Exploring the Level and Influencing Factors of Digital Village Development in China: Insights and Recommendations

Xizi Cao 1,*, Mingyi Yan 1 and Jun Wen 2

1 Department of Statistics, School of Economics and Finance, Xi’an Jiaotong University, Xi’an 710061, China; ymy1963@xjtu.edu.cn
2 Department of Industrial Economics, School of Economics and Finance, Xi’an Jiaotong University, Xi’an 710061, China
* Correspondence: sue05522006@outlook.com

Abstract: Digital rural construction is an important strategy for rural revitalization. In order to improve the precision of digital rural measurement, a set of evaluation indicators for digital rural construction was devised in this study. The study uses the entropy method, kernel density estimation, and system clustering to quantify the level of China’s digital rural construction, as well as the Tobit test and other techniques. From the perspective of time series evolution, the construction of digital villages grew continuously, with a peak in 2020. After that, the speed of digital village construction slowed down slightly because of economic changes in both domestic and international environments. In terms of dynamic evolution, the core density curve of China’s digital rural construction shifted to the right between 2011 and 2021, accompanied by gradient influence and a multipolar development trend; local general budget revenue, the per capita disposable income of rural residents, rural infrastructure investment, computer ownership per 100 rural residents, added value of primary industry, education level, and rural power generation are some of the factors that affect the development level of China’s digital countryside. This study is helpful in understanding the influencing aspects of China’s digital rural construction, thereby facilitating the formation of suitable digital rural development strategies in various regions depending on the real scenario.

Keywords: level; influencing factors; digital village

1. Introduction

The digital economy is an economic model that displays the flow of information digitally. It uses digital technologies to facilitate significant changes in economic environments and activities. The 20th National Congress of the Communist Party of China proposed continuing to comprehensively promote the rural revitalisation strategy with the overall goal of accelerating the building of agricultural power. The digital countryside is a strategic direction for rural revitalisation. In the new development stage, the construction of a digital countryside provides new opportunities to improve agricultural production efficiency, activate rural resources, and broaden farmers’ income channels. Over the past decade, China has developed and implemented digital technologies rapidly. The spread and spatial spillover effects of digital technology have significantly changed China’s industrial and economic structures. The comprehensive application of big data, the Internet, artificial intelligence, blockchain, satellite remote sensing, and other technologies in agriculture and rural areas will bring about innovation in agricultural production technology and in agricultural commercial formats, as well as the modernisation of rural governance. Digital village construction is not only a strategic direction for rural revitalisation but also an important part of the construction of digital China. The Chinese government attaches great importance to the construction of a digital countryside. The Outline of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development proposes accelerating the
construction of digital rural areas, building a comprehensive agricultural and rural information service system, establishing an inclusive service mechanism for agriculture-related information, and promoting the digitalisation of rural management services. Recently, the Chinese government has widely applied digital technologies in various fields, such as rural industry, people’s livelihoods, and rural governance. In digital agriculture, 5G, the Internet of Things, and big data are used to assist agricultural modernisation, build a new agricultural management model, and simulate, monitor, judge, forecast, and recommend the whole process of agricultural production, from planning, investment, and production to harvest, processing, and sales, to reduce costs and improve resource utilisation, production efficiency, product quality, and the ecological environment. Digital information platforms will be built to promote the development of new forms of business, such as rural e-commerce and online live broadcasting, so as to increase farmers’ incomes and rural prosperity. In terms of rural governance, digital technology is used to build a rural governance platform, and WeChat is used to inform government policies. Video phones are used to construct a “mobile conference hall” for village affairs, which integrated government services, and improved the efficiency of public affairs. In 2022, China’s National Development and Reform Commission issued the Action Plan for Digital Rural Development (2022–2025): “By 2025, 4G will be further popularized in rural areas, 5G innovative applications will be made, and the digitalisation of agricultural production and operations will be significantly accelerated, the construction of smart agriculture has achieved initial results, and several high-quality and distinctive rural e-commerce product brands have been developed, the rural network culture is developing vigorously, and the rural digital governance system is gradually improving; By 2035, significant progress is expected in the construction of digital villages, the “digital divide” between urban and rural communities has narrowed significantly, and farmers’ digital literacy has improved significantly.” Digital rural construction provides new opportunities to improve agricultural production efficiency, activate rural resources, and broaden income channels for farmers. It has also had a profound impact on the transformation of rural governance and organisational forms.

Simultaneously, countries are building digital village ecosystems adapted to their national conditions: In 2001, South Korea launched the “Information Village” program to build an ultra-high-speed Internet environment and e-commerce infrastructure for rural areas with backward information technology. The village information committee is responsible for the government’s professional information guidance personnel, the operation and maintenance of rural information organisations, and the supervision and improvement of villagers’ information literacy. The construction of digital rural infrastructure in Japan has undergone three stages: E-Japan, U-Japan, and I-Japan. Through e-commerce legislation, the establishment of an electronic trading platform for agricultural products and a specialised online store for agricultural products, specialisation, and large-scale management of agricultural products have been realised. India has been working on digital literacy education for its residents, with the 2017 PMGDISHA program for rural areas providing digital literacy education to 60 million citizens in rural areas and digital literacy training for students from ethnic communities. The Brazilian government, through “WI-FI Brazil”, “North and Northeast connectivity”, and “Smart City”, during the COVID-19 pandemic, online shopping, electronic payment, distance education and digitisation of agriculture in Brazil have developed rapidly, promoting the digitalisation of the economy and people’s livelihood. Based on their own economic realities, countries have made in-depth progress in rural infrastructure construction, digital literacy improvement of rural residents, industrial digitalisation, and digital industrialisation, providing a blueprint for mutual learning and cooperation in the construction of digital villages in various countries. It is worth noting that with the promotion of AI technology, the construction of digital villages worldwide is facing unprecedented opportunities and challenges. On the one hand, the application of AI technology can replace repetitive labour and assist human workers, helping to improve productivity. On the other hand, the application of AI technology will have a major impact on both blue- and white-collar jobs. Hang et al. [1] believed that an AI’s lack of
interpersonal skills and emotions will hinder the realisation of AI’s potential. This will become a new topic which must be considered in the construction of the digital countryside, which will be related to systematic and major changes in the educational choices of young rural people, the job market, and the rural business mode. Through the analysis of the digital economy experience and the latest digital technology development trend of various countries, several experiences are worth learning for China: 1. A professional team under the guidance of the government is systematically responsible for the operation of the digital village. 2. Pay attention to the overall improvement of the digital literacy of rural residents; a massive digital literacy campaign could be launched. 3. Use digital platforms to enhance the scale and specialisation of agricultural services. 4. The role of digital technology in promoting rural economic development under special conditions, such as the epidemic. 5 AI technology is having a profound impact on the construction of digital villages, including business models and organisational structures; technical ethics must be taken into consideration when constructing the digital village system.

2. Literature Review

2.1. The Implications of the Digital Economy

The digital economy was first proposed by American scholar Tapscott [2], who believed that the digital economy is “an economic model that presents information flow in a digital way”. Goldfarb et al. [3] suggested the digital economy as an economic activity that uses digital technology to reduce intermediate transaction, search, trade, and transportation costs. Bukht et al. [4] proposed that the digital economy consists of the digital sector, the digital economy, and the digital economy.

