of websites per 100 companies	
	Enterprise participation in e-commerce activity （%）	Proportion of enterprises participating in e-commerce transaction activities	
	Fixed investment in social digital industry (CNY10,000 yuan)	Information transmission computer services and software industry fixed asset investment	

Mediating variable: Rural technology acceptance（RTA）

The mediating variable is rural technology acceptance, which measures the degree of acceptance and adoption of digital technologies by rural subjects. The World Bank report on “digital dividends” examines in detail the spread and impact of digital technologies globally (Group, 2016). Key indicators of regional technology acceptance are the Digital Adoption Rate, the Internet Penetration Rate, and the Technology Utilization Rate. “Technology Utilization Rate.” The Digital Economy and Society Index (DESI) developed by Eurostat also specifies that the Internet Usage Rate and the Enterprise Digital Technology Adoption Rate, as well as the Internet Penetration Rate, the Internet Penetration Rate and the Technology Utilization Rate, are the most important indicators of the economy (Skare & Soriano, 2021). Digital Technology Adoption Rate, can be used to measure regional technology acceptance (Colussi et al., 2024). Therefore, in this study, the rural technology acceptance evaluation index adopts the “Rural Technology Utilization Rate” as the evaluation index, and the rural technology market's turnover as a percentage of GDP (rural technology market transaction volume/GDP) is used to measure it.

Moderating variable: Rural policy interventions (RPI)

The moderating variable is rural policy interventions, which is used to measure the impact of policy measures taken by the government or relevant agencies in promoting technology acceptance and adoption on the overall effect. Based on the research of Maiorano et al. (2021) and Dong & Chunlai (2023), the ratio of local government general public service expenditures (in billions of dollars) to GDP is used to determine the “degree of rural government intervention”. The calculation uses the ratio of rural fiscal expenditure or local government expenditure on general public services (in billions of dollars) to GDP as the measurement indicator.

Control variables: Rural human capital (RHC) and rural industrial structure (RIS)

Two variables, rural human capital (RHC) and rural industrial structure (RIS), are chosen as control variables to observe the impact of the development level of rural industry digitization on the development level of comprehensive rural revitalization. According to the findings of Wang et al. (2021), Lee & Wang (2025), and Su et al. (2021), the rural human capital (RHC) is calculated as the ratio of the 10,000 students enrolled in higher education to the region's total population. The ratio of tertiary to secondary industrial output is used to measure the rural industrial structure (RIS) (Yu & Luo, 2024).

Empirical Results

Descriptive statistics

Table 3 shows significant fluctuations in the data for the variables and a differentiated distribution. The dependent variable “comprehensive rural revitalization” with Mean = 0.289, SD = 0.117, suggesting that the overall progress is stable but regional differences are limited, and that standardized policies may constrain balanced development (Mallinson, 2021). Given that digitalization of rural industry is still in its infancy and that there are regional imbalances that call for structural policy support (Zhang et al., 2023), the independent variables with the lowest mean values are rural digital facilities (Mean = 0.038), digital applications (Mean = 0.031), digital management (Mean = 0.027), and digital industry (Mean = 0.041). Economic disparities that distinguish technology adoption and policy implementation are shown in the notable fluctuations in rural technology acceptance (Mean = 0.097, SD = 0.163) and rural policy interventions (Mean = 0.340, SD = 0.171) (Scovell, 2022). Between the two control variables, rural human capital (Mean = 0.370, SD = 1.169) develops in a balanced manner, while rural industrial structure (Mean = 0.147, SD = 0.142) shows that the proportion of non-agricultural industries is low and the regional differences are prominent, and the pattern of agricultural dominance has not fundamentally changed. The data reveal that rural areas need to break through the triple bottlenecks of insufficient digital transformation, technology acceptance disconnection and industrial homogeneity.

