

Evaluating Digital Rural Development from a Resilience Perspective: Evidence from Zhejiang Province

Yongjia Zhao

School of Public Administration, Sichuan University, Chengdu 610000, China

Abstract

Drawing on resilience theory, this study develops an evaluation framework for assessing the development level of digital rural areas and applies it to 90 counties (districts and county-level cities) in Zhejiang Province. Using statistical data from 2022, the entropy weight method and a comprehensive evaluation approach are employed to measure county-level digital rural resilience. The results reveal significant regional disparities in digital rural resilience across Zhejiang Province. High-resilience areas are primarily concentrated in the economically developed northeastern region, whereas low-resilience areas are mainly located in western and mountainous counties. Based on these findings, this study proposes policy recommendations to enhance county-level digital rural resilience and promote coordinated regional development.

Keywords

Digital Rural Areas; Resilience Theory; Zhejiang Province.

1. Introduction

1.1. Background

Since 2019, China has continuously promoted digital rural development as a key strategy for rural revitalization and agricultural modernization. With the widespread application of digital technologies in agricultural production, rural governance, and public services, improving the resilience of digital rural areas has become increasingly important for sustainable development. Zhejiang Province, which has ranked first nationwide in digital rural development for four consecutive years, provides a representative case for this study [1]. Therefore, this study develops a resilience-based evaluation framework and assesses the level of digital rural resilience across 90 counties in Zhejiang Province.

1.2. Related Work

Digital rural development has become an important research topic with the advancement of China's Digital China and Rural Revitalization strategies. Existing studies have mainly focused on three aspects: the conceptualization of digital rural development, governance mechanisms, and implementation pathways. Digital rural development is generally regarded as an integrated system that combines digital infrastructure, digital technologies, the digital economy, and rural governance to facilitate rural transformation[2-4]. Previous studies also emphasize collaborative governance involving governments, markets, and local communities[5-8], while proposing development pathways from perspectives such as governance modernization and smart growth, and addressing practical challenges including the digital divide, insufficient institutional support, and governance coordination [9-14].

In recent years, increasing attention has been paid to evaluating digital rural development. Existing studies have constructed evaluation indicator systems from perspectives such as agricultural informatization and the digital economy[15-16], measured development levels using methods including the entropy weight method and factor analysis[17-19], and examined

influencing factors from institutional, technological, organizational, and economic dimensions [21-23]. Although these studies provide valuable insights into the assessment of digital rural development, they mainly focus on development performance, while resilience, which reflects the capacity to withstand risks and sustain long-term development, has received relatively limited attention. To address this gap, this study integrates resilience theory into the evaluation of digital rural development and develops a county-level resilience-based evaluation framework for Zhejiang Province.

1.3. Contributions and Limitations

This study develops a resilience-based evaluation framework for county-level digital rural development by integrating five dimensions: governance, society, economy, ecology, and infrastructure. However, the analysis is based only on cross-sectional data from Zhejiang Province in 2022. Future research should further validate the framework using longitudinal and multi-regional data.

2. Theoretical Framework

2.1. Theoretical Analysis

Resilience theory emphasizes the capacity of a system to withstand external shocks, adapt to changing environments, and achieve sustainable development, providing an important theoretical foundation for digital rural development. Existing studies generally regard rural resilience as a multidimensional concept encompassing economic, social, ecological, governance (institutional), and infrastructure dimensions, with specific frameworks varying according to different research contexts [24-28]. Overall, rural resilience reflects the synergistic effects of multiple subsystems rather than a single capability. Based on this perspective, this study develops a county-level digital rural resilience evaluation framework consisting of five dimensions: governance, society, economy, ecology, and infrastructure.

2.2. Evaluation Framework

Table 1. Evaluation Framework for Digital Rural Resilience

Dimension	Sub-dimension	Indicator
Governance Resilience	Governance Capacity	Per capita public service expenditure
		Public service expenditure as a share of GDP
	Digital Government Services	Number of online government services
		Satisfaction rate of government websites
Social Resilience	Human Resources	Local fiscal expenditure on education
		Proportion of primary and secondary school students
	Social Security	Participants in basic pension insurance
		Participants in basic medical insurance
Economic Resilience	Economic Development	GDP per capita
		Per capita disposable income of rural residents
	Agricultural Modernization	Total agricultural machinery power
		Mechanized cultivated area
	E-commerce	E-commerce coverage of administrative villages
		E-commerce sales as a share of GDP
Ecological Resilience	Production Environment	Postal and telecommunication services
		Cultivated land per capita
	Living Environment	Fertilizer application intensity
		Population density
		Proportion of days with good air quality
		Annual average PM2.5 concentration
Infrastructure Resilience	Development Foundation	Electricity consumption
		Highway mileage
	Digital Infrastructure	Fixed broadband subscribers
		Mobile phone subscribers