2.2. Factors Influencing the Digital Economy

Katharine Willis [5] researched rural villages in Cornwall, England, to highlight the implications of integrating information technologies with rural communities. He discovered the mechanism of digital infrastructure transformation, particularly the role of rural village committees in providing resources to support digital integration and developing a place to integrate digital skills and resources within the community. Fujisaki et al. [6] found that Japan’s integration of private-sector digital technology into rural public services has solved the problem of declining utilisation, income, and the attractiveness of rural public transport. Through regional planning and management, digital technology matches the needs of the community, and the public transportation information of the community can be incorporated into the public transportation network to realise the sustainable development of rural transportation. Jane E. Fountain [7] stated that the development of a digital government should be a process where technical innovation and modifications in governance structure work in parallel. The success of the development of digital government can only be ensured if the governance structure and organisational culture continuously adapt to technological advancements. Jeffre Roy [8] highlighted that in the process of government digital transformation, cross-sectoral governance, organisational culture, and personnel within the government play a significant role; leaders must possess relevant digital technological skills and be able to create the conditions for their initial trials. Akerman et al. [9] discovered that digital technology has a skill bias; the widespread use of broadband technology has largely replaced low-skilled and unskilled people and complemented high-skilled workers in completing non-routine intellectual jobs. By analysing the conceptual model of e-commerce in rural Iran, Jalali et al. [10] concluded that, for farmers, the education level, degree of information technology, and knowledge of the relevance of e-commerce are important elements directly influencing rural e-commerce development. Rotz et al. [11] found that rising land costs and data control issues have an impact on digital agriculture and rural construction and suggested that attention should be paid to the impact of new technologies on increasing labour exploitation and deepening the marginalisation of labour and space.
2.3. Three Ways for Digital Economy Measuring

It is a common practice worldwide to establish a digital economy evaluation index system by constructing multidimensional indicators. The United Nations International Telecommunication Union ICT (2018) constructs a multidimensional evaluation system from three dimensions: ICT use, ICT access, and ICT skills. The EU (2015) constructs a digital economy and society index from five dimensions: broadband access, human capital, digital technology, internet application, and digital public services. Meanwhile, the China Academy of Information and Communications Technology selects indicators from four levels: macroeconomy, converged application, basic industries, and basic capabilities to build the Digital Economy Index (DEI). Myovella et al. [12] constructed an evaluation index system from seven dimensions, including self-employment, technological innovation, human capital quality of life, ICT, economic development, and economic structure, to measure the development level of the digital economy. While the index measurement method can reflect the development level of the digital economy in a specific region according to the actual situation of the digital economy development, there may be potential instability in data sources due to the subjective nature of index construction.

The satellite account method is a commonly used measurement method, and the Digital Economy Satellite Account (DESA) considers the entirety of digital economic activities to ensure the comprehensiveness of statistics in the field of the digital economy. This method provides more accurate insights into the operation and development of enterprises under the digital economy. In 2017, the OECD established the “Expert Resource Group for Measuring GDP under the Digital Economy” and proposed the basic framework of a digital economy satellite account. The digital transaction in the digital economy satellite account framework includes four elements: producer, product, transaction characteristics, and user. The framework aims to prepare the supply and use table of DESA. While the digital economy satellite account can systematically reflect the characteristic activities of the digital economy in various industries of the national economy, it is still in the research stage, and its development is relatively immature. The framework needs to be constantly adjusted according to the actual situation of the development of the digital economy.

The value-added method is used to measure the total worth of the digital economy. Ahmad et al. [13] established a supply and use table of the digital economy to determine this amount. In 2018, the U.S. Department of Commerce’s Bureau of Economic Analysis (BEA) divided the digital economy into three categories: infrastructure, e-commerce, and other chargeable digital services. Additionally, the Department for Digital, Culture, Media and Sport (DCMS) divided the digital economy into nine sub-sectors, including electronics and computer manufacturing, wholesale of computers and electronic products, publishing (excluding translation and interpretation), software release, film, television, video, radio, and music, telecommunications, computer programming, consulting, and related activities, information service activities, and computer and communication equipment maintenance. The China Academy of Information and Communications Technology divides the digital economy into industrial digitalisation and digital industrialisation. The digital economy accounting method is included in the G20 Digital Economy Measurement Toolbox. The value-added method relies on the pre-investment national economic accounting system, which is relatively mature. However, due to the limitations of indicators, it is difficult to entirely demonstrate the latest characteristics associated with digital economy development.

2.4. Impact of the Digital Economy on Economic Development and Social Well-Being

Using data from OECD countries from 1997 to 2007, Czernich et al. [14] found that the installation of broadband infrastructure enhanced economic growth. André Jansson [15] presented the interdependence between digital networks and rural communities through the study of Swedish network society and rural communities and highlighted the functions of digital networks in connecting farmers’ interests, enhancing farmers’ sense of belonging, and promoting the stability of rural society. Singh et al. [16] found that digital technology has played a significant role in fostering the development of high-quality agricultural and
precision irrigation and recommended using digital platforms to measure the soil, environment, and other essential aspects, conducting analysis, and implementing visual charts and reading for agricultural precision monitoring and control. Xie et al. [17] studied the long-term practices of China, Japan, and South Korea since the digital economy is included in the framework of economic growth considerations together with a sustainable environment, natural resources, and political globalisation. They found that a high level of digitalisation may lead to a decline in the economic welfare of various countries by increasing the uneven distribution of technological facilities and rent-seeking behaviours. Kupiryanova et al. [18] found that rural areas suffer from severe digital discrimination, which contributes to a decline in their profitability. To increase the competitiveness and profitability of the agricultural sector, strengthening the construction of rural digital infrastructure, eliminating the digital divide between urban and rural areas, and narrowing the quality of life gap between urban and rural areas are necessary. Marco Haenssgen [19] analysed cross-sectional data from rural India and found that the spread of mobile phones has made health care easier for people with mobile phones but has exacerbated the deterioration of those without mobile phones in poor areas.

Academics have fully studied the construction of a digital village and its influencing factors, which has laid a good foundation for the measurement of digital villages and studying the factors influencing digital village construction; however, some problems are yet to be solved. Most studies considered the impact of digital rural construction from a single dimension or variable and lacked a systematic analysis of multidimensional digital rural construction, leading to an insufficient mechanism analysis of the level of digital rural construction. Additionally, existing research mainly focused on cluster analysis of the construction level of the digital countryside; however, a few researchers focused on the dynamic evolution of the construction level of the digital countryside across the country. In this study, a comprehensive index of digital rural construction was constructed from the aspects of digital rural infrastructure construction, digital industrialisation, and industrial digitalisation. Kernel density estimation was used to depict the dynamic evolutional characteristics of digital rural construction, and a detailed analysis of each influencing factor was conducted individually to provide targeted policy suggestions.

3. Research Framework

3.1. Connotation

The outline of the digital economic development plan describes the digital countryside as an endogenous process of applying networking, informatisation, and digitalisation in the development of the agricultural and rural economy and society, as well as the enhancement of farmers’ modern information skills. The synergy theory asserts that disparities between subsystems within a system foster cooperation and coordination across subsystems, resulting in the production of novel functionalities that cannot be accomplished by subsystems alone [20]. According to endogenous development theory, rural construction should be based on the inherent resources of rural areas. Learnings from foreign knowledge, technology, and systems can give full play to the subjective initiative of rural areas, which can control decision-making power and the right to enjoy development benefits [21]. Digital rural construction will sink urban information resources into rural areas based on local realities and resource endowments, adapt measures to local conditions, and play a role in digital empowerment through the extensive participation of rural residents to jointly realise the rational use and creative appreciation of local resources and stimulate the endogenous power of rural development.

Based on Tapscott’s definition of the digital rural, synergy theory, endogenous development theory, and emerging characteristics of China’s digital village development, this study presents the definition of the digital rural to be ‘The digital village is built on the digitalisation of rural infrastructure, using the digitalisation of rural industry and digital industrialisation as its vehicles, and aims to network, digitalise, and informatise the rural economy and society. The objective of rural modernisation is to achieve prosperity in
rural industries, ecological liveability, an effective government, rural civilisation, and a prosperous way of life.'

3.2. Evaluation Index System


Table 1. Evaluation index system of digital rural construction level.

