Digital Rural Construction Drives Rural Revitalization: Based on Empirical Evidence from 28 Provinces

Lai Kaifeng* and Liu Ying

College of Economics and Business Administration, North China University of Technology, Beijing 100144, China
Email:2416998848@qq.com (L.K.F.)
*Corresponding author

Abstract—**Digital rural construction is a new paradigm of agricultural and rural development and an important way to promote rural revitalization. This paper firstly elaborates the promoting effect of digital rural construction on rural revitalization in theory. Then, this paper using the panel data of 28 provinces from 2018 to 2020 and calculates the rural revitalization index as well as the sorted digital rural index to empirically tests the effect of digital rural construction on rural revitalization and development. Research findings: (1) Digital rural construction has a significant driving effect on rural construction. (2) The heterogeneity analysis shows that the digitalization of rural economy and rural governance has a significant driving effect on rural revitalization; The construction of digital countryside in the eastern region and the northeast region has an obvious promoting effect on the rural revitalization, while the central and western regions have not shown the due driving effect. This situation indicates that there is an obvious digital gap in the current construction of digital countryside. Next, promoting rural revitalization should focus on developing the digitalized agricultural economy and rural governance, and narrowing the digital divide.**

Keywords—**rural revitalization, digital rural construction, digitalization of rural economy, digitalization of rural governance**

I. INTRODUCTION

In the era of digital economy, digital rural is the strategic direction of rural revitalization and a crucial building block towards a digital China. Accelerating the construction of digital rural has important positive significance for giving full play to driving and leading role of informatization in rural revitalization, and overall driving and improving the development of agricultural and rural modernization. Today, digital economy is rapidly extending and has penetrated into agriculture and rural areas, providing an opportunity for digital rural construction and rural revitalization.

Around the internal relationship between digital countryside and rural revitalization, there have been a lot of in-depth studies on this field. By using the sectional data of 1601 countries in 2018, some scholars found that digital rural construction plays a significant role in promoting rural revitalization (Liu *et al.,* 2022). Digital technology not only exerts significant impact on smart urbanization but also facilitates the construction of digital villages. However, the realization of digital villages hinges upon the enhancement of digital infrastructure in rural areas. (Mailk *et al.,* 2022). As a new driving force for China's economic development, digital economy provides a good opportunity for rural revitalization. Moreover, scholars have also measured the digital economy development index from a more macroscopic definition and found that the digital economy has a substantial promoting effect on rural revitalization and a spatial spillover effect on rural revitalization (He *et al.,* 2022). On the other hand, farmers are the main force of rural revitalization, and the ultimate goal of rural revitalization is to enhance farmers' happiness and their sense of achievement. Therefore, some studies focus on analyzing how digital rural construction impacts the consumption of rural residents who represent the main subject of rural revitalization Some scholars found that the construction of digital villages has a significant positive contribution to upgrading rural consumption and is conducive to the expanding the overall scale of rural consumption (Zhang & Liang, 2022) and (Wang *et al.,* 2021). The development of rural e-commerce exerts a positive influence on farmers' income and generates spillover effects on rural digital infrastructure and human resources for e-commerce (Chao *et al.,* 2021). To summarize the above-mentioned scholars' research, both the development of digital economy at the macro level and the construction of digital countryside at the micro level highlight the important role of "digital empowerment" in promoting high-quality agricultural and rural development.

At the current stage, China's digital village construction is still in its early stages, and the driving effect of digital village construction on rural revitalization faces many realistic challenges. Some studies point out some possible obstacles - the insufficiency of the current rural digital infrastructure construction, the lag in the development of agricultural science and innovation system, the immaturity in the market system of agricultural data elements, and a lack of composite talents for digital rural construction (Ma *et al.,* 2023). In addition, the "digital divide" caused by uneven allocation of digital resources may widen the gap between urban and rural areas and increase the governance of relative poverty (Ai & Tian, 2022); challenges such as the difficulties of digital transformation, insufficient data security (Sun & Zhang, 2023), and the "governance deficit" (Feng & Xu, 2021) of rural digitalization will further prevent "digital empowerment" from having its proper effect.