Based on resilience theory, this study defines digital rural resilience as the capacity of rural areas to withstand external risks, adapt to changing conditions, and achieve sustainable development during the process of digital transformation. Drawing on previous studies of digital rural development and rural resilience, a county-level evaluation framework is developed from five dimensions: governance, society, economy, ecology, and infrastructure. A total of 24 indicators are selected to assess the digital rural resilience of 90 counties (districts and county-level cities) in Zhejiang Province in 2022. The evaluation framework is presented in Table 1.

2.3. Study Area and Data

Zhejiang Province has consistently ranked among the leading regions in China's digital rural development, making it a representative case for this study. Accordingly, this study evaluates digital rural resilience across 90 counties (districts and county-level cities) in Zhejiang Province. The dataset was compiled from the China Statistical Yearbook, the Zhejiang Statistical Yearbook (2023), municipal statistical yearbooks, the China Digital Rural Development Report (2022), and publicly available statistical bulletins and government work reports. Missing values were imputed using the mean substitution method, while some indicators were derived from the original data.

2.4. Research Method

2.4.1. Entropy Weight Method

To reduce the bias associated with subjective weighting, the entropy weight method is employed to determine the weight of each indicator. The raw data are first standardized, after which the entropy value and weight of each indicator are calculated. The weighted standardized indicators are subsequently aggregated to obtain the composite digital rural resilience score.

(1) Normalization

Positive and negative indicators are normalized using Eqs. (1) and (2), respectively, where x_{ij}' denotes the standardized value.

For positive indicators,

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

For negative indicators,

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

(2) Entropy Weight Calculation

The entropy value is calculated as:

$$e_j = -k \sum_{i=1}^n x_{ij}' \ln(x_{ij}') \quad (3)$$

where $k = \frac{1}{\ln(n)}$, and n is the number of observations. The weight of indicator j is then determined by:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^m (1 - e_j)} \quad (4)$$

2.4.2. Comprehensive Evaluation

After determining the indicator weights using the entropy weight method, the overall digital rural resilience score is calculated using a weighted summation approach. Higher scores indicate higher levels of digital rural resilience.

$$Y_i = \sum_{j=1}^m w_j x_{ij}' \quad (5)$$

where w_j denotes the weight of indicator j , x_{ij}' is the standardized value of indicator j for county i , and m is the total number of indicators. Based on the comprehensive scores, the digital rural resilience levels of the 90 counties (districts and county-level cities) in Zhejiang Province are evaluated.

3. Spatial Distribution of Digital Rural Resilience

Based on the comprehensive digital rural resilience scores, the Natural Breaks (Jenks) classification method in ArcGIS was employed to classify the 90 counties (districts and county-level cities) in Zhejiang Province into five levels: high, relatively high, medium, relatively low, and low resilience. The classification results are presented in Table 2, and the spatial distribution is illustrated in Figure 1.

Table 2. Classification of Counties by Digital Rural Resilience Level (Natural Breaks Method)

Resilience Level	Score Range	Counties
High	0.447-0.524	Yiwu, Xiaoshan, Cixi
Relatively High	0.318-0.447	Yuhang, Yueqing, Haining, Rui'an, Yongkang, Zhuji, Tongxiang, Wenling, Yuyao, Linhai, Quzhou District
Medium	0.251-0.318	Yongjia, Pinghu, Dongyang, Cangnan, Xihu, Pingyang, Tiantai, Gongshu, Keqiao, Jingning, Shengzhou, Shangyu, Pan'an, Changxing, Shangcheng, Qiantang, Ou Hai, Haishu, Linping, Lin'an, Qingyuan
Relatively Low	0.214-0.251	Yuhuan, Chun'an, Xiangshan, Taishun, Beilun, Wucheng, Jiangshan, Haining, Huangyan, Jinyun, Xianju, Liandu, Luqiao, Qujiang, Anji, Wuyi, Jiande, Xianju, Binhai, Wuxing, Yuecheng, Lucheng, Ninghai, Kaihua, Fuyang, Xiuzhou, Longwan, Jiaojiang, Jiashan, Qingtian
Low	0.172-0.214	Deqing, Lanxi, Xinchang, Zhenhai, Longyou, Nanhu, Suichang, Fenghua, Longquan, Tonglu, Wencheng, Nanhu, Songyang, Putuo, Dinghai, Jindong, Pujiang, Sanmen, Yunhe, Songyang, Dongtou, Jiangbei, Kecheng, Longgang