<table>
<thead>
<tr>
<th>Target Layer</th>
<th>Rule Layer</th>
<th>Specific Indicators</th>
<th>Unit</th>
<th>Nature</th>
<th>Index Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital rural infrastructure construction (A1)</td>
<td>Number of Internet broadband access users X1</td>
<td>10,000 households</td>
<td>Positive</td>
<td>Total number of rural Internet broadband access users</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Internet domain names ten thousand</td>
<td>Positive</td>
<td>Total number of rural Internet domain names</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Length of long-distance optical cable line X3</td>
<td>kilometre</td>
<td>Positive</td>
<td>Length of rural long-distance optical cable line</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of meteorological observation stations X4</td>
<td>individual</td>
<td>Positive</td>
<td>Number of rural meteorological observation stations</td>
<td></td>
</tr>
<tr>
<td>Rural Industry digitisation (A2)</td>
<td>Rural e-commerce logistics level X5</td>
<td>10,000 pieces</td>
<td>Positive</td>
<td>Rural business volume of e-commerce logistics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural online retail sales X6</td>
<td>CNY 100 million</td>
<td>Positive</td>
<td>Rural online retail sales</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agricultural irrigation level X7</td>
<td>hectares</td>
<td>Positive</td>
<td>Effective agricultural irrigation area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural e-commerce scale X8</td>
<td>individual</td>
<td>Positive</td>
<td>Number of Taobao villages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agricultural fertilizer use per unit output value X9</td>
<td>CNY 100 million /10,000 tons</td>
<td>Negative</td>
<td>Ratio of total agricultural output value to agricultural fertilizer use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Investment level of agricultural production X10</td>
<td>%</td>
<td>Positive</td>
<td>Increase in fixed asset investment in agriculture, forestry, animal husbandry and fishery</td>
<td></td>
</tr>
<tr>
<td>Rural Digital Industrialisation (A3)</td>
<td>Information technology service income X11</td>
<td>CNY 10,000</td>
<td>Positive</td>
<td>Main business income of information technology industry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural digital finance level X12</td>
<td>/</td>
<td>Positive</td>
<td>Rural digital finance index *</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accumulated value of express revenue X13</td>
<td>CNY 10,000</td>
<td>Positive</td>
<td>Total income of rural express</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural Internet of Things level X14</td>
<td>ten thousand people</td>
<td>Positive</td>
<td>Average service population of rural postal outlets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction level of rural network culture X15</td>
<td>%</td>
<td>Positive</td>
<td>Ratio of rural cable TV access households to total households</td>
<td></td>
</tr>
</tbody>
</table>

Note: * It is obtained by multiplying the digital inclusive financial index of Peking University from 2011 to 2021 by the proportion of rural population in each province. Data source: The author collates the calculation results based on entropy method.
Considering the development of digital rural infrastructure (A1), the number of rural households with broadband internet connections represents the overall state of rural broadband internet connectivity, the number of domain names indicates the number of domain names in the village, the length of the optical cable lines indicates the development of the optical cable infrastructure, and the creation of digital infrastructure for rural meteorological operations reflects the number of meteorological observation stations.

The level of rural e-commerce logistics represents the prevalence of rural e-commerce in terms of rural industry digitisation (A2), rural online retail sales reflect the digitalisation of the rural retail industry, agricultural irrigation reflects the extent of digital building of farmland and water conservation infrastructure, the magnitude of rural e-commerce indicates the growth of rural e-commerce models, and investment in agricultural production represents the status of digital production in agricultural production.

In terms of rural digital industrialisation (A3), income from information technology services indicates the growth of the information technology industry during the construction of the digital countryside; the level of digital finance in rural areas shows the use of digital technology in rural financial development, and the construction level of rural network culture represents the influence of digital technology on rural network culture.

3.3. Data Sources

The majority of the data were obtained from China’s statistical yearbook, China’s rural statistical yearbook, China’s provincial statistical yearbook, the provincial statistical bulletin on national economic and social development, the website of the National Bureau of Statistics, Guotai’an database, provincial rural statistical yearbook, 2020 China Taobao Rural Research Report, Peking University Digital Inclusive Finance Index 2011–2020, and other sources. These data were supplemented by an interpolation approach.

4. Methodology

4.1. Entropy Method

The construction of the digital countryside should consider the coordination of various influencing factors, including the construction of digital infrastructure, industrial digitalisation, digital industrialisation, and many other factors that are composed of economic systems. Each factor has a different impact on the construction of the digital countryside, some of which may be positive while others may be negative, and their degrees of impact are different. The entropy method can avoid the subjectivity caused by the expert scoring method [22], reflect the nature of each parameter and its contribution to the comprehensive index, amplify the influence of different parameters, and objectively reflect the internal differences between the data through weights. Zhao et al. [23] used the entropy method to measure the construction of a digital countryside in Zhejiang, China. The specific calculation steps are as follows:

First, the data were standardised using Equation (1):

\[
X'_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} (+)
\]

\[
X''_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} (-)
\]

where \(X'_{ij}\) and \(X''_{ij}\) are the standardized positive and negative indicators of the \(j\)th year of the \(i\) evaluation index respectively.

\(X_{ij}\) is the result of index standardization, \(\max(X_{ij})\) is the maximum value of index \(X_{ij}\), \(\min(X_{ij})\) is the minimum value of index, and \(i = 1, 2, \ldots, m; j = 1, 2, \ldots, n\).

The proportion of the \(j\) index in the total sample in the \(i\) year was calculated as follows:

\[
P_{ij} = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}}
\]

(2)
Information entropy of the j indicator was calculated as follows:

\[ e_j = -1/ \ln(m) \sum_{i=1}^{m} \{ P_{ij} \ln(P_{ij}) \} \] (3)

Weight of the j indicator was calculated as follows:

\[ \psi_j = -(1 - e_j)/ \sum_{j=1}^{n} (1 - e_j) \]

\[ \psi_j \in [0, 1]; \sum_{j=1}^{n} \psi_j = 1 \] (4)

The development index of each subsystem in the i year was calculated as follows:

\[ f(x)_{org}(y) = \sum_{j=1}^{n} \psi_j \times X'_{ij} \] (5)

where in Equations (2)–(5), m is the number of years, n is the number of indicators, and \( f(x) \) is the digital rural construction index.

4.2. Kernel Density Estimation

The kernel density estimation method was proposed by B W Silverman [24], who used continuous kernel density curves to describe the random distribution of random variables for spatial aggregation region analysis with strong robustness and weak dependence on the model. Density estimation was used to measure innovation development efficiency [25]. The more clustered the kernel density curve, the higher the efficiency, and vice versa.

Kernel density estimation was used in this study to examine the spatial distribution trend of digital rural buildings in 30 Chinese provinces. The probability density estimation formula for the random variable at the point \( x \) was obtained by assuming an independent distribution sample for the density function of the random variable by

\[ f(x) = f(x_1, x_2, x_3) \]

\[ x_1, x_2, x_3, \text{as follows:} \]

\[ f(x) = \frac{1}{Nh} \sum_{i=1}^{N} K\left(\frac{x_i - x}{h}\right) \] (6)

where \( N \) is the total number of samples (30 provinces), \( K(x) \) is a random kernel function, and \( h \) is the density estimation bandwidth. The smoother the density estimation and the greater the divergence, the greater the bandwidth.

4.3. Tobit Model

Since the China digital rural construction composite index ranges from 0 to 1, the dependent variable is restricted. To prevent parameter estimation bias, a Tobit model was constructed using the maximum likelihood approach for the analysis of the dependent variables in this study. The measurement equation is as follows:

\[ y_{it} = \varphi_0 + \varphi_1gov + \varphi_2rev + \varphi_3inf + \varphi_4com + \varphi_5ind + \varphi_6edu + \varphi_7pow + \varepsilon_{it} \] (7)

wherein \( y_{ij} \) represents the level of China’s digital rural construction in t year of province i, which is measured by China’s digital construction index; \( gov \) is the explanatory variable, indicating the general budget expenditure of local finance; \( rev \) is the explanatory variable, indicating the per capita disposable income of rural residents; \( inf \) is the explanatory variable, indicating rural infrastructure investment; \( com \) is the explanatory variable, indicating the number of computers owned by rural residents per 100 households; \( ind \) is the explanatory variable, indicating the added value of the primary industry; \( edu \) is the explanatory variable, representing education level of rural residents; \( pow \) is the explanatory variable, representing rural power generation; and \( \varepsilon_{it} \) is a random disturbance term. To address the model’s
endogeneity problem, the lag times of some variables were used as instrumental variables for the re-regression.

4.4. Explanation of the Variables

4.4.1. Explained Variables

Relevant indicators were selected to measure the comprehensive index of China’s digital rural construction from three aspects: digital rural infrastructure construction, digital rural industrialisation, and rural industry digitisation, which could reflect the level of China’s digital rural construction based on the findings of previous research.

4.4.2. Explanatory Variables

General budget expenditure of local finance: Referring to CY Lee [26], the government can offer kinetic energy for scientific and technological innovation through industrial policies and financial investments in science and technology. By directing the flow of the production factors of social capital, fiscal expenditure promotes the optimal allocation of resources for the entire society in the construction of the digital countryside.

Per capita disposable income of rural residents: The income of the rural population influences the development of the digital countryside in several ways. Galor et al. [27] note that income inequality affects economic growth through multiple channels of capital accumulation and technological innovation. This study examined rural households’ disposable income per capita to measure the effect of income on digital rural development.