The above discussion provides useful references for a more comprehensive understanding of the opportunities and challenges of digital village construction. Specific to empirical research, involves the construction of digital village indicator system and rural revitalization indicator system. Then, the analysis consists of quantitatively measuring and evaluating the development levels of the respective systems and weighing the availability of data as well as the rationality of the indicator system.

For the construction of rural revitalization indicator system, some scholars have identified industrial construction,

ecological construction, welfare construction, cultural construction and political construction as the first-tier indicators (Cai *et al.,* 2019). Similarly, certain scholars also start from the five general requirements of rural revitalization and take industrial prosperity, ecological livability, rural style civilization, effective governance, and affluent living as the first-tier indicators (Liu *et al.,* 2022). For the digital countryside indicator system, scholars have constructed the rural digital economy system from an economic perspective with four first-level indicators: digital environment, digital inputs, digital benefits, and digital services (Cui & Feng, 2020). While a more comprehensive digital countryside indicator system takes rural digital infrastructure, economic digital index, rural governance digitalization, and rural life digitalization as first-level indicators (Institute of New Rural Development, Peking University, 2022). However, the current construction of a comprehensive system for digital countryside and rural revitalization is mostly interpreted theoretically and lacks measurability, and the coverage of existing studies on digital countryside indicators is insufficient with many studies only focusing on a certain perspective to carry out analysis (Zhu & Chen, 2022).

In summary, based on the existing studies, this paper selects the core explanatory variables from the County Digital Countryside Index (2020), which represents the level of digital countryside development as comprehensively and accurately as possible. Applying the subjective and objective assignment method, we attempt to construct a rural revitalization index evaluation system and conduct further heterogeneity analysis on the role of digital rural construction in driving rural revitalization.

The remainder of this paper is organized as follows: First, the continuation of the theoretical analysis and research hypothesis. Based on "digital empowerment", the driving effect of digital village construction on rural revitalization is explained from the theoretical level. The third part is the setting of the econometric model and index construction. The fourth part is the results of the empirical tests, including the interpretation of the baseline regression results and the treatment of endogeneity issues. The fifth part is the heterogeneity test, which distinguishes digital rural construction heterogeneity and tests regional heterogeneity for further analysis. The last part concludes with policy recommendations.

II. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

As the digital economy gradually penetrates rural areas, digital empowerment can overcome the constraint of traditional production factor scarcity, reduce the separation between supply and demand, and accelerate the transformation of production methods and the modernization of agriculture and rural areas. Specifically, at the factor level, digital factors intervene in agriculture and rural areas, and the production function of rural industries is reconstructed, amplifying the spillover effects of agricultural technology, production knowledge and market information. At the approach level, digital technology transforms agricultural and rural production methods, and smart agriculture makes agricultural production scientific, refined and controllable. In daily life, digital consumption drives rural consumption to a new level. With the improvement of rural digital infrastructure, the consumption concept of rural residents is changing dramatically, and the structure of rural consumption shifts from the consumption of basic necessities to the consumption of recreational and developmental goods. As a result, this paper proposes the core research hypothesis regarding the relationship between digital village construction and rural revitalization.

H1: Digital village construction has a significant positive impact on rural revitalization.

A. Rural Digital Infrastructure Construction and Rural Revitalization

The construction of rural digital infrastructure is the prerequisite for the construction of digital villages and is the first step towards "digital empowerment". In agricultural production, digital modern agricultural technologies help promote a green, low-carbon and recyclable rural environment. For example, digital dynamic monitoring technology facilitates precise control of production conditions, real-time transmission of soil moisture, and effective reduction of pesticide and chemical fertilizer use, creating conditions for the development of green agriculture and improving the rural ecological environment. New rural e-commerce platforms and Internet platforms for rural specialty agricultural products builds a bridge between the production side and the consumption side, promoting the integration of information resources between the supply side and the demand side and enhancing farmers' ability to obtain market information and improve overall resource utilization efficiency.

