Abstract: Since the reform and opening up in 1978, China’s economy has grown significantly, but rural development still lags. China has implemented a rural revitalization strategy to reduce the gap between urban and rural areas. Meanwhile, the digital economy has gradually become a new economic growth engine for China. With the digitalization of rural industries, the digital economy gradually integrated into rural development and revitalization. However, how the digital economy impacts rural revitalization remains unclear. Based on the entropy method, previous studies measured rural revitalization levels from the perspectives of economy, civilization, and ecological environment. In this paper, using panel data from 11 prefecture-level cities in Zhejiang Province from 2011 to 2019, we use the entropy method to quantify the development level of the digital economy, industrial upgrading, and rural revitalization. Then, we investigate the relationship among them using fixed effect regression. The empirical results show that the digital economy obviously promotes rural revitalization. The mediation effect test shows that industrial upgrading plays a mediating mechanism between the digital economy and rural revitalization. In addition, heterogeneity analysis reveals that the promotion effect of the digital economy on rural development in southwestern Zhejiang is stronger than that of northeastern Zhejiang. The results imply that government should strengthen digital infrastructure construction in rural areas to promote rural revitalization. Moreover, rural areas with different economic development levels should implement a differentiated rural revitalization strategy.

Keywords: digital economy; industrial upgrading; rural revitalization; mediating effect

1. Introduction

In recent years, the digital economy has attracted increasing attention from academia, institutions, and policymakers [1,2]. Information processing technologies are becoming increasingly mature, strengthening human data analysis capabilities. As a result, data have become a critical factor of production. The digital economy has fostered formation of new industries, new models, and new power [3]. Digital technology lowers economic costs, including search, replication, transportation, tracking, and verification costs [4]. In addition, the digital economy also lowers information asymmetry and facilitates information dissemination. Digital economic activities have accelerated industrial digitization and digital industrialization of various countries [5,6]. In the last twenty years, China’s digital economy has developed fast. According to the Chinese Academy of Information and Communications, from 2015 to 2020, China’s digital economy of GDP increased from 27.0% to 38.6%. In 2020, China’s digital economy was CNY 39.2 trillion. The data-driven digital economy has emerged as a crucial driving force in China’s economic future growth and recovery after the COVID-19 pandemic [7]. More and more business activities have intensely depended on network connectivity and digital devices after the COVID-19 pandemic [8].
Since China implemented economic reform and opening up, China’s GDP has grown significantly. However, China’s rural development is still lagging and faces acute problems due to environmental deterioration, poor sustainability, insufficient financial supply, weak infrastructure, lacking economic opportunity, and so on [9–11]. At the same time, aging and depopulation in the rural society is severe [11]. Lacking sufficient labor force in rural industries has aggregated unbalanced economic development between urban and rural areas [12]. In order to promote rural development, China has implemented the rural revitalization strategy. In 2021, the No. 1 document of the Central Committee of the Communist Party stressed that rural revitalization should be prioritized in the modernization process. Rural revitalization is a critical strategy to solve the unbalanced social development between rural and urban China. It is a meaningful way to achieve the common prosperity strategy of China. The strategy emphasizes using diversity policies and instruments to promote rural development. Rural revitalization requires various industries, because the sole dependence on the agricultural sector will result in the decline of rural communities [13]. Therefore, achieving the goals of rural revitalization requires new economic development engines. It is critical to the sustainable development of China’s rural economy and society.

Meanwhile, digital technologies have pervaded integrally and invisibly into rural life in the digital era [14]. The convergence between the digital economy and rural revitalization has been widely discussed by the government and the industry [12,13,15]. Digitalization provides new driving power for rural and agricultural development. Digital technologies enhance the matching ability of supply side and demand side. Disconnected Internet will hinder the recovery of rural small and medium enterprises [8]. Expanding the depth and breadth of the digital economy will benefit traditional rural industries upgrading. For example, banking armed with digital technologies has resulted in e-banking, which promotes financial inclusion and eases the financial constraint of rural small enterprises [16]. Therefore, how does the digital economy promote rural revitalization? What is the promotion mechanism? What is the heterogeneous effect? Clarifying these issues can enrich the theoretical research on the digital economy and rural economy. It also provides empirical evidence for policymakers to promote rural revitalization implementation.