Table 3 Descriptive statistical analyses of all variables

Variable	Sample	Minimum	Maximum	Mean	Standard Deviation (SD)
Comprehensive rural revitalization (CRR）	420	0.054	0.726	0.289	0.117
Digital facilities (DF)	420	0.008	0.096	0.038	0.020
Digital applications (DA)	420	0.003	0.069	0.031	0.015
Digital management (DM)	420	0.001	0.319	0.027	0.041
Digital industry (DI)	420	0.002	0.333	0.041	0.043
Rural technology acceptance (RTA)	420	0.000	0.997	0.097	0.163
Rural policy interventions (RPI)	420	0.059	0.976	0.340	0.171
Rural human capital (RHC)	420	0.002	0.973	0.370	0.169
Rural industrial structure (RIS)	420	0.004	0.958	0.147	0.142

Hypothesis Testing and Results

Table 4 shows the results of the effects of digitalization of rural industry and comprehensive rural revitalization. The fixed effect model (FEM) is preferred to the random effect model (REM). Therefore, the direct impact of rural industrial digitization on both comprehensive rural revitalization (Model 1) and rural technology acceptance (Model 2) is empirically examined using the FEM. The results of Model 1 show that when the significant level is 1% ($p < 0.01$), the four elements of digitization of rural industry (DRI), namely digital facilities (DF), digital applications (DA), digital management (DM) and digital industry (DI), have a positive effect on comprehensive rural revitalization, and their respective effect coefficients (β) are 2.331, 0.855, 1.050 1.366, confirming the hypothesis that the digitization of rural industry can promote the revitalization of the countryside in all aspects (H1a-H1d), especially through the improvement of infrastructure (β = 2.331) and the industry participating in e-commerce transaction activities or information transmission (β = 1.366) to drive rural development. Similarly, in Model2, when $p < 0.01$, the coefficients of the four elements affecting rural technology acceptance are 1.540, 2.192.0.512, 0.394, respectively. The results support hypotheses H2a–H2d and indicate that increasing farmers' digital technology application skills is crucial, as is raising the level of acceptability of digital infrastructure in rural areas.

Table 4 Results of the effects of digitalization of rural industry and comprehensive rural revitalization

Variable	Model 1 (CRR)				Model 2 (RTA)			
Constant	**0.132**** (0.014)	**0.174**** (0.019)	**0.193**** (0.012)	**0.175**** (0.011)	**-0.057**** (0.011)	**-0.117**** (0.027)	**-0.054**** (0.011)	**-0.055**** (0.011)
Digital facilities (DF)	**2.331**** (0.244)				**1.540**** (0.431)			
Digital applic- -ations (DA)		**0.855*** * (0.355)					**0.512**** (0.105)	
Digital manage- -ment (DM)			**1.050**** (0.122)			**2.192**** (0.849)		
Digital industry (DI)				**1.366**** (0.106)				**0.394**** (0.059)
Rural human capital (RHC)	**0.067*** (0.030)	**0.125**** (0.033)	**0.103**** (0.030)	**0.089**** (0.028)	**0.107*** (0.048)	**0.211**** (0.036)	**0.185**** (0.035	**0.133**** (0.037)
Rural industrial structure (RIS)	**0.289**** (0.036)	**0.285**** (0.040)	**0.197**** (0.037)	**0.166**** (0.034)	**0.375**** (0.061)	**0.462**** (0.056)	**0.462**** (0.056)	**0.333**** (0.057)
Observations	420	420	420	420	420	420	420	420
R-squared	0.315	0.176	0.291	0.403	0.641	0.651	0.648	0.651
Adj. R-squared	0.310	0.17	0.286	0.399	0.638	0.648	0.645	0.648
F-test	63.856**	29.607**	56.962**	93.670**	247.171**	258.307**	254.812**	258.250**
Hausman test	-4.407	12.74**	7.730*	11.74**	8.675*	26.658**	-3.326	19.690**
Model selection	REM	FEM	FEM	FEM	FEM	FEM	REM	FEM
Standard error in parentheses, **p<0.01, *p<0.05.								