Thus, this paper proposes hypothesis H2: Rural digital infrastructure construction promotes rural revitalization.

B. Digitalization of Rural Economy and Rural Revitalization

The digitization of the rural economy is a top priority in the construction of the digital village, which aims to better integrate digital technology into agricultural production, logistics and transportation, and marketing processes. On the production level, digital production in agriculture is conducive to transforming modern agricultural science and technology, promoting smart agriculture, improving high-quality agricultural output, and amplifying modern agricultural knowledge spillover effects; In terms of logistics, the digital supply chain serves to integrate rural industry chain, facilitates the flow of logistics, information and capital, direct large logistics enterprises to extend their services to rural areas, establishes efficient logistics and transportation networks in rural areas, and improves the efficiency of transporting high-quality agricultural and consumer goods in and out of the village; In terms of marketing, live-streaming with goods and the new rural e-commerce industry will help enhance the sales of agricultural products, expand brand value and awareness, and boost farmers' income.

Thus, this paper proposes hypothesis H3: Digitalization of rural economy promotes rural revitalization.

C. Digitalization of Rural Governance and Rural Revitalization

Digital village construction promotes the improvement of rural grassroots governance effectiveness. Digital technology reduces the cost of collective selection of rural governance

rules and the dissemination and formulation of village regulations. It also improves the efficiency and adaptability of rural governance rule supply (Wang & Li, 2022). For example, with the development of rural digital governance practices, more and more "village affairs" and "party affairs" services can be handled online, which improves the efficiency of rural grassroots governance and reduces the time and labor costs for villagers to complete various tasks. By building a village affairs platform, the use of big data feedback can better identify the problems of grassroots self-government and improve the accuracy of the two village committees in solving problems.

Thus, this paper proposes hypothesis H4: Digitalization of rural governance promotes rural revitalization.

D. *Digitalization of Rural Life and Rural Revitalization*

The construction of digital villages is conducive to promoting the entry of entertainment, education, medical and other resources into rural areas through internet, providing better entertainment and leisure resources for rural areas. Through the development of the tourism industry, the digital village also fosters the integration of village tourism resources, the development of local special rural tourism and

leisure agriculture, and improvement of the local ecological environment and the construction of rural civilization.

Thus, this paper proposes hypothesis H5: The digitization of rural life promotes rural revitalization.

III. ECONOMETRIC MODEL AND INDEX CONSTRUCTION

A. *Model Setting*

According to the research objectives and hypotheses, to test the effect of digital village construction on rural revitalization, the following econometric model is established in this paper:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Ctrl_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Among them, Y_{it} denotes the rural revitalization index of the i-th province in period t. X_{it} denotes the digital rural index of the i-th province in period t, which is the core explanatory variable of this paper. $Ctrl_{it}$ is a series of control variables. μ_i denotes provincial individual fixed effects; λ_t denotes time fixed effects; ε_{it} denotes the random perturbation term.

B. *Variable Description and Index Construction*

1) *Dependent variable*

Table 1. Rural revitalization indicator system

Tier 1 indicators	Tier 2 indictors	Unit	Indicator Description	Subjective Weights	Objective Weights	Combined Weights
Industrial prosperity	Per capita output value of agriculture, forestry, animal husbandry and fishery	Yuan/Person	Positive	0.1	0.0756	0.0878
	Total agricultural machinery power per capita	Kilowatt/person	Positive	0.0832	0.0966	0.0899
Ecological Livability	Solar water heater per capita in rural areas	Square meter/person	Positive	−0.14	0.2204	0.0402
	Soil erosion control area per capita in villages	Hectare/person	Positive	−0.1365	0.1776	0.0205
Countryside Civilization	Countryside Cultural Stations	Number	Positive	0.068	0.0996	0.0838
	Rural per capita expenditure on education and culture	Yuan/Person	Positive	0.085	0.0260	0.0555
Effective governance	Number of institutions providing assistance and support for rural	Number	Positive	-0.02	0.1862	0.0831
	Digital index of rural governance		Positive	0.1603	0.0444	0.1023
Wealthy living	Rural disposable income per capita	Yuan/Person	Positive	0.8	0.0737	0.4368

Promoting rural revitalization should be carried out in accordance with the general requirements that lead to prosperous industry, ecological livability, civilized countryside, effective governance, and affluent living. Therefore, the rural revitalization index system should include the basic connotations of the above five aspects. Drawing on the research results of Liu *et al.* (2022) and Cai *et al.* (2019), the rural revitalization index evaluation system weighs the rationality of rural revitalization indicators and the availability of data, as shown in Table 1.