In order to answer the above questions, this paper selects Zhejiang Province for research as a case study, in which the digital economy has been fully developed. Zhejiang is one of the most economically developed provinces in China. In 2003, Zhejiang implemented the “Beautiful Village” plan, dramatically improving the life quality of rural residents and the rural ecological environment. At the same time, digital finance developed rapidly in Zhejiang, where Alibaba is based. For a long time, the Zhejiang government has attached great importance to using digital finance to serve the real economy. Therefore, the case of Zhejiang is representative when exploring the impact of the digital economy on rural revitalization. Based on the data from 2011 to 2019, this paper comprehensively measures the digital economy and rural revitalization level of 11 cities in Zhejiang Province. Then, this paper uses panel data to empirically test the impact of the digital economy on rural vibration. The results show that the digital economy effectively promotes rural revitalization, and the mediation mechanism is rural industrial upgrading. The heterogeneity test shows that the promotion effect exists in regional heterogeneity. After a series of robustness tests, the conclusions still hold. The remaining sections are organized as follows. The relevant literature is presented in Section 2. The theoretical analysis and the formulation of research hypotheses are provided in Section 3. Section 4 provides the econometric design, which includes the variable construction, data sources, and econometric model. The empirical results are reported in Section 5. Section 6 provides the conclusion and policy implications.

2. Literature Review

This paper relates to prior research on the digital economy and rural revitalization. The digital economy has a variety of definitions. Tapscott (1996) related the digital economy to economic activities that can be enhanced by the Internet [17]. Similarly, Mesenbourg (2001) divided the digital economy into the construction and economic application of
ICT infrastructure [18]. Since then, the boundary of the digital economy has gradually expanded [6]. According to the OECD, the digital economy refers to all economic activities that depend on, or are greatly enhanced by, digital inputs, such as digital technologies, digital infrastructure, and digital services [2]. According to Bukht and Heeks (2017), the core of the digital economy includes hardware manufacturing, software and IT consulting, information services, and telecommunications [6]. The digital economy includes a narrow scope and a broad scope. The narrow digital economy evolves into digital services, such as platform economy, sharing economy, and the gig economy. E-business, e-commerce, Industry 4.0, precision agriculture, and algorithmic economy belong to the broad digital economy [6]. Moreover, digital finance is an important part of the digital economy. Cevik et al. (2022) found that there is a two-way Granger causality between Bitcoin spot and futures [19]. Therefore, digital currencies can be used as financial instruments to hedge energy price fluctuation [20].

Research related to rural revitalization primarily focuses on the connotation, evaluation system, and promotion path. Scholars explained the connotation of rural revitalization from different perspectives, including urban–rural integrated development, rural agricultural modernization, high-quality development, and modernization processes [21,22]. Based on connotation of rural revitalization, researchers built an evaluation system of rural revitalization from different perspectives, including economic, political, social, cultural, and ecological perspectives [23,24]. After selecting a series of comprehensive indicators, the entropy weight method and the principal component analysis method were applied to measure rural revitalization level. Some researchers proposed strategic paths to promote rural revitalization, such as urban–rural integrated development, deepening rural reform, and rural agricultural modernization [10,25]. Other researchers considered more specific implementation paths of rural revitalization, such as talent training, system construction, technical innovation, financial support, and tourism [26–28].

Studies related to this paper also involve integration of digital economy and rural economy. Chen (2021) found that the digital economy and rural industry can be coupled and integrated, despite insufficient methods and support [29]. The digital economy helps the supply side in remote and underdeveloped rural regions access markets that were hard to reach in the past. Tapscott (1996) argued that the digital economy facilitated information transition and communication [17]. The ability of the Internet has facilitated commercial transactions [18]. For example, e-commerce platforms can expand the scope of the sales market as well as the channels of agricultural products. Internet platforms, as information distribution centers, can effectively match agricultural supply side and demand side. Buyers and sellers of agricultural products can trade directly in the digital trade platform, reducing the cost of agricultural products deals. Therefore, the digital economy improves the production efficiency of agriculture, and thus enhances competitiveness of agriculture. Broadband in rural areas has expanded the accumulation of rural human capital, and promotes high-quality development of the rural economy [30,31]. The digital economy encourages an open, inclusive, co-governance and sharing, intelligent, and efficient model [32]. This is consistent with the aim of sustainable rural development concepts, which are innovative, coordinated, green, open, and shared. Digital technologies reduce the front-end transaction costs for rural finance, provide technical support for rural financial innovation, ease rural financial constraints, and contribute to rural economic development [33]. Xiao (2019) highlighted that big data could improve environmental protection and innovate the ways of interactive cultural communication, thereby promoting rural sustainable development [34]. Erdogan et al. (2022) found that the important source of carbon emissions from tourism is transportation, and environmental innovations can significantly lower carbon emissions and eliminate the negative effects of international tourism on the environment [35]. According to Cao et al. (2021), digital finance effectively improved energy-environmental performance by promoting green technology innovation [36]. Therefore, the digital economy is expected to reduce carbon emission of the rural tourism industry.
In summary, previous studies provide valuable insights into the digital economy and rural economy. However, direct research on the impact of the digital economy on rural revitalization is rare. Moreover, previous research mainly used the normative method, concentrating on concepts and policy paths, lacking empirical research. The quantitative impact of the digital economy on rural revitalization still needs to be further explored.