Table 5 show the test results of rural technology acceptance as a mediating effect. Model 3, when rural technology acceptance is used as an independent variable, the effect coefficient on comprehensive rural revitalization is β = 0.129 ($p < 0.01$), thus, hypothesis H3 is supported. The results indicate that technology acceptance can drive comprehensive rural revitalization. When rural technology acceptance is used as a mediator for digital facilities (DF), digital applications (DAa), digital management (DM), and digital industry (DI), respectively, the effect coefficients (β) of rural technology acceptance declines at the 1% significant level ($p<0.01$). Meanwhile, the effect coefficients (β) of digital facilities (DF), digital applications (DA), digital management (DM), and digital industry (DI) also showed different degrees of attenuation compared with model 1. It indicates that technology acceptance assumes a partial transmission role in the digital transformation of rural industries, and the H4a-H4d mediated transmission effect is investigated. It shows that farmers' technological adaptability to the new industry is the main bottleneck in digital industry-enabled rural revitalization, and that technological complexity depends more on the conduction of farmers' technological adaptability. To improve the conduction efficiency of the mediating pathway, farmers' technological adaptability to the new industry needs to be strengthened through skills training.

Model 5 in table 5 shows the results of the test of the moderating effect of rural policy interventions in rural technology acceptance and comprehensive rural revitalization. Rural policy interventions, when used as an independent variable, present a negative effect on comprehensive rural revitalization (β = -0.304, $p < 0.01$); this negative effect is slightly attenuated by the introduction of rural technology acceptance (β = -0.299, $p < 0.01$); however, a significant positive effect is seen (β = 1.037, $p < 0.01$) when the interaction effect between rural policy interventions and rural technology acceptance (RTA × RPI) is taken into account, proving Hypothesis H5. The results imply that a notable synergistic impact exists. Although rural policy interventions alone may have limitations, their combination with technology adoption appears to have significant potential to promote rural revitalization. However, this potential depends on various contextual factors, and it is therefore recommended that policy design be tailored to promote technology. Careful consideration of the level of technology adoption among rural residents may improve the overall effectiveness and sustainability of regeneration efforts.

Table 5 Results of the mediation and moderation effects

Variable	**Model 3 (CRR)**	**Model 4 (CRR)**				**Model 5 (CRR)**		
Constant	**0.224**** (0.021)	**0.219**** (0.018)	**0.172**** (0.024)	**0.227**** (0.018)	**0.228**** (0.005)	**0.351**** (0.018)	**0.274**** (0.016)	**0.278**** (0.015)
Digital facilities (DF)		**1.375**** (0.197)						
Digital applic- -ations (DA)			**0.780**** (0.389)					
Digital manage- -ment (DM)				**0.293**** (0.053)				
Digital industry (DI)					**0.684**** (0.077)			
Rural technology acceptance (RTA)	**0.129**** (0.024)	**0.103**** (0.024)	**0.117**** (0.024)	**0.094**** (0.025)	**0.054**** (0.024)		**0.125**** (0.048)	**0.178**** (0.050)
Rural policy interventions (RPI)						**-0.304**** (0.030)	**-0.299**** (0.030)	**-0.266**** (0.031)

RTA×RPI								**1.037**** (0.346)
Rural human capital (RHC)	**0.051**** (0.018)	**-0.047*** (0.022)	**0.043*** (0.018)	**0.040*** (0.018)	**0.074*** (0.031)	-0.017 (0.032)	-0.050 (0.034)	**0.053**** (0.034)
Rural industrial structure (RIS)	**0.225**** (0.029)	**0.166**** (0.029)	**0.235**** (0.029)	**0.207**** (0.029)	**0.161**** (0.028)	**0.323**** (0.036)	**0.228**** (0.051)	**0.231**** (0.050)
Observations	420	420	420	420	420	420	420	420
R-squared	0.641	0.329	0.199	0.297	0.405	0.167	0.38	0.385
Adj. R-squared	0.638	0.322	0.191	0.291	0.4	0.161	0.374	0.377
F-test	247.171**	50.755**	25.726**	43.934**	70.73**	27.755	63.667	51.794
Hausman test	11.891**	2.417*	6.56**	4.165*	23.66**	0.154	-2.594	-10.531
Model selection	FEM	FEM	FEM	FEM	FEM	REM	REM	REM

Standard error in parentheses, **p<0.01, *p<0.05.