Rural infrastructure investment: As a factor of production, rural infrastructure investment can improve the output of the production function, according to Barrow’s theory of economic growth. This study calculated the influence of the determinants of rural infrastructure investment on digital rural construction by dividing rural infrastructure investment by regional gross domestic product.

According to Czernich et al. [14], network technology is a driving force for economic growth in rural areas, as measured by the percentage of rural homes using a computer. This study used computer ownership data per 100 rural homes as the characterisation variable to examine its impact on China’s digital rural development.

Primary industry’s added value: Based on the research of Benin [28] on productivity improvement for agricultural mechanization, this study selected the added value of the primary industry from 2011 to 2021 as the characterization variable for the examination of its effect on China’s digital rural construction level.

Education level: Referring to Galasso et al. [29], elite capture in the development of digital technology exists at the level of education, which impacts rural families’ participation prospects in the digital economy. This study used the number of rural college graduates in each province from 2011 to 2012 as an indicator variable to examine its impact on the degree of digital rural development in China.

Rural power generation: Power scarcity is a significant barrier to the digital economy’s development. This study employed the logarithm of rural power generation in each province to determine the effect of rural power generation on the number of digital rural buildings in China. According to the statistics of the Energy Research Institute of the State Grid, in 2018, the total number of racks of large and above data centres in the country has reached 2.04 million, and the number of racks of these data centres is expected to reach 8.02 million by 2025. In 2018, the total power consumption of data centres in China reached 160.9 billion kWh, accounting for 2.35% of the country’s electricity consumption [30].

5. Result and Analysis

5.1. Evaluation of Digital Village Construction in China

5.1.1. Spatiotemporal Evolution Characteristics

The digital village construction index for 30 provinces in China from 2011 to 2021 using the entropy approach utilised ARCGIS software to graphically represent the results, as shown in Figure 1. The comprehensive index of digital rural construction across the
30 provinces, autonomous areas, and cities ranged from 0.0444 to 0.9763, with a mean of 0.4198. From the standpoint of the construction level of digital villages in the country’s four major regions, the following trend emerged: Central Region > Northeast Region > West Region > East Region. Central China had the highest level of digital rural construction at 0.4659, whereas in the eastern area, the level of digital rural construction was lowest at 0.3977.

Figure 1. Comprehensive index of China’s digital village construction.

- Overall Spatiotemporal Evolution Characteristics of China’s Digital Village Construction

China’s digital rural development has made substantial progress from 2011 to 2021. Significant improvements have been made in network speed, digital technology’s contributions to industrial development, the “digital divide” between urban and rural areas, farmers’ digital literacy, and the effectiveness of digital governance. Figure 2 shows the complete index of China’s digital rural construction level measured using the entropy technique from 2011 to 2021, with the time-series mean value used.

Figure 2. Time series evolution characteristics of China’s digital village construction composite index.

During the sample survey period, the digital village strategy accelerated, and the comprehensive index of digital village building rose steadily; the comprehensive index of digital rural construction in 2011 was 0.17, which was the lowest in 2011–2021. With the strong support of the government and active engagement of businesses, the digital village plan was further executed, and the digital village’s building and development achieved spectacular results, reaching a high of 0.6 in 2020. In 2021, the digital economy industry was undergoing necessary layout adjustment and industrial structure optimisation, and the growth rate of digital rural construction slowed owing to the influence of domestic and foreign economic environments, high-quality economic development and transforma-
tion, and the promotion of rural revitalisation strategies. However, China’s digital rural construction still maintained a relatively rapid growth rate.

Figure 3 shows the cross-sectional evolution trend of China’s digital rural construction comprehensive index and the fluctuation variance histogram and line chart based on the comprehensive index and index variance of the digital rural construction level for 30 provinces, regions, and cities, to further investigate the regional differences and fluctuations in China’s digital rural construction level.

Figure 3 shows the cross-sectional evolution trend of China’s digital rural construction.

During the sample survey period, Beijing had the lowest comprehensive development index at 0.076, whereas Chongqing had the highest at 0.5. From the perspective of the degree of fluctuation of the comprehensive index of digital rural construction, Liaoning, Jiangsu, Jilin, and Yunnan had a large degree of fluctuation, with an amplitude greater than 0.4, while Anhui, Beijing, Fujian, and Gansu had the smallest fluctuations, with an amplitude of less than 0.4. Beijing, as the capital, had a high urbanisation rate, and the construction of the digital economy was concentrated in its cities. The digital divide between urban and rural areas was significant, and therefore, the level of digital rural construction must be enhanced. Fujian’s digital rural construction maintained a high level and developed relatively maturely, while the development of digital villages in Anhui and Gansu was relatively flat, indicating that the development trend of the construction of digital villages in the two provinces was relatively stable.

Figure 4 presents a line graph based on the average value of the comprehensive index of digital rural construction in the four key economic regions of China. From 2011 to 2016, the degree of digital rural construction in northeast China was the lowest. In 2019, the rate of digital rural construction reached a peak at 0.9%, following a period of strong growth beginning in 2016. Since then, despite a minor dip, the level of development has remained higher than that in other regions of the country. With the support of the innovation-driven development strategy, northeast China has seized the development opportunities of the digital countryside, empowering traditional industries with digital technology, fully utilising the advantages of the country’s main grain-producing areas, raw-material-producing areas, and border trade, and converting black land resources into digital assets. The degree of construction in the digital countryside has steadily increased. From 2011 to 2017, the creation of digital communities in the central region was the highest in the nation. After 2017, the progress rate slowed and fell behind that of the northeast, maintaining the second-highest level of construction in the country. The Central Region has made significant strides in rural digital financial innovation, effectively narrowing the income gap between farmers and the education gap between urban and rural areas. Additionally, the central region has made significant efforts to develop digital agriculture and has explored practical and viable solutions for precision planting and breeding and digital marketing of agricultural products. The level of digital countryside creation has gradually increased. Before 2016, the rate of digital village development in the western area was comparable to that in the eastern area; however, since 2016, the western area’s rate of construction has steadily surpassed that of the eastern area. The western region...
made full use of its beautiful landscape and abundant resources, actively developing the ‘live broadcasting economy’ and ‘goods economy’, and effectively encouraging the growth of the county economy and expansion of people’s income. According to the ‘Digital Economy Development Report’, published in 2020 by the New Rural Development Institute of Beijing University and the Ali Research Institute, 91 of the top 100 counties with the fastest development in the digital village index are located in the west. In recent years, the eastern region has been deeply involved in the construction of smart villages, focusing on digital governance and industrial intelligence, creating a model for the development of the entire industrial chain of digital villages, developing a new model of ‘smart governance’ and ‘sharing rural governance’, continuously deepening the construction of digital basic public services, opening the ‘last mile’ for rural public services, and striving to serve the rural population. Overall, although the creation of digital villages in the four major regions had some hurdles, they have maintained a stable and progressive annual growth trend.

Figure 4. Comprehensive index of digital village development in four regions of China (2011–2021).

- **Overall Spatiotemporal Evolution Characteristics of China’s Digital Village Construction Subsystem**

  Digital rural infrastructure (F) maintained a constant growth trend, increasing from 2011 to 2019 and from 0.031 in 2011 to 0.187 in 2019. During this period, the country’s investment in the construction of digital rural infrastructure has increased annually; the project of information entering rural areas and households has been successfully implemented, and communication infrastructure, including optical fibre broadband and network signals, has continued to expand into remote areas. The digital transformation of traditional rural infrastructure continued to advance; the level of digital, networked, and intelligent services in rural infrastructure vastly improved; and the foundation for digital rural development was continually strengthened. As a result of the effects of industrial layout optimisation and digital economy adjustment within the context of the economic cycle and high-quality development, the rate of digital rural infrastructure construction fell between 2019 and 2021. Simultaneously, the country’s investment in digital infrastructure increased, and in 2020, the US FCC invested USD 2 billion to subsidise rural broadband construction and help rural digital infrastructure. Japan’s Ministry of Finance has provided sufficient financial support for the ‘high-quality development of information and communication technology’ and is planning to invest a total of JPY 430 billion more over four years to provide operational guidelines for the supervision of ICT infrastructure funds.