In terms of the selection of weights for each indicator, this paper mainly adopts the comprehensive weighting method combining both the subjective and objective aspects. This is in consideration of the fact that the entropy weighting method, as an objective assignment method, is more difficult to reflect the economic correlation and practical significance of the indicators. The subjective assignment method relies more on the personal judgment of the researcher and lacks an overall

grasp of the objective reality, so combining the two can reflect the rationality of the comprehensive weighting to a certain extent. The specific calculation is as follows:

a) *Dimensionless processing of indicators*

Since the indicators are all positive, they are dimensionless using polar deviation normalization:

$$Z_{\lambda ij} = (x_{\lambda ij} - x_{min})/(x_{max} - x_{min}) \quad (2)$$

In the formula, $x_{\lambda ij}$ denotes the value of the jth indicator in the λth year for the ith province, x_{max}, x_{min} denotes the maximum and minimum values of indicators j, $Z_{\lambda ij}$ is the normalized index value.

b) *Normalization of indicators*

$$P_{\lambda ij} = Z_{\lambda ij}/\sum_{\lambda=1}^{h}\sum_{i=1}^{m} Z_{\lambda ij} \quad (3)$$

c) *Calculate the entropy value of each indicator*

$$E_j = -k \sum_{\lambda=1}^{h} \sum_{i=1}^{m} P_{\lambda ij} ln P_{\lambda ij} \qquad (4)$$

where k=1/ln(h×m), here h=3, m=28.

d) *Calculate the redundancy of the entropy value of each indicator*

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

e) *Calculate the objective weights of each indicator*

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

f) *Calculating the combined weights*

$$W_k = (W_j + W_s) / 2 \qquad (7)$$

where k, s = 1,2, 3, …,9. W_s denotes the weight of the subjective assignment.

g) *Calculating the rural revitalization index*

$$Y_{it} = 1000 \times \sum W_k \times P_{\lambda ij} \qquad (8)$$

In Table 1, the comprehensive weight of prosperous industry and wealthy living is as high as 0.6145. "Prosperous industry" is an important foundation to revitalize the material aspect of rural civilization and is also essential in driving rural revitalization. The weight of civilization of countryside, ecological livability and effective governance is 0.3855, which reflects the level of spiritual civilization construction in the countryside, and the two complement each other and promote each other, which is the inevitable requirement to comprehensively promote high-quality rural revitalization.

2) Core independent variable

The core independent variable Digital Countryside Index X_{it} measures the level of digital construction of a region's countryside, and its four first-level indicators are Countryside Digital Infrastructure Index (27%), Countryside Economic Digitalization Index (40%), Countryside Governance Digitalization (14%), and Countryside Life Digitalization Index (19%). These four aspects can demonstrate a more comprehensive digital countryside development, reflecting the latest rural digital economy development of new business.

3) Control variables

According to the studies of some scholars (Cai *et al.*, 2019; Ge & Qian, 2021), in order to control the different variables, we need to take (1) the logarithm of each province's GDP because the level of economic development has a certain relationship with rural revitalization and (2) the proportion of tertiary industry value added to GDP in each region. (3) Demographic structure, demographic changes would affect rural revitalization through rural production, rural life, and rural ecology (Liao & Gao, 2018). (4) Urbanization level is also considered because some studies argue that the overall effect of urbanization on rural development level is positive, but the urbanization of population will suppress rural development level and offset the positive promotion effect brought by the non-agriculturalization of some industries (Tu & Le, 2018). The level of urbanization is added to the model to clarify the effect of urbanization level on rural revitalization.