To verify the robustness of the regression results, this study chooses rural life enrichment (RLE) to replace the original explanatory variable comprehensive rural revitalization (CRR) for variable replacement model estimation. From the test results of Model 6 in table 6, the effect coefficients (β) of digital facilities (DF), digital applications (DA), digital management (DM), and digital industries (DI) with the replacement variable rural life enrichment (RLE) are 0.184, 0.070, 0.125, and 0.096, respectively, at the 1% significance level ($p < 0.01$). The created explanatory model has strong stability, as evidenced by the consistency of the results and benchmarks regression results (Model 1).

Table 6 Robustness test results

Variable	**Model 6 (RLE)**				**Model 7 (DRI)**	**Model 8 (CRR)**
Constant	**0.035**** (0.003)	**0.045**** (0.003)	**0.039**** (0.002)	**0.039**** (0.002)	**0.077**** (0.007)	**0.155**** (0.019)
Digital facilities (DF)	**0.184**** (0.046)					
Digital applications (DA)		**0.070**** (0.062)				
Digital management (DM)			**0.125**** (0.022)			
Digital industry (DI)				**0.096**** (0.021)		
Lag1_(digitalization of rural industries)					**0.433**** (0.044)	

Pred_digitalization of rural industries						**0.459**** (0.130)
Rural human capital (RHC)	**0.017**** （0.006)	**0.020**** （0.006)	**0.019**** (0.005)	**0.019**** （0.006)		**0.085*** (0.034)
Rural industrial structure (RIS)	**0.032**** (0.007)	**0.019**** （0.007)	**0.023**** (0.007)	**0.024**** (0.007)		**0.272**** (0.039)
Observations	420	420	420	420	419	419
R-squared	0.141	0.108	0.172	0.151	0.188	0.190
Adj. R-squared	0.135	0.093	0.166	0.144	0.186	0.184
F-test	23.858**	16.814**	28.765**	24.451**	96.477**	32.415**
Hausman test	19.021**	13.813**	32.939**	0.155**	5.279*	4.36*
Model selection	FEM	FEM	FEM	FEM	FEM	FEM

To address potential endogeneity issues and to verify the robustness of the regression results, endogeneity tests were conducted using two-stage least squares (2SLS). The analysis uses the lagged one-period value of the core explanatory variable digitization of rural industry (Lag1_Dri) as an instrumental variable to ensure its exogeneity. In Model 6 (first stage regression), the relationship between the lagged period of digitization of rural industry (Lag1_Dri) and the endogenous variable of digitization of rural industry was examined, and the results showed a significant positive effect (β = 0.433, $p < 0.01$), which indicating that digitization exhibits persistence over time. The validity of the instrumental variables was confirmed by the model's $R^2 = 0.188$, $F = 96.477$, $p < 0.01$. Model 7 (second stage regression) assessed the effect of the predicted value of digitization of rural industry on (comprehensive rural revitalization. Model 8, the results show a significant positive effect (β = 0.459, $p < 0.01$), consistent with the analysis of Model 1. In addition, rural human capital (β = 0.085, $p < 0.05$) and rural industrial structure (β = 0.272, $p < 0.01$) also show significant positive effects, highlighting the importance of human capital and industrial structure reforms in enhancing comprehensive rural revitalization. The results are consistent with ealier analyses, the findings support models in tables 4 and 5 strongly.

CONCLUSIONS

This study uses the entropy method to measure the level of development of rural industry and comprehensive rural revitalization, based on data on rural development from 30 Chinese provinces between 2010 and 2023. By building the multiple regression models, it systematically accepts the validity of the transmission path of "digitization of rural industry—rural technology acceptance—comprehensive rural revitalization." By constructing a multiple intermediary regulation model, we systematically verified the “digitization of rural industry--rural technology acceptance-- comprehensive rural revitalization”. By constructing a multiple intermediary regulation model, the study systematically verifies the effectiveness of the transmission path of “digitization of rural industry--rural technology acceptance-- comprehensive rural revitalization” and reveals the regulation mechanism of rural policy interventions. The following are the study's main findings:

1. Comprehensive rural revitalization is directly affected by the statistically significant digitization of rural industry. All four elements of digitization of rural industry which are digital facilities, digital applications, digital management, and digital industry—shows relevance in the positive directions. The digital facilities and digital industry show the strongest effects among them. These results imply that the development of creative digital industries ("software") and the fundamental creation of digital infrastructure ("hardware") work in concert as two forces that support comprehensive rural revitalization (Boonlua et al., 2024).