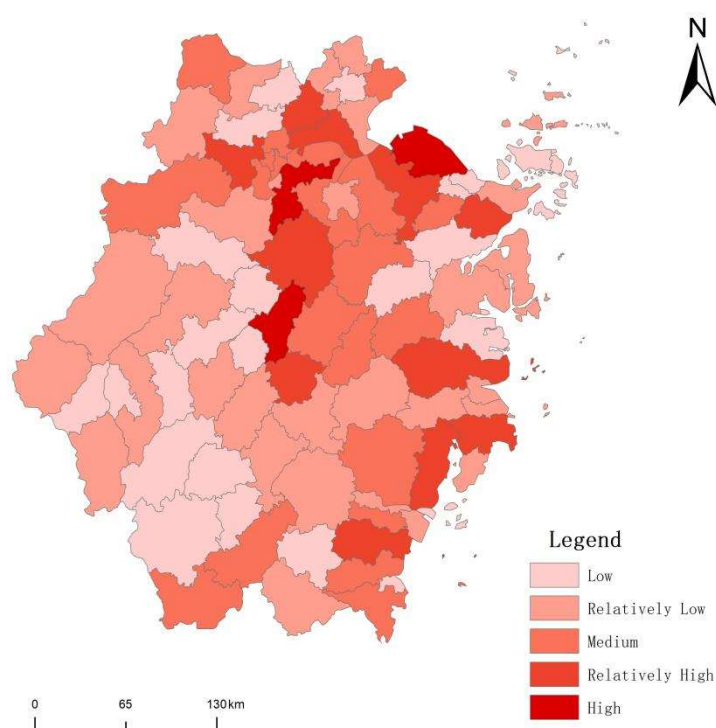


Figure 1. Spatial Distribution of Digital Rural Resilience in Zhejiang Province, 2022.

Figure 1 shows a clear spatial disparity in digital rural resilience across Zhejiang Province. High-resilience counties are mainly concentrated in the northeastern coastal region and the Hangzhou metropolitan area, whereas low-resilience counties are primarily located in the western and central mountainous regions. A total of 14 counties (15.56%) fall into the high- and relatively high-resilience categories, benefiting from stronger economic foundations, resource concentration, and digital infrastructure. In contrast, 55 counties (61.11%) are classified as low or relatively low resilience, reflecting constraints in economic development and resource endowment. Counties with medium resilience are mainly distributed in Jinhua and Wenzhou.

4. Summary

4.1. Conclusion

This study developed a resilience-based evaluation framework for digital rural development from five dimensions: governance, society, economy, ecology, and infrastructure. Using the entropy weight method and a composite evaluation approach, the digital rural resilience of 90 counties (districts and county-level cities) in Zhejiang Province was assessed based on 2022 data. The results reveal significant regional disparities in digital rural resilience. High-resilience counties are mainly concentrated in northeastern Zhejiang and economically developed areas, whereas western, central, and mountainous counties generally exhibit lower resilience, indicating persistent regional imbalances.

4.2. Policy Implications

The findings suggest that digital rural development should move beyond a technology-driven approach toward a resilience-oriented development strategy. Policymakers should strengthen the coordination of governance capacity, public services, digital infrastructure, and socioeconomic development to improve the overall resilience of rural areas. In addition, differentiated policy measures should be adopted according to local development conditions,

with greater support provided to less resilient counties to reduce regional disparities and promote more balanced and sustainable digital rural development.