Table 2. Variable description

Variable Type	Symbols	Description	Data source
Core independent variable	X_{it}	Digital Countryside Index	Institute of New Rural Development of Peking University & Ali Research Institute County Digital Countryside Index 2020
Control variables	$lngdp_{it}$	Logged GDP by province (in current year prices)	China Statistical Yearbook 2019–2021
	$structure_{it}$	Share of tertiary sector value added in GDP by province	China Statistical Yearbook 2019–2021
	odr_{it}	Old dependency ratio: Number of middle-aged and older people (65 years and older) as a share of the working-age population	China Statistical Yearbook 2019–2021
	ydr_{it}	Children dependency ratio: Number of children and adolescents in the population (0-15 years) as a proportion of the working-age population	China Statistical Yearbook 2019–2021
	$city_{it}$	Urbanization rate	China Statistical Yearbook 2019–2021

Notes: based on the time range of the study, the data with independent and control variables were selected from 2018–2020.

Table 3. Descriptive statistics of variables

Variable	Symbol	Sample size	Mean	Standard error	Min	Max
Rural Revitalization Index	Y_{it}	84	11.905	3.943	4.293	24.343
Digital Countryside Index	X_{it}	84	52.349	11.034	21.806	82.570
Economic Development Level	$lngdp_{it}$	84	28.387	1.002	25.719	30.036
Industry Structure	$structure_{it}$	84	50.930	3.388	42.700	60.400
Demographics	odr_{it}	84	17.028	4.211	8.040	25.480
	ydr_{it}	84	25.425	6.192	13.080	38.380
Urbanization rate	$city_{it}$	84	59.999	8.275	33.800	74.150

IV. EMPIRICAL TESTING

A. Benchmark Regression

Since the disturbance terms between different years in the same province are generally autocorrelated, and the default ordinary standard error calculation method assumes that the

disturbance terms are independently and identically distributed, the ordinary standard error estimates may not be accurate. In addition, each province has different "provincial conditions" and there may be omitted variables that do not change over time, so a fixed-effects model is considered. The Hausman test also verifies that fixed effects should be chosen.

Table 4. Benchmark regression result

	(1)	(2)	(3)	(4)
Digital Countryside Index	0.2638***	0.0544**	0.0312*	0.0375*
	(0.0422)	(0.0215)	(0.0154)	(0.0185)
Economic Development Level		0.6003		0.8603
		(1.1820)		(0.7233)
Industry Structure		0.0557		−0.0302
		(0.0445)		(0.0317)
Old dependency ratio		0.2100***		0.1063**
		(0.0596)		(0.0451)
Children dependency ratio		−0.1472***		−0.0507*
		(0.0478)		(0.0297)
Urbanization rate		0.8008***		0.0955
		(0.1247)		(0.2064)
Individual fixed effects	Controlled	Controlled	Controlled	Controlled
Time fixed effects	Uncontrolled	Uncontrolled	Controlled	Controlled
Sample size	84	84	84	84
adj. R2	0.454	0.904	0.943	0.948

Notes: Robust criteria errors for clustering to the provincial level are indicated in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ (the same below).

For a better comparative analysis, columns (1)–(4) denote, in order, the individual fixed effects without the addition of control variables, individual fixed effects with the addition of control variables, double fixed effects without the addition of control variables, and double fixed effects with the addition of control variables. Column (4) is the main result of interest in this paper. The core explanatory variables are significant at the 10% level, indicating that digital village construction can significantly contribute to rural revitalization.

In terms of control variables, neither the level of economic development nor the industrial structure is significant, indicating that the economic level of each province does not directly affect the level of rural revitalization. The coefficient of old-age dependency ratio is positive, while the coefficient of children support ratio is negative. Empirically, the old-age dependency ratio should be negative, implying that the increase of old-age dependency burden is not conducive to rural revitalization. The possible reason for the positive coefficient is that China's population face the trend of aging and a decline in birth rate, which leads to the trend of joint changes in the development of population aging and rural revitalization. The negative coefficient of the children support ratio indicates that the burden faced by the younger population in caring for the elder is a negative effect on rural

revitalization, and the urbanization level does not reflect a significant effect in the empirical evidence.