3. Theoretical Analysis and Hypothesis Development

In theory, the promotion of the digital economy on rural revitalization can be reflected in four aspects. Firstly, the digitization of agricultural trade. The combination of digital economy and trade produces digital agricultural trade, which will reduce agricultural trade costs and accelerate agricultural modernization. Secondly, digitalization of agricultural trade can decrease agriculture circulation costs, diminish logistics time, and lower logistics losses of agricultural products. Thereby, the profit margin of agricultural products and farmers’ income is largely improved [37]. On the one hand, the digital transformation of agriculture can precisely control and trace the whole agricultural production process, including agricultural input, production, and circulation. Thus, the digital economy can raise the quality of the agricultural supply side. On the other hand, digital devices of agriculture obtain agricultural data in real time, improving the agricultural production process and helping to form a whole-process standardized production system that will boost agricultural production and operation efficiency, reducing production costs [38].

Thirdly, digital governance improves rural governance capabilities and administrative efficiency. Digital rural government can promptly obtain more information to improve the level of scientific decision-making. Internet service platforms can also promote information sharing, eliminate data gaps, and improve rural administrative efficiency. Finally, digital finance eases financial constraints for rural residents. Digital finance enhances the availability, convenience, and comprehensiveness of financial services. The marginal cost of digital financial inclusion is nearly zero, significantly reducing the threshold of financial services for rural residents [39]. Poor farmers can obtain better access to financial resources thanks to digital finance, which also eases rural financial constraints. Therefore, the digital economy expands the coverage and depth of rural financial services [40]. According to the research presented above, the digital economy promotes rural revitalization through rural digitization and modernization. As a result, the first hypothesis is presented.

Hypothesis 1. The digital economy promotes rural revitalization.

The digital economy has become an important driving force for industrial upgrading, because industrial structure layout can be optimized by digital technologies [41]. Digital infrastructures include mobile Internet, big data, cloud computing, and artificial intelligence. These technologies can improve the traditional industrial structure, supporting the upgrading and transformation of the industrial structure. The integration of digital technologies with agriculture, manufacturing, and service industries has spawned new industries, formats, and models. Sheng (2020) pointed out that the digital economy will promote the upgrading, production efficiency, and high-quality development of traditional industries [42]. At the same time, county-level industrial upgrading has become the key driving force for economic growth. The industrial structure dividend accounts for 4% of the county-level GDP and contributes 24% to the GDP growth [43]. Industrial upgrading has continued extending the urban secondary and tertiary industries to rural areas. Digital technology is driving the integrated development of the entire industry in rural areas. New business models, such as sightseeing agriculture and rural tourism, are constantly emerging. Industrial upgrading also provides farmers with more nonagricultural employment opportunities and enhances the revenue sources available to people in rural areas. Therefore, the second hypothesis is presented as follows.

Hypothesis 2. The digital economy affects rural revitalization through industrial upgrading.
The digital economy has the characteristics of high technology, high growth, and high permeability. It compresses information dependence on geographical time and space by digital technologies, enhancing the interconnection depth and breadth among surrounding areas. However, the digital economy growth differs significantly in different regions of China. In areas without Internet, the role of the digital economy in rural development is negligible. Areas with smooth Internet speed will have a better digital economic infrastructure. At the same time, scale of the digital economy needs to reach a certain critical point before the promotion effect can be instantly amplified. As a result, promotion effect of the digital economy on rural revitalization will be different due to various digital economic infrastructure. Many studies have shown that the impacts of the digital economy on high-quality economic development, industrial upgrading, and regionally coordinated development exhibit regional heterogeneity [44]. Zhao and Long (2021) found noticeable regional differences in the impact of China’s digital economy on rural revitalization based on the panel data of China from 2015 to 2019 [45]. The economic development of Zhejiang Province is unbalanced because of its history and geographical environment. The digital economy circle in northeastern Zhejiang developed better than that in southwestern Zhejiang [46]. Therefore, we propose the second hypothesis of this paper.