References

- [1] Cyberspace Administration of China. (2023). China digital rural development report (2022). https://www.cac.gov.cn/2023-03/01/c_1679309718486615.htm
- [2] Zeng, Y. W., Song, Y. X., Lin, X. Z., et al. (2021). Several issues concerning digital rural development in China. *Chinese Rural Economy*, (4), 21-35.
- [3] Shen, F. W., & Ye, W. X. (2021). Digital rural development: A strategic choice for high-quality rural revitalization. *Journal of Nanjing Agricultural University (Social Sciences Edition)*, 21(5), 41-53.
- [4] Wang, S., Yu, N., & Fu, R. (2021). Digital rural development: Mechanisms, practical challenges and implementation strategies. *Reform*, (4), 45-59.
- [5] Xing, Z. J. (2021). The national logic of digital rural development. *Journal of Jishou University (Social Sciences)*, 42(6), 58-68.
- [6] Hu, W. W., & Lu, Y. N. (2023). Formation and operation of the digital rural governance community: Evidence from China's first greenhouse village. *Journal of Public Management*, 20(1), 133-143.
- [7] Costopoulou, C., Ntaliani, M., & Karetsos, S. Studying mobile apps for agriculture.
- [8] Ding, B. (2022). Digital governance: A new model of village governance in digital rural areas. *Journal of Northwest A&F University (Social Sciences Edition)*, 22(2), 9-15.
- [9] Wang, W. B., & Zhao, L. Z. (2023). Digital rural governance transformation: Structural adjustment, functional enhancement and practical path. *E-Government*, (5), 29-37.
- [10] Shen, F. W., & Ye, W. X. (2022). Pathways to digital rural development: An exploration based on smart growth theory. *Humanities Magazine*, (4), 69-80.
- [11] Liu, T. Y., & Tian, B. H. (2022). Practical dilemmas and optimization paths of digital rural development from the perspective of governance modernization. *Jiangnan Tribune*, (3), 116-123.
- [12] Feng, C. R., & Xu, H. Y. (2021). Practical dilemmas and breakthrough paths for digital rural development. *Journal of Yunnan Normal University (Philosophy and Social Sciences)*, 53(5), 93-102.
- [13] Li, L. L., Zeng, Y. W., & Guo, H. D. (2023). Digital rural development: Underlying logic, practical misunderstandings and optimization paths. *Chinese Rural Economy*, (1), 77-92.
- [14] Zhang, H., & Wang, L. (2023). Measurement and promotion paths of digital rural development in western China. *East China Economic Management*, 37(11), 70-78.
- [15] Shen, J. B., & Wang, Y. K. (2019). Evaluation index system of agricultural informatization in China. *Transactions of the Chinese Society of Agricultural Engineering*, 35(24), 162-172.
- [16] Cui, K., & Feng, X. (2020). Indicator system design for the rural digital economy from the perspective of digital rural development. *Research of Agricultural Modernization*, 41(6), 899-909.
- [17] Zhu, H. G., & Chen, H. (2023). Measurement, spatiotemporal evolution and promotion paths of digital rural development in China. *Issues in Agricultural Economy*, (3), 21-33.
- [18] Xu, J. H., Wang, N. Q., & Guo, F. L. (2023). Construction and empirical analysis of an evaluation index system for digital rural development. *Statistics & Decision*, 39(2), 73-77.
- [19] Liu, Q. (2023). Measurement and spatiotemporal evolution of digital rural development: Evidence from Henan Province. *Statistics & Decision*, 39(9), 85-90.
- [20] Chen, T., & Wang, P. (2020). Information divide and digital rural development. *E-Government*, (12), 2-12.
- [21] Chen, L., & Fan, Z. Q. (2022). Influencing factors of digital rural development based on the TOE framework: Evidence from 115 counties in Sichuan Province. *Western Economic Management Forum*, 33(6), 10-17.
- [22] Yang, Y. J., Peng, P., He, S., et al. (2024). Regional characteristics and influencing factors of county-level digital rural development in Sichuan Province. *Journal of Natural Science of Hunan Normal University*.

- [23] Liu, C. M., Wang, R., & Shao, M. J. (2024). Spatial pattern and driving factors of county-level digital rural development in China. *Tropical Geography*, 44(1), 79-91.
- [24] Heijman, W. J. M., & Hagelaar, J. L. F. (2007). Rural resilience as a new development concept. *General Information*, 383-396.
- [25] Sharifi, A. (2016). A critical review of selected tools for assessing community resilience. *Ecological Indicators*, 66, 629-647.
- [26] Wilson, A. G., Hu, Z., & Rahman, S. (2018). Community resilience in rural China: The case of Hu Village, Sichuan Province. *Journal of Rural Studies*, 60, 130-140.
- [27] Tang, R. W., & Guo, W. J. (2018). Evolutionary resilience of rural revitalization and its internal governance logic. *Reform*, (8), 64-72.
- [28] Lei, X. K., & Wang, J. (2020). Paths and strategies for resilience governance in poor rural areas under rural revitalization. *Journal of University of Jinan (Social Sciences)*, 30(1), 92-99.