  The industrial digitalisation (I) index shows a substantial upward trend from 2011 to 2021, rising from 0.044 in 2011 to 0.38 in 2021. From 2011 to 2016, the rate of industrial digitalisation increased at a sluggish rate. During this period, the level of industrial digitalisation was always lower than that of digital industrialisation development. Industrial digitalisation rapidly increased between 2016 and 2021, surpassing the rate of digital industrialisation and infrastructure development, reaching a peak of 0.38 in 2021. Generally, between 2011 and 2021, rural real economy and digital economy integration expanded, and rural digital productivity increased. By empowering rural industries with technical services and platform development, the scope of rural industry digitalisation continually widened, and the vitality of rural traditional industries was continuously enhanced.
The digital industrialisation (D) index showed a consistent and upward development trend between 2011 and 2021, from a minimum value of 0.099 in 2011 to a maximum value of 0.193 in 2019. The development level of digital industrialisation maintained a modest growth pattern compared with industrial digitalisation. With the growth in industrial digitisation, a declining trend was observed in 2019 and subsequent years. As shown in Figure 5, although digital industrialisation maintained a steady growth momentum, the relative level was low, reflecting that the new digital foundation in rural areas of China was still relatively weak, 5G layout planning was not perfect, and the degree of integration of digital technology and the real economy needs improvement.

![Figure 5](image)

**Figure 5.** Shows a broken-line chart based on the three subsystem indices for digital village construction in China.

Based on the sectional data of the three subsystems of digital rural construction in each province, a broken-line chart was drawn, as shown in Figure 6.

![Figure 6](image)

**Figure 6.** Cross-sectional evolution characteristics of Chinese digital rural construction composite index.

As can be observed in Figure 6, except for individual provinces, the industrial digitalisation index was the highest, whereas the rural infrastructure construction index was the lowest. The level of digital industrialisation construction lies between digital rural infrastructure construction and industrial digitalisation. Specifically, the lowest value of the three systems was the level of digital infrastructure construction in Shanxi (0.025), and the highest value was the industrial digital development level in Jiangsu Province (0.2943). The top three cities for rural digital infrastructure were Hainan, Tianjin, and Chongqing; the top three cities for rural digital industrialisation were Chongqing, Zhejiang, and Yunnan; and the top three cities for rural digital industrialisation were Chongqing, Zhejiang, and Yunnan. From a key point of view, Chongqing was outstanding in the construction of the digital countryside and ranked first in western China for the level of digital rural infrastructure construction. Chongqing gave full play to the role of information technology in improving the quality of agricultural production and the efficiency of rural governance, and the vitality of rural areas was fully stimulated. In 2020, five counties and districts in Chongqing joined the national digital village pilot project as a model for the nationwide construction of digital villages. As a traditionally strong province of the digital economy, Zhejiang has actively cultivated new reforms of industrial development with digital technology in recent
years, actively explored rural digital governance innovation, built a ‘rural brain’, promoted the collection of rural data resources, and helped the ‘resources into assets’ of rural data. In 2022, the overall development level of county agriculture and rural areas in Zhejiang reached 66.7%, ranking first in China for three consecutive years.

- Overall Spatiotemporal Evolution Characteristics of China’s Digital Rural Construction by Region

In this study, the spatiotemporal evolutional characteristics of the digital rural construction level in the Yangtze River Delta, Bohai Rim, Sichuan-Chongqing, and Pearl River Delta regions were selected for discussion, as shown in Figure 7.

![Figure 7](image_url)  
Figure 7. Spatial and temporal evolution characteristics of Chinese digital rural construction composite index by region.

This study indicated that the degree of digital rural buildings in the four regions increased annually from 2011 to 2021, with a minor decline from 2019 to 2021 but a high level of development. From 2011 to 2014, the level of development was in the order of Pearl River Delta Region > Sichuan and Chongqing Region > Bohai Rim Region > Yangtze River Delta Region. The years 2011–2014 represented an early stage in the development of China’s digital economy. The Pearl River Delta region had a solid base for processing, manufacturing, and agricultural industries and had numerous manufacturing plants located in rural areas. As the ‘leader’ of the four key regions in the early stages of digital economy creation in China, the Pearl River Delta region was at the forefront. From 2014 to 2019, the degree of development of digital villages in Sichuan and Chongqing exceeded that in the Pearl River Delta, demonstrating an astounding explosive force of digital rural construction. The Sichuan and Chongqing region came up as an important industrial base for electronic information technology, with a good endowment of digital technology resources, a frequent flow of factors between urban and rural areas, and a fast industrial conversion efficiency of digital technology. The opening of the Chongqing–Xinjiang–Europe special train has brought new opportunities for the development of processing and agricultural industries in Sichuan and Chongqing, which have strongly promoted the construction of the digital countryside. Since rural regions of Sichuan and Chongqing are situated in mountainous regions with steep topography, compared to plains areas, infrastructure building for digital rural construction in Sichuan and Chongqing was more challenging and required a larger investment, necessitating a systematic plan and high construction standards. In 2020, the Yangtze River Delta ranked first in digital village development, surpassing Sichuan, and Chongqing. The Yangtze River Delta region had a comparatively high level of urbanisation. The initial phase of digital rural development mostly collaborated with the digital economic development of central cities. The performance of e-commerce and online retail was comparatively exceptional, but the development of digital governance in rural areas and industrial digitalisation lagged. After adjusting its industrial structure, the Yangtze River Delta expedited reforms in agricultural and rural digitalisation, rural industry digitalisation and efficiency development, and rural digital service enhancement. The rehabilitation of rural network culture and enhancement of digital infrastructure in rural areas required precise efforts. Owing to the impact of the economic cycle, the construction of digital vil-
lages regressed to 0.6973 after achieving rapid growth, surpassing the other three regions to reach a high level of 0.8358. In the Bohai Rim region, the number of digital rural buildings has increased from 0.2115 in 2011 to 0.7052 in 2020. Based on big data technology, villages surrounding the Bohai Sea integrated digital infrastructure and information platforms into the development of the marine economy and agriculture, developing scientific digital technology solutions and establishing a new pattern of digital rural development.

5.1.2. Dynamic Evolution Characteristics of China’s Digital Rural Construction

To further investigate the dynamic evolution of China’s digital rural construction, kernel density estimation was utilised to analyse the distribution location and polarisation characteristics of China’s digital rural construction between 2011 and 2021 (Figure 8).

**Figure 8.** Composite index of digital rural construction in four regions (a) Bohai Rim; (b) Yangtze River Delta Region; (c) Pearl River Delta Region; (d) Sichuan-Chongqing region.

- **Dynamic Progression Characteristics of Digital Rural Construction in the Main Economic Zones**

Figure 8 shows the temporal evolution of digital rural construction in various regions. Specifically, in the Bohai Rim region, Figure 8a shows a major peak gradually moving to the right, suggesting that the level of digital rural construction is increasing annually. This peak value fell, and its width increased, indicating that the degree of aggregation at the digital rural construction level has a declining tendency over time. The level of digital rural construction in the Bohai Rim region exhibited a clear right-tail phenomenon, and the extension was expanded, indicating that individual regions have a clear pulling effect on the level of digital rural construction and that regional differences increased. Yangtze River Delta region in Figure 8b, from 2011 to 2011, shows the primary peak distribution shifting to the right, indicating that the number of rural digital buildings increased annually, the main peak value increased and then decreased, and the width increased, indicating that the degree of rural digital development in the region was concentrated that dispersed with time. From the standpoint of distribution extensibility, the right tail phenomenon was evident, and distribution extensibility was expanding, reflecting the exceptional contribution of some regions to the level of digital rural construction in the process of digital rural construction, and this characteristic was continuously strengthened. From Figure 8c, the Pearl River Delta region shows a major peak continuing to move to the right, and the
rate of rural digital buildings consistently increasing, with the width of the primary peak remaining steady, indicating that the amount of rural digital construction in the region stabilised over time. In terms of distribution and extensibility, digital villages did not exhibit a discernible lagging tendency, indicating that the degree of construction in the Pearl River Delta was largely balanced. From Figure 8d, the Sichuan-Chongqing region shows a primary peak of the kernel density function curve continuing to shift to the right and the level of digital rural construction progressively increasing. The growing peak value and decreasing width indicate that the level of digital rural construction aggregation is increasing over time. From the perspective of extensibility and distribution, this region demonstrated the phenomenon of right trailing, and the contraction in extensibility indicated that, in the process of digital rural construction, the level of digital rural construction between the regions was insignificantly different.