B. Endogenous Problem Solving

The endogeneity problem of this paper may be reflected in the following three aspects: the first is the problem of omitted variables. Although this paper includes control variables and fixed effects in the model, the model may have endogeneity problems caused by omitted variables because rural revitalization has various concepts, and some cannot be measured completely quantitatively. Control variables also cannot guarantee that there are no omitted variables. The second is the two-way causality problem, which is also the most obvious endogenous problem in this paper. The construction of digital countryside drives rural revitalization, and, in turn, the development of rural revitalization further promotes the construction of digital countryside, leading to a two-way causality problem. The third is the measurement error. Since the rural revitalization index system selects data at the provincial level, certain summation and averaging are carried out in the statistical process, so a certain measurement bias could exist.

To address the endogeneity problem, a two-stage least squares treatment is used in this paper. Drawing on the studies of (Liu *et al.,* 2022) and (Huang, Yu & Zhang, 2019), the number of provincial fixed telephone subscribers from 2000-2002 was selected as the instrumental variable. The results are shown in the Table 5:

Table 5. Two-stage least squares regression results

	Rural Revitalization Index
Digital Countryside Index	0.181***
	(0.0373)
Control variables	Controlled
Individual & time fixed effect	Controlled
Adj.R-square	0.977
Sample size	84
First stage F-statistic	12.5877

Comparing the regression results in column (4) of Table 4, it can be found that the driving effect of digital countryside index on rural revitalization index is more significant after considering the endogeneity issue, indicating that the original endogeneity issue will underestimate the promotion effect of digital countryside construction be significantly underestimated.

V. HETEROGENEITY ANALYSIS

A. Heterogeneity Test to Distinguish between Digital Rural Index

From the benchmark regression results, it is concluded that digital village construction can significantly contribute to rural revitalization. Next, the Digital Rural Index is further divided into Rural Digital Infrastructure Index, Rural Economic Digital Index, Rural Governance Digital Index, and Rural Life Digital Index. Regressing them separately with the rural revitalization index produced the following results:

Table 6. Heterogeneity test to distinguish between digital rural index

Variable	(1)	(2)	(3)	(4)	(5)
Rural Digital Infrastructure	−0.00555 (0.00522)				0.0147** (0.00550)
Digitalization of the rural economy		0.0427*** (0.0115)			0.0567*** (0.0128)
Digitalization of rural governance			0.0294*** (0.00881)		0.0314*** (0.00768)
Digital Village Life				0.00456 (0.0161)	−0.0133 (0.00939)
Constant	−74.14** (34.76)	−58.17* (29.56)	−90.56** (34.54)	−69.80* (34.99)	−71.64** (29.70)
Sample size	84	84	84	84	84
Adj.R2	0.894	0.914	0.912	0.892	0.934

Note: Individual & time fixed effects are controlled.

From the results in Table 6, the regression coefficients of rural economic digitization and rural governance digitalization are significantly positive. Because the weight of economic digitization and governance digitization reaches 54% in the calculation of the digital countryside index, it can be assumed that the digital countryside construction mainly enhances rural digitization through economic digitization and governance digitization, which also promotes rural revitalization. The digitalization of rural economy is mainly in digital production, supply chain, marketing, and digital finance to improve the overall productivity of rural areas through "digital empowerment". Digital governance is mainly in government services, online processing, and "village affairs" big data, reducing information costs and improving the effectiveness of grassroots governance. Therefore, hypotheses H3 and H4 hold in this paper. However, the regression coefficients for both rural digital infrastructure and the digitization of rural life were not significant and failed to test hypotheses H2 and H5. The possible reason is that because the overall rural digital infrastructure in China has reached a relatively high level, the overall regional differences are not significant. However, the rural revitalization index varies widely between regions, which leads to the inability of the rural digital infrastructure index to have the desired effect on the rural revitalization index (Liu *et al.,* 2022). The same reason exists for the digitization of village life, that is, the level of digitization of village life in China is generally not high and the regional differences are relatively small, which makes it difficult to produce the desired effect on rural revitalization.