2. There is clear variation across several digital elements in the relationship between digitalization of rural industry and comprehensive rural revitalization. The rural technology acceptance shows a partial mediating influence. According to the mediation effects model, the effect of rural technology acceptance fluctuates based on whether it pertains to digital industry followed by digital management, digital facilities, and digital applications, respectively. Particularly, the digital application area is where the mediating function of rural technology acceptance is most noticeable, highlighting the significance of farmers' adaptability and readiness to embrace new technologies. These results give acceptance to the idea of a "technology adoption gap" and highlight the necessity of tackling the crucial "last mile" issue of ensuring efficient end-user involvement and utilization to advance rural digital transformation.

3. The relationship between rural technology acceptance and overall comprehensive rural revitalization is moderated by rural policy interventions. The effectiveness of a synergistic "policy–technology" appliance is established by the moderation analysis, which shows that the connection between policy support and technology acceptance greatly increases the impact on revitalization outcomes. Interestingly, this effect is more noticeable when rural people have relatively high levels of technology acceptance, indicating that policies work best when they are in line with local technical capabilities. The results, however, also highlight the potential disadvantages of stand-alone policy initiatives and emphasize the significance of adaptive policy design that takes rural communities’ actual digital literacy and readiness into account.

The study reveals that the revitalization of China's countryside requires the construction of a triadic synergistic mechanism of “digital infrastructure, technological capability, and policy system”. To eventually achieve the unity of digital empowerment and humanistic development, it is recommended that priority be given to promoting the equalisation of digital infrastructure, concentrating on enhancing farmers' training in internalising digital technology, and simultaneously creating a "technology-adapted" policy toolbox to maximise the intensity of policy provision through dynamic monitoring of technology adoption.

IMPLICATIONS

This study can provide the policy recommendations of digitalization of the rural industry as follows:

1. It is to increase investment in rural digital infrastructure construction. The government should increase investment in rural digital infrastructure construction, improve network coverage and penetration of technical equipment in rural areas, and provide a solid material foundation for the digital transformation of rural industries.

2. It is to promote the dissemination and application of digital technology in rural areas. Comprehensive digital technology training activities should be carried out to improve farmers' ability to apply digital technology and increase their acceptance and adaptation to new technologies as to promote the digital transformation of rural industries.

3. It is to improve the efficiency of rural policy intervention appliances. When formulating and implementing rural policies, the government should fully consider the technological acceptance of rural residents, systematically integrate policies with technology promotion, improve the effectiveness and relevance of policies, and promote the comprehensive revitalization of rural areas.

4. It is to continue monitoring and evaluation of policies. The government should establish a worthy policy impact evaluation system, continuously monitor and evaluate the impact of policies and measures, timely improve and enhance the effectiveness of policies according to the evaluation results, and ensure the effectiveness of sustainable policies.

Limitations

This study has a number of limitations even though it provides insightful information about how digitization of rural industries propels overall rural revitalization. The use of panel data at the provincial level may limit the ability to capture subtle, micro-level phenomena by masking localized dynamics that take place at the province or county level. Furthermore, the assessment of technology adoption ignores important contextual elements that influence rural technology adoption, such as social networks, demographic diversity, and cultural norms, in favor of concentrating only on perceived utility and usability. Additionally, the moderating effect of policy interventions was mostly studied from the perspective of intensity thresholds, which left the interplay between various policy tools—like fiscal subsidies and rural financial inclusion—understudied.

Future research recommendations

To build nested models that more effectively reflect geographical heterogeneity and technological diffusion spillovers, future research should place a high priority on multi-scale data integration by fusing digital footprint data with farmer-level surveys. Social capital, educational attainment, and community-specific structures, such clan networks, might all be added to the theoretical framework to better understand how they affect the relationship between policy support and technological adoption. Furthermore, using dynamic models like panel autoregression may reveal lag effects and long-term relationships between digital uptake and the results of rural revitalization. Emphasizing ethical considerations is also necessary to guarantee that digital transformation promotes inclusive and context-sensitive rural development, especially in relation to cultural homogenization and data governance.

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