- Dynamic Evolutionary Characteristics of China’s Digital Rural Construction

Figure 9a shows that from 2011 to 2021, from a national perspective, the primary peak shifts to the right, indicating that the level of China’s digital rural building is rising annually. From the standpoint of the evolutionary trend of the primary peak, the peak value declined, and the width widened, indicating that the degree of aggregation in China’s digital rural construction level showed a declining tendency over time. From the perspective of distribution and extensibility, the kernel density curve of China’s digital rural construction level showed an apparent right-tailed phenomenon, and the extensibility was widened, indicating that certain provinces play an important role in the process of China’s digital rural construction, and the absolute difference continues to grow. From 2011 to 2015, it is evident from Figure 9b that China’s digital rural construction exhibited a polarisation trend. From 2016 to 2021, as indicated in Figure 9c, China’s digital rural construction exhibited a clear multi-polarisation trend, indicating that there is a multi-polarisation development trend in China’s digital rural construction and that the multi-polarisation characteristic is becoming more pronounced.

![Figure 9. Comprehensive index of China Digital Village Construction.](image-url)

5.2. Empirical Results and Analyses

5.2.1. Benchmark Regression Results Based on the Tobit Model

To make the regression results more compelling based on the theoretical analysis, the Tobit model was used as a benchmark model, and Stata was used for the empirical analysis. A regression analysis of digital rural construction was conducted separately for the entire nation, East, including the Middle, West, and Northeast. Table 2 presents the specific findings of the regression analysis.

Nationwide, the coefficient of general budget spending on local finance was 0.082, which was statistically significant at the 1% level, indicating the positive effect of local financial expenditures on the development of digital villages. Local financial expenditures play a crucial role in integrating rural resources, bringing the digital industry to rural areas, and directing the digital transformation of rural areas.
Table 2. Regression results based on Tobit model.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nationwide</th>
<th>Eastern Region</th>
<th>Central Region</th>
<th>Western Region</th>
<th>Northeast Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>gov</td>
<td>0.082 ***</td>
<td>0.150 ***</td>
<td>0.151 ***</td>
<td>0.030 **</td>
<td>0.096 **</td>
</tr>
<tr>
<td></td>
<td>(7.84)</td>
<td>(3.18)</td>
<td>(4.01)</td>
<td>(2.29)</td>
<td>(2.68)</td>
</tr>
<tr>
<td>rev</td>
<td>0.094 ***</td>
<td>0.090 ***</td>
<td>0.086 ***</td>
<td>0.494 ***</td>
<td>1.113 ***</td>
</tr>
<tr>
<td></td>
<td>(2.65)</td>
<td>(1.39)</td>
<td>(4.13)</td>
<td>(6.01)</td>
<td>(4.71)</td>
</tr>
<tr>
<td>infra</td>
<td>0.087 ***</td>
<td>0.075 ***</td>
<td>0.106 ***</td>
<td>0.007 **</td>
<td>0.016 ***</td>
</tr>
<tr>
<td></td>
<td>(6.20)</td>
<td>(3.39)</td>
<td>(6.37)</td>
<td>(−0.21)</td>
<td>(−0.35)</td>
</tr>
<tr>
<td>ind</td>
<td>0.000 ***</td>
<td>0.000 ***</td>
<td>0.000 ***</td>
<td>0.000 **</td>
<td>0.000 ***</td>
</tr>
<tr>
<td></td>
<td>(7.49)</td>
<td>(4.27)</td>
<td>(4.61)</td>
<td>(−1.19)</td>
<td>(−1.20)</td>
</tr>
<tr>
<td>edu</td>
<td>−0.004 **</td>
<td>−0.003 **</td>
<td>−0.006 *</td>
<td>−0.032 **</td>
<td>−0.029 **</td>
</tr>
<tr>
<td></td>
<td>(−0.53)</td>
<td>(−2.05)</td>
<td>(0.35)</td>
<td>(−2.10)</td>
<td>(0.62)</td>
</tr>
<tr>
<td>pow</td>
<td>0.018 ***</td>
<td>0.016 ***</td>
<td>0.029 ***</td>
<td>0.021 ***</td>
<td>0.032 ***</td>
</tr>
<tr>
<td></td>
<td>(4.36)</td>
<td>(2.65)</td>
<td>(3.74)</td>
<td>(2.79)</td>
<td>(−0.91)</td>
</tr>
<tr>
<td>com</td>
<td>0.003 ***</td>
<td>0.002 ***</td>
<td>0.004 ***</td>
<td>0.005 **</td>
<td>0.003 **</td>
</tr>
<tr>
<td></td>
<td>(3.91)</td>
<td>(1.95)</td>
<td>(3.25)</td>
<td>(2.10)</td>
<td>(−0.93)</td>
</tr>
<tr>
<td>Constant</td>
<td>−1.072 ***</td>
<td>−1.007 **</td>
<td>−1.278 ***</td>
<td>−4.417 ***</td>
<td>−9.255 ***</td>
</tr>
<tr>
<td></td>
<td>(−3.09)</td>
<td>(−1.50)</td>
<td>(−2.14)</td>
<td>(−5.92)</td>
<td>(−4.02)</td>
</tr>
<tr>
<td>Observations</td>
<td>319</td>
<td>99</td>
<td>66</td>
<td>121</td>
<td>33</td>
</tr>
<tr>
<td>Pseudo R2</td>
<td>0.509</td>
<td>−2.5138</td>
<td>−3.5449</td>
<td>−4.3576</td>
<td>11.3834</td>
</tr>
<tr>
<td>Loglikelihood</td>
<td>0.498</td>
<td>49.526064</td>
<td>82.87855</td>
<td>74.964753</td>
<td>34.155134</td>
</tr>
</tbody>
</table>

Note: Values in the parentheses are t-statistics; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; the regression results omit the constant term, the same below.

The coefficient of per capita disposable income of rural residents was 0.094 and had a positive significance at the level of 1%, reflecting that the factor of per capita disposable income of rural residents has a very significant positive impact on the construction of the digital countryside. An adequate disposable income can effectively guarantee the initiative and participation of farmers in the construction of the digital countryside. The active participation of farmers stimulates the innovation momentum of digital elements, effectively boosting the construction of rural networking, digitisation, and information technology and providing a strong endogenous impetus for the construction of the digital countryside. Furthermore, this will help create a sound and stable rural digital culture and effectively boost the quality and efficiency of rural digital construction.

The coefficient of investment in rural infrastructure construction was 0.087, which was significant at the level of 1%, reflecting the important role of rural infrastructure in the construction of the digital countryside. Since the construction of rural infrastructure effectively improves rural production and living environments, complete water, electricity, education, health, and other facilities can guarantee the rational distribution and solid progress of the construction of the digital countryside, promoting the accumulation of human capital, reducing production and transportation costs, and indirectly bringing about economic growth.

The coefficient of the added value of the primary industry was 0.000, which was significant at the level of 1% and reflected the impact of the development of the primary industry on the construction of the digital countryside. Agricultural modernisation promotes the digital transformation of traditional agriculture in an all-round and whole-chain manner, accelerates the improvement of total productivity, and promotes the development of the digital countryside. However, as the construction of the digital countryside involves the development of rural industry, organisational governance, ecological construction, livelihood guarantees, village culture, and many other aspects, the impact of the primary industry on the construction of the digital countryside is relatively less evident.

The coefficient of education level was −0.004, which was statistically significant at the 5% level, suggesting that education level has a negative effect on digital rural construction. The primary causes are as follows:
• Urbanisation has led talents with higher academic credentials to frequently choose to leave the countryside and move to the city, resulting in the outflow of a high-quality professional population to the countryside.
• Elderly people with lower educational levels and residents lacking professional skills tend to remain in the countryside, making it difficult for them to have a direct and positive impact on the rural digital construction industry.
• The constant evolution of digital technology requires higher professional and thinking mode reforms for digital talent. A high level of education, inherent educational background, and skill reserve is preventing the direct promotion of the digital countryside’s development.

The coefficient of rural power generation was 0.018, which was statistically significant at the 1% level, indicating that adequate power supply has a beneficial effect on digital rural buildings.