**Hypothesis 3.** The impact of the digital economy on rural revitalization is regionally heterogeneous.

### 4. Empirical Research Design

#### 4.1. Data Source

This paper chooses 11 prefecture-level cities in Zhejiang Province as the research samples. The entropy method was used to construct development indexes for the digital economy, rural revitalization, and industrial upgrading. The data span from 2011 to 2019 and come from three sources. First, the digital finance index used for constructing the digital economy comes from the Peking University Digital Inclusive Finance Index (2011–2020), released by the Digital Finance Research Center of Peking University [47]. Second, democratic and legal village data come from the Law Popularization Office of Zhejiang Province. Other data are sourced from the “Zhejiang Statistical Yearbook” and the statistical yearbooks of prefecture-level cities over the years. Third, democratic and legal village data come from the Law Popularization Office of Zhejiang Province. Missing data were filled in with interpolation.

#### 4.2. Variable Selection

##### 4.2.1. Explained Variable

The explained variable is the rural revitalization index \( \text{Rural} \), which is measured following the method of Zhang et al. (2018) [23]. Combined with China’s “Rural Revitalization Strategic Plan (2018–2022)”, the evaluation system selects 5 first-level and 11 second-level indicators. These indicators are shown in Table 1. The first-level indicators include prosperous industry, effective governance, prosperous life, ecological livability, and rural civilization. Then, the entropy method is used to calculating the rural revitalization index.
4.2.2. Explanatory Variable

The core explanatory variable is the digital economy development index \((Digital)\). Following the method of Zhao et al. (2020) [48], the digital economy development index is calculated using the entropy method from the perspective of the Internet development and digital finance inclusion index. The indicators are shown in Table 2. The Internet development indicators include the Internet penetration rate, mobile phone penetration rate, and total telecommunications services per capita. The digital financial inclusion index comes from Guo et al. (2020) [47].

4.2.3. Mediating Variable

The mediating variable is the industrial upgrading index \((Isu)\). Chang et al. (2019) built an industrial upgrading evaluation based on the industrial structure evolution law of the Petty–Clark theorem and Kuznets curve [49]. Following the research of Chang et al. (2019) [49], we construct an industrial upgrading index to measure the level of industrial upgrading. The calculation formula is as follows.

\[
Isu = q_1 \times 1 + q_2 \times 2 + q_3 \times 3
\]

\(q_i\) is the proportion of the i-th industry output value. The \(Isu\) index ranges from 1 to 3. The low \(Isu\) value reflects that the industrial structure upgrading speed is slow in the region. If \(Isu\) is close to 1, the industrial upgrading level is low. On the contrary, the higher the \(Isu\) value, the higher the industrial upgrading level of the region.

4.2.4. Control Variables

Considering that economic development, urbanization level, fiscal expenditure level, and industrial structure have a significant impact on rural revitalization, referring to previous research [47,49], these factors are selected as the control variables.

4.2.5. Descriptive Statistics

Table 3 shows the meaning of the main variables and their summary statistics. The mean value of \(Rural\) is 1.01, the maximum value is 2.56, and the minimum value is 0.14.
The mean value of Digital is 1.01, the maximum value is 1.92, and the minimum value is 0.18. The digital economy development and rural revitalization levels vary widely among Zhejiang Province’s cities. The mean value of Isu is 2.42.

### Table 3. Variable definition and descriptive statistics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
<th>Obs</th>
<th>Mean</th>
<th>Std</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Rural revitalization development level</td>
<td>99</td>
<td>1.01</td>
<td>0.58</td>
<td>0.14</td>
<td>2.56</td>
</tr>
<tr>
<td>Digital</td>
<td>Digital economy development level</td>
<td>99</td>
<td>1.01</td>
<td>0.40</td>
<td>0.18</td>
<td>1.92</td>
</tr>
<tr>
<td>pGDP</td>
<td>Economic development level</td>
<td>99</td>
<td>82,429</td>
<td>29,741</td>
<td>30,643</td>
<td>152,465</td>
</tr>
<tr>
<td>Urban</td>
<td>Urbanization level</td>
<td>99</td>
<td>63.5</td>
<td>7.25</td>
<td>44.8</td>
<td>78.5</td>
</tr>
<tr>
<td>Fiscal</td>
<td>Fiscal expenditure level</td>
<td>99</td>
<td>1.12</td>
<td>0.53</td>
<td>0.41</td>
<td>2.75</td>
</tr>
<tr>
<td>Industry</td>
<td>Industrial structure</td>
<td>99</td>
<td>0.47</td>
<td>0.06</td>
<td>0.32</td>
<td>0.57</td>
</tr>
<tr>
<td>Isu</td>
<td>Industrial upgrading Index</td>
<td>99</td>
<td>2.42</td>
<td>0.07</td>
<td>2.28</td>
<td>2.64</td>
</tr>
</tbody>
</table>