B. *Regional Heterogeneity Test*

There is an inter-regional imbalance in the construction of digital countryside in China, and the development level of rural revitalization varies widely across regions. Next, a regional heterogeneity test is conducted to divide China into four regions, namely, the eastern, central, western, and northeastern regions, and to study the differences in the effectiveness of digital rural construction-driven rural revitalization in the four regions.

The regression results in Table 7 show that the regions with the most obvious driving effect of digital rural construction on rural revitalization in China are the east and the northeast. On a theoretical level, the positive effects of digital countryside empowering agriculture and rural areas often need to be discussed when the digital countryside is developed to a certain extent. The eastern region has a higher level of overall digital village development, and the digital economy has been applied in the rural areas earlier, which has a greater effect on promoting rural revitalization. The fertile land in the Northeast is suitable for modern agricultural farming and can use large agricultural machinery to improve the production and supply of agricultural products (Tian, Ye, Huang & Liu, 2022), which can be combined with digital advantages to improve the production efficiency per unit area and promote rural revitalization. In contrast, the overall digital countryside construction level in central and western regions is low, and the effect on rural revitalization has not yet been revealed.

Table 7. Regional heterogeneity test

	(1) Eastern	(2) Central	(3) Western	(4) Northeastern
Digital Countryside Index	0.1072*** (0.0085)	−0.0988 (0.1052)	0.0031 (0.0220)	0.0198*** (0.0000)
Constant	74.6586** (21.2834)	−2.5e+02*** (55.1225)	17.7952 (37.0057)	−2.2e+02*** (0.0447)
Sample size	21	18	36	9
adj. R2	0.997	0.935	0.971	1.000

VI. CONCLUSIONS

This paper starts from the perspective that digital countryside construction contributes to rural revitalization and points out the positive effect of digital countryside construction on driving rural revitalization at the theoretical level. Subsequently, based on the countryside revitalization index measured by the authors and the collated digital countryside index, it empirically examines the intrinsic relationship between digital countryside and countryside revitalization and draws the following main conclusions:

(1) Digital village construction can significantly drive rural revitalization and, the improvement of digital village level can promote the development of rural villages, which still holds after endogeneity treatment.

(2) The test of heterogeneity in distinguishing digital countryside dimensions found that the digitalization of rural economy and the digitalization of rural governance are two important elements of digital countryside construction in promoting the development of rural revitalization. The reason that the digital infrastructure of villages and the digitalization of village life fail to manifest their effects is that they have little disparity nationwide while there is an obvious regional disparity in rural revitalization, and thus the promotion effect of both on rural revitalization has not been confirmed in the empirical study.

(3) Regional heterogeneity test shows that there is a "digital divide" in the construction of digital countryside, uneven development among regions, and regional differences in the impact on rural revitalization. Among them, in the eastern and northeastern regions, the effect of digital village construction driving rural revitalization is most obvious. The central and western regions fail to show the promotion effect on rural revitalization due to the current low level of digital village construction.

Based on the above research findings, this paper proposes

the following policy recommendations:

(1) Release the digital production capacity of the rural economy and build an integrated modern agricultural production and management system.

(2) Promote digital upgrading of rural governance. Promote full online coverage of county, township, and village government services, increase the proportion of agriculture-related services online, and promote the construction of "do it now, do it online, do it on the palm of your hand" convenience services.

(3) Implement a differentiated digital village construction strategy. The level of rural revitalization and digital countryside index vary greatly between regions. It is necessary to analyze specific problems, explore advantageous industries of digital economy suitable for local development, find advantageous positioning in the digital supply chain, and lay a good digital foundation for rural revitalization.

Suggestions for further study:

Data improvement. Since this paper uses provincial data, it may not be able to accurately measure digital village construction and rural revitalization at the county level, which leads to measurement bias. Therefore, future research in this area could use county-level data, expand the simple size. But the possible drawbacks are the large amount of data collection and the presence of more missing values.