The coefficient of the number of computers owned by farmers per 100 households was 0.003, which was significant at the 1% level, reflecting the major role of computers as an important physical carrier of digital rural construction in rural industry digitalisation, rural governance, and the upgrading of farmers’ digital skills.

Overall, the general budget expenditure on local finance, per capita disposable income of rural residents, rural infrastructure investment, rural power generation, and the number of computers owned by every 100 rural households were positively correlated with the level of digital rural construction in China and were statistically significant at the 1% level, indicating that sufficient financial tilt, sufficient per capita disposable income of rural residents, and high rural power generation are necessary for the development of digital rural areas. The added value of the primary industry had no effect on the development of the digital countryside, and the degree of rural education had a negative effect on the development of the digital countryside. According to the size of the coefficient, the local general financial budget expenditure, the per capita disposable income of rural residents, and rural infrastructure investment had the greatest impact on the construction of digital rural areas, indicating that increasing local financial investment in rural areas, improving the level of rural infrastructure construction, and continuing to increase farmers’ incomes are crucial issues to be addressed to promote the construction of digital rural areas.

5.2.2. Endogenous Test

Endogenous errors may occur due to measurement errors, missing variables, or reverse causality. To address endogeneity, this study used the first-order lag term of local government general budget expenditure, industrial added value, and rural infrastructure investment as instrumental variables of Models 1, 2, and 3, respectively. The coefficients of the regression results of each lag item were significantly positive at various significance levels, and the generated regression results were not significantly different from those of the benchmark regression model, indicating that no endogeneity problem exists in the model, as shown in Table 3.

5.2.3. Robustness Test

To verify the robustness of the model further, the following robustness testing techniques were employed in this study:
• Transform estimation model: The Tobit model was replaced with an OLS model to run a robustness test and assess the sensitivity of the coefficient to China’s digital rural construction.
• Modification of the format of control variables: The percentage of rural households that own a computer and the percentage of rural households that own a television were checked.
• Reducing the number of samples: Based on the systematic clustering of the results of this study, the robustness test selected the digital rural construction demonstration area, digital rural construction high-level area, digital rural construction good devel-
opment area, and digital rural construction as improved areas and then estimated the robustness of the coefficient across various regions and sample sizes. The robustness results are presented in Table 4.

Table 3. Regression results of instrumental variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gov</td>
<td>0.076 ***</td>
<td>0.080 ***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.69)</td>
<td>(7.09)</td>
<td></td>
</tr>
<tr>
<td>rev</td>
<td>0.068 *</td>
<td>0.094 **</td>
<td>0.103 ***</td>
</tr>
<tr>
<td></td>
<td>(1.82)</td>
<td>(2.37)</td>
<td>(2.62)</td>
</tr>
<tr>
<td>infra</td>
<td>0.086 ***</td>
<td>0.088 ***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.97)</td>
<td>(6.05)</td>
<td></td>
</tr>
<tr>
<td>ind</td>
<td>0.000 ***</td>
<td></td>
<td>0.000 ***</td>
</tr>
<tr>
<td></td>
<td>(7.16)</td>
<td></td>
<td>(7.01)</td>
</tr>
<tr>
<td>edu</td>
<td>−0.002</td>
<td>−0.005</td>
<td>−0.003</td>
</tr>
<tr>
<td></td>
<td>(−0.26)</td>
<td>(−0.62)</td>
<td>(−0.38)</td>
</tr>
<tr>
<td>pow</td>
<td>0.018 ***</td>
<td>0.020 ***</td>
<td>0.018 ***</td>
</tr>
<tr>
<td></td>
<td>(4.18)</td>
<td>(4.56)</td>
<td>(4.15)</td>
</tr>
<tr>
<td>com</td>
<td>0.003 ***</td>
<td>0.003 ***</td>
<td>0.003 ***</td>
</tr>
<tr>
<td></td>
<td>(3.34)</td>
<td>(3.14)</td>
<td>(3.07)</td>
</tr>
<tr>
<td>L.gov</td>
<td>0.075 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.ind</td>
<td>0.000 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L.infra</td>
<td></td>
<td>0.102 ***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.48)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−0.790 **</td>
<td>−1.054 ***</td>
<td>−1.129 ***</td>
</tr>
<tr>
<td></td>
<td>(−2.20)</td>
<td>(−2.74)</td>
<td>(−2.97)</td>
</tr>
<tr>
<td>Observations</td>
<td>290</td>
<td>290</td>
<td>290</td>
</tr>
<tr>
<td>Pseudo R2</td>
<td>−2.197</td>
<td>−2.056</td>
<td>−2.064</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>136.805</td>
<td>130.764</td>
<td>131.122</td>
</tr>
</tbody>
</table>

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

As shown in Table 4, the local government’s general budget expenditure, rural residents’ per capita disposable income, rural infrastructure investment, rural residents’ computer ownership per 100 households, rural residents’ television ownership per 100 households, the added value of the primary industry, and the coefficients are all positive and statistically significant at the 1% level, while the coefficient of education level is negative and statistically insignificant. In conclusion, following a careful examination of the replacement model, replacement variables, and sample reduction, the findings of the robustness test can be aligned with the benchmark regression model, showing that the benchmark regression results of this study are successful and robust.

Table 4. Results of robustness test.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS</th>
<th>Substitution Variables</th>
<th>Reduce Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>gov</td>
<td>0.082 ***</td>
<td>0.113 ***</td>
<td>0.132 ***</td>
</tr>
<tr>
<td></td>
<td>(7.31)</td>
<td>(10.51)</td>
<td>(11.05)</td>
</tr>
<tr>
<td>rev</td>
<td>0.105 ***</td>
<td>0.279 ***</td>
<td>0.265 ***</td>
</tr>
<tr>
<td></td>
<td>(2.91)</td>
<td>(9.35)</td>
<td>(8.44)</td>
</tr>
<tr>
<td>infra</td>
<td>0.092 ***</td>
<td>0.061 ***</td>
<td>0.052 ***</td>
</tr>
<tr>
<td></td>
<td>(5.70)</td>
<td>(4.45)</td>
<td>(3.90)</td>
</tr>
<tr>
<td>lnind</td>
<td>0.000 ***</td>
<td>0.095 ***</td>
<td>0.035 ***</td>
</tr>
<tr>
<td></td>
<td>(7.97)</td>
<td>(8.32)</td>
<td>(3.24)</td>
</tr>
<tr>
<td>edu</td>
<td>−0.004 **</td>
<td>−0.027 ***</td>
<td>−0.073 ***</td>
</tr>
<tr>
<td></td>
<td>(−0.46)</td>
<td>(−3.49)</td>
<td>(−11.37)</td>
</tr>
</tbody>
</table>
6. Discussion

6.1. Overall Evolution Trend

From 2011 to 2020, the overall level of China’s digital village construction has increased year by year. During the study period, the average overall development of the digital countryside in China was 0.4198. Regionally, the level of rural digital construction showed the characteristics of “Central > Northeast > West > East”, and the gap between the levels of rural digital construction in different regions was steadily narrowing. From the perspective of system evolution characteristics, from 2011 to 2021, industrial digitalisation showed a rapidly rising trend and sufficient vitality for development. The development trends of digital rural infrastructure and industrialisation were found to be relatively stable, and the construction level needs improvement. From the perspective of key economic construction regions, the level of digital village construction in the Yangtze River Delta, Pearl River Delta, Bohai Sea, Sichuan, and Chongqing regions from 2011 to 2021 showed a rapid rise in fluctuations, reflecting the characteristics of digital village development in these regions. In recent years, China’s policies have increased investment in the construction of digital villages, and by the end of 2021, the proportion of broadband in administrative villages across the country had reached 100%, and the mobile payment business handled by banking financial institutions in rural areas had increased by 22.2%. According to calculated data from the China Academy of Information and Communications Technology, under the same coverage, the number and investment scale of 5G base stations increased at least three times that of 4G, and the high investment cost restricted investment in digital infrastructure to a certain extent. Paul Romer highlighted that technological progress is the core of economic growth and that the research and development ability of basic software and key equipment is not strong, limiting improvement in the construction level of digital infrastructure. In 2020, China imported 543.5 billion pieces of integrated circuits, and the self-sufficiency rate of integrated circuits was only 15%. Data are a key production factor for the development of a digital economy. In 2019, the total scale of China’s data production was 3.9 ZB, accounting for 9.3% of the total global data production (42 ZB). To prevent data monopoly and reduce the risk of data abuse, China has put forward new requirements on the risk prevention, control, and security compliance of enterprise and government network data activities and has further improved the cybersecurity and data security laws to formulate more stringent standards for the establishment of digital enterprises and investment in digital industries, which, to a certain extent, have delayed the process of digital industrialisation.