### 4.3. Model Setting

The following model is constructed to examine the relationship between the digital economy and rural revitalization.

\[
\ln_{Rural_{it}} = \alpha_0 + \alpha_1 \ln_{Digital_{it}} + \delta X_{it} + \lambda_i + \epsilon_{it} \tag{2}
\]

To alleviate heteroscedasticity and multicollinearity problems, all variables are treated logarithmically. Among them, \(i\) represents the \(i\)-th city; \(t\) represents the time; \(Digital_{it}\) is the core independent variable; the vector \(X_{it}\) represents control variables; \(\lambda_i\) represents individual fixed effects that do not vary over time; \(\epsilon_{it}\) denotes the error term. If \(\alpha_1 > 0\) , assumption 1 holds. According to Baron and Kenny (1986) [50], the mediating effect model is constructed as follows:

\[
\ln_{Isu_{it}} = \beta_0 + \beta_1 \ln_{Digital_{it}} + \delta X_{it} + \lambda_i + \epsilon_{it} \tag{3}
\]

\[
\ln_{Rural_{it}} = \gamma_0 + \gamma_1 \ln_{Digital_{it}} + \gamma_2 \ln_{Isu_{it}} + \delta X_{it} + \lambda_i + \epsilon_{it} \tag{4}
\]

The existence of mediation effect of industrial upgrading requires that \(\alpha_1\) is significant in Equation (1). The following situations are considered: (1) If \(\beta_1\) and \(\gamma_2\) are significant, but \(\gamma_1\) is not significant, the industrial upgrading is a complete mediating effect. (2) If \(\beta_1\), \(\gamma_1\), and \(\gamma_2\) are significant, the industrial upgrading is a partial mediating effect, which can be calculated by \(\beta_1 \times \gamma_2\). (3) If \(\beta_1\) or \(\gamma_2\) are not significant but still pass the Sobel test, then the industrial upgrading is a partial mediating effect.

### 5. Empirical Result

#### 5.1. The Direct Impact of the Digital Economy on Rural Revitalization

Table 4 shows the baseline results of the impact of the digital economy on rural revitalization. The fixed effect model is used in order to alleviate the endogeneity problem as much as possible. The control variable is added gradually from columns (1) to (5). All the estimated coefficients of the digital economy index are positive at the 1% significance level, indicating that the digital economy plays a significant role in promoting rural revitalization, which verifies Hypothesis 1. Column (5) shows that if the digital economy index rises by 1%, the rural revitalization index will increase by 0.338%. The coefficient of economic development level (\(\ln_{pGDP}\)) is notably negative, which is consistent with Cai et al. (2019) [9]. The possible reason could be that cities are the primary source of GDP growth in Zhejiang rather than rural areas. The level of urbanization (\(\ln_{Urban}\)) has no significant impact on rural revival. Because urbanization will lead to a large-scale transfer of rural labor to cities, resulting in a shortage of rural labor, the level of fiscal expenditure (\(\ln_{Fiscal}\)) has a significant role in promoting rural revitalization. The impact of industrial structure (\(\ln_{Industry}\)) on rural revitalization is insignificant because this paper measures
the industrial structure with the proportion of the secondary industry, which accounts for a relatively small proportion of rural industries.

Table 4. Baseline regression results.