Conduct research on the mechanism of digital rural construction promoting rural revitalization. The influence mechanism can be further explored, such as through intermediary variables, testing the mediating effect.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

These authors contributed equally to this study. Liu Ying provided constructive comments on the revision of the entire paper; Lai Kaifeng analyzed the data and conduct empirical analysis; Lai Kaifeng wrote the paper; all authors had approved the final version.

REFERENCES

Ai, X., Tian, Y. 2022. The poverty reduction effect of the digital economy. *Journal of Hunan University (Social Science),* 1: 50–56.

Cai, X., Cai, H., Zhao, J. 2019. An empirical study on the impact of financial development on rural revitalization and development. *Contemporary Economic Management,* 8: 91–97.

Chao, P., Biao, M., Chen, Z. 2021. Poverty alleviation through e-commerce: Village involvement and demonstration policies in rural China. *Journal of Integrative Agriculture,* 20(4): 998–1011.

Cui, K., Feng, X. 2020. Research on the indicator system design for rural digital economy from the perspective of digital village construction. *Research of Agricultural Modernization,* 11: 899–909.

Feng, Z., Xu, H. 2021. Practical Dilemmas in the current digital village construction and possible solutions. *Journal of Yunnan Normal University (Humanities and Social Sciences Edition),* 9: 93–102.

Ge, H., Qian, Y. 2021. Impact mechanism and empirical test of digital inclusive financial services on rural revitalization. *Modern Economy Research*, 5: 118–126.

He, L., Wang, F., Wang, C. 2022. How will the Digital Economy Drive China's Rural Revitalization. *Inquiry into Economic Issues,* 4: 1–18.

Huang, Q., Yu, Y., Zhang, S. 2019. Internet development and productivity growth in manufacturing industry: internal mechanism and China experience. *China Industrial Economics*, 8: 5–23

Liao, L., Gao, X. 2018. Progress and prospect of research on the impact of population aging on rural development. *Progress in Geography,* 5: 617–626.

Liu, L., Zhang, Y., Bi, Y. 2022. Digital village construction boosts rural revitalization: internal mechanism and empirical test. *World Agriculture,* 8: 51–65.

Ma, G., Yang, Q., Wang, H. 2023. The Inner Mechanism, Realistic Challenges and Breakthroughs of the Digital Economy Empowering Rural Industrial Revitalization. *Contemporary Economic Management*. Available: https://kns.cnki.net/kcms/detail/13.1356.F.20230512.1254.002.html.

Mailk, P. K., Singh, R., Gehlot, A., Akram, S. V., Das, P. K. 2022. Village 4.0: Digitalization of village with smart internet of things technologies. *Computers & Industrial Engineering*. Available: https://doi.org/10.1016/j.cie.2022.107938.

Sun, J., Zhang, A. 2023. Digital rural construction in the era of digital economy: significance, challenges and countermeasures. *Journal of Northwest Normal University (Social Science)*, 1: 127–134.

Tian, Y., Huang, J., Liu, Q. 2022. The internal mechanism and empirical test of rural industrial revitalization driven by digital economy: based on the mediating effect of urban and rural integration development. *Issues in Agricultural Economy,* 11: 84–96.

Tu, L., Yue, Z. 2018. Village urbanization and rural revitalization in China: an empirical analysis based on rural construction theory. *Issues in Agricultural Economy,* 11: 78–91.

Wang, Y., Xu, F., Ye, Y. 2021. Can digital village construction boost rural consumption upgrading? *Management Review,* 11: 135–144.

Wang, Y., Li, X. 2022. Institutional Analysis and Theoretical Enlightenment for the Impact of Digital Technology on Rural Governance. *Chinese Rural Economy*, 8: 2–15.

Zhang, Q., Liang, S. 2022. The impact of digital village construction on rural residents' consumption in the new development stage. *Rural Market,* 11: 145–148.

Zhu, H., Chen, H. 2022. Level measurement. spatial-temporal evolution and promotion path of digital village development in China. *Issues in Agricultural Economy,* 7: 210–233.