6.2. Dynamic Evolution Trend

From 2011 to 2021, the nuclear density curve for China’s digital village construction shifted to the right, indicating an increase in the level of China’s digital village construction annually. According to the trend of the main peak evolution, the peak value decreased, and the width expanded. From the perspective of distribution ductility, the curve of nuclear density showed an evident right-trailing phenomenon, and the ductility widened,
reflecting an apparent pulling role of some provinces in the construction of the digital countryside in China. Inter-provincial differences were found to be constantly expanding due to their different resource endowments and regional digital economy policies. The ‘Digital Village Development Plan 2022–2025’, formulated by the Chinese government, proposes to promote the development of digital villages in an orderly manner based on the development basis of different regions and according to different village development laws in different regions, providing guidelines for the digital construction of rural areas. Yilmaz [31] reported that digital technology affects economies of scale and network diffusion that can effectively overcome the limitations of geographical space. The spillover effect of urban digital technology has an important impact on the construction of the digital countryside in the region, and thereby, inter-provincial differences continue to expand from the perspective of regional development. The construction level of the digital countryside in Northeast China from 2018 to 2021 ranked first among the four major economic regions in China, indicating that digital technology and economic development level are not the only decisive factors for the development of the regional digital countryside but regional geographic endowments and industrial scale are. Furthermore, population quality and social and cultural factors are important reasons for the multi-polarisation of the digital economy.

6.3. Influencing Factor

From the perspective of the influencing factors of digital rural construction, the strength of each influencing variable ranged from strong to weak in the following order: per capita disposable income of rural residents > investment in rural infrastructure > local budget revenue > rural power generation > computer ownership of 100 rural households > added value of primary industry > education level. Besides the negative impact of the educational level, other variables demonstrated a positive impact on digital rural construction. Since financial support has an important impact on the development of the digital economy, Tang et al. [32] argued that the government’s expenditures on research and development can promote technological innovation through fiscal tools, which supports the conclusion of this research. Sufficient power generation is an essential condition for the digital economy, and computers are necessary tools for the development of the digital economy. Notably, the level of education has a negative impact on the construction of the digital countryside, and the movement of people can be blamed. Mohamed et al. [33] explained that migration from the countryside to the city can bring positive benefits to the labour force. Rural residents with higher educational levels tend to have higher income expectations; therefore, they choose to leave the countryside and gain more economic benefits in the city with their knowledge and skills. According to China’s 7th National Census, the proportion of rural working-age population to the country’s total working-age population continued to decline from 46.6% in 2011 to 32.5% in 2020. In 2020, the registered rural population reached 770 million, but many of these people worked and lived in urban areas. Furthermore, the number of illiterate people in rural areas was still huge in 2020, accounting for 72.4% of the country’s total illiterates, which also restricted the development of rural digitalisation. The reduction in the high-quality rural labour force is restricting the promotion of advanced technologies and hindering the developmental process of the digital countryside.

7. Conclusions

7.1. Theoretical Implications

In this study, the level of digital rural construction in China was measured using the entropy method, kernel density estimation, and system clustering, and the factors influencing it were analysed through the Tobit test. The construction level of China’s digital countryside in 2021 presented the characteristics of ‘Northeast > West > Central > East’ (data). The academic implications analysed are as follows:

- In areas with relatively backward economic and technological levels, the influence of resource endowment and industrial policy on the level of digital village construction
exceeded that of digital technology itself, and a higher level of digital village development can be achieved through reasonable policy combinations, as shown in Figure 5.

- Since the implementation of the digital countryside strategy for five years, digital technology innovation and research and development levels have become the main problems restricting the construction of the digital countryside. Although the detailed policy standards are conducive to the construction of a digital countryside in the long run, they delay the process of digital infrastructure and digital industrialization in the short run, as shown in Figure 6.

- Education has a negative impact on the construction of the digital countryside, and population flow should be considered an intermediary variable whereby education level affects the digital level of rural areas.

7.2. Managerial Implications

Based on the results and conclusions, the following four suggestions are proposed:

- Rural governance and business models should be innovated according to local realities to undertake the transfer of digital technology and digital industry. Regions with higher digital technological levels should actively explore innovation in industrial models and perform well in terms of technology transfer. South Korea’s Digital Twin Programme and experience from Japan Agricultural Co-operatives are worth learning from [34,35]. Regions with less developed digital technologies should mine more data resources based on local resource endowments, such as tourism and natural resources, and explore a digital economy model for sustainable development.

- Policies should be formulated based on the actual conditions of each region to give local governments more flexibility in governance, paying attention to social responsibility education in digital enterprises, reducing short-term profit-making behaviours of digital enterprises in investment and operation, and promoting the sustainable development of the digital countryside.

- More preferential policies and attractive salary and incentive mechanisms should be formulated to attract digital technical talents. Basic education and digital skills training for rural residents should be strengthened by conducting training programmes that are designed to meet the development needs of rural people of different ages and occupations. The experience of India should be used as an example in developing digital literacy campaigns for the rural population.

- The construction of rural infrastructure should be accelerated to improve the integration of roads, electricity, logistics, and land resources that are compatible with the digital economy. More attention should be paid to cloud computing, artificial intelligence, remote sensing data, power data, and other specific applications for their applicability in agriculture and rural governance.

7.3. Suggestions for Future Research

Previous studies have often focused on the impact of the digital economy on the industrial structure. This study found that regions with less developed digital technology, especially in the northeast and western regions of China, can achieve a higher level of digitalisation through the optimal combination of resource endowment and policies. This could provide a new research perspective for people regarding industrial structure optimisation and policy combinations affecting the development level of the digital economy. Furthermore, rural population flow can be used as the intermediary variable emphasised in future research for the influence of educational level factors on the digital countryside.

Author Contributions: Conceptualization, X.C.; Data curation, X.C.; Formal analysis, X.C.; Formal analysis, X.C.; Methodology, X.C.; Supervision, X.C.; Software, X.C.; Writing, original draft, X.C.; Writing, review and editing, M.Y. and J.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Social Science Fund of China (19AJL007).
Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data come from the China Statistical Yearbook, the China Rural Statistical Yearbook, the provincial statistical yearbook, the provincial statistical bulletin on national economic and social development, the website of the National Bureau of Statistics, the Guotai’an database, and the provincial rural statistical yearbook, the 2020 China Taobao Rural Research Report, the Peking University Digital Inclusive Finance Index 2011–2020; A few missing data are supplemented by interpolation method and aggregate growth rate method according to indicator characteristics and data change trend. The website of the National Bureau of Statistic: http://www.stats.gov.cn/ (accessed on 15 February 2023), the Guotai’an database: https://www.gtarsc.com/ (accessed on 15 February 2023).

Conflicts of Interest: The authors declare no conflict of interest.

References
5. Willis, K.S. Making a “Place” for ICTs in Rural Communities: The Role of Village Halls in Digital Inclusion. In Proceedings of the 9th International Conference on Communities & Technologies—Transforming Communities, Vienna, Austria, 3–7 June 2019; ACM: Vienna, Austria, 2019; pp. 136–142. [CrossRef]
17. Xie, C.; Jin, X. The Role of Digitalization, Sustainable Environment, Natural Resources and Political Globalization towards Economic Well-Being in China, Japan and South Korea. Resour. Pol. 2023, 83, 103682. [CrossRef]
23. Zhao, Y.; Li, R. Coupling and Coordination Analysis of Digital Rural Construction from the Perspective of Rural Revitalization: A Case Study from Zhejiang Province of China. *Sustainability* 2022, 14, 3638. [CrossRef]
30. Chen, X. Digital infrastructure will lead to a surge in electricity demand, how to deal with? *Caijing Mag.* 2020, 14, 100–105.
34. Park, J.; Choi, W.; Jeong, T.; Seo, J. Digital Twins and Land Management in South Korea. *Land Use Policy* 2023, 124, 106442. [CrossRef]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.