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) lnRural</th>
<th>(2) lnRural</th>
<th>(3) lnRural</th>
<th>(4) lnRural</th>
<th>(5) lnRural</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnDigital</td>
<td>0.863 ***</td>
<td>0.624 ***</td>
<td>0.560 ***</td>
<td>0.336 ***</td>
<td>0.338 ***</td>
</tr>
<tr>
<td></td>
<td>(8.81)</td>
<td>(8.08)</td>
<td>(6.55)</td>
<td>(4.01)</td>
<td>(3.82)</td>
</tr>
<tr>
<td>lnGDP</td>
<td>0.088 ***</td>
<td>0.231</td>
<td>-0.382 **</td>
<td>-0.370 **</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.72)</td>
<td>(1.26)</td>
<td>(-2.79)</td>
<td>(-2.91)</td>
<td></td>
</tr>
<tr>
<td>lnUrban</td>
<td>1.99</td>
<td>0.181</td>
<td>0.037</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.77)</td>
<td>(0.19)</td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnFiscal</td>
<td>0.823 ***</td>
<td>0.885 ***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.73)</td>
<td>(4.67)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnIndustry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnIndustrial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.111 ***</td>
<td>-7.87 ***</td>
<td>-11.0 ***</td>
<td>3.39</td>
<td>4.02</td>
</tr>
<tr>
<td></td>
<td>(-15.2)</td>
<td>(-3.78)</td>
<td>(-2.69)</td>
<td>(0.70)</td>
<td>(0.79)</td>
</tr>
<tr>
<td>Fix effect</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Observations</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.82</td>
<td>0.86</td>
<td>0.88</td>
<td>0.93</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Note: Number in the parentheses is robust standard error. ** and *** represent statistical significance at 10%, 5%, and 1%, respectively. Adj. R² is the adjusted R².

5.2. Mediating Effect Analysis

In order to investigate whether the digital economy promotes rural revitalization by affecting industrial upgrading, this paper constructs the industrial upgrading level (Isu) as the mediating variable to test the mediating effect. Table 5 displays the results. Panel A represents the two-step mediation test, while Panel B represents the Sobel test. Column (1) in Panel A shows that the impact of the digital economy on the upgrading of the industrial structure is significantly positive at the 1% significance level. Column (2) shows that after adding the mediating variable (lnIsu), the regression coefficient of the digital economy and rural revitalization is still significantly positive at 1%, suggesting that the mediating effect of industrial upgrading exists. The Sobel test also showed a mediating effect, with an indirect effect coefficient of 0.053, accounting for 18.7% of the total effect. The above conclusion is consistent with Tao et al. (2022), who found that developing e-commerce in rural areas optimizes county industrial structure, which is beneficial to rural revitalization [51]. To sum up, the mediating effect test clearly shows that the transmission path of “digital economy→industrial upgrading→rural revitalization” exists. Hypothesis 2 holds.

Table 5. Mediating effect testing results.

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Variables</th>
<th>(1) lnIsu</th>
<th>(2) lnRural</th>
<th>Panel B: Sobel Test</th>
<th>Variables</th>
<th>(1) lnRural</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnDigital</td>
<td>0.016 ***</td>
<td>0.285 ***</td>
<td>Indirect effect 0.053 **</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.06)</td>
<td>(3.88)</td>
<td>(1.91)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnIsu</td>
<td>3.32</td>
<td>0.285 ***</td>
<td>Direct effect 0.285 ***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.31)</td>
<td></td>
<td>(4.81)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>yes</td>
<td>yes</td>
<td>Control yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fix effect</td>
<td>yes</td>
<td>yes</td>
<td>Fix effect yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>99</td>
<td>99</td>
<td>Observations 99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.89</td>
<td>0.93</td>
<td>Mediate proportion 18.7%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Number in the parentheses is robust standard error. ** and *** represent statistical significance at 10%, 5%, and 1%, respectively.
5.3. Heterogeneity Analysis

Considering that the economic development level and geographical environment of northeastern Zhejiang and southwestern Zhejiang are pretty different, this paper tests the heterogeneity of these two regions. The results are shown in Table 6. For both regions, the regression coefficients of the digital economy are significantly positive at the 1% significance level, indicating that the digital economy plays a significant role in promoting rural revitalization. It is worth noting that the coefficients in the two regions are different. The regression coefficient of the digital economy in southwestern Zhejiang is 0.318, which is greater than 0.164 in northeastern Zhejiang. This implies that the promotion effect of southwestern Zhejiang is more significant than that of northeastern Zhejiang. Hypothesis 3 holds. This conclusion is analogous to Cao et al. (2021), who found that digital finance has a greater promotion effect on environmental performance in regions with underdeveloped capital markets than in regions with developed capital markets [36].

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) Northeastern</th>
<th>(2) Southwestern</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnDigital</td>
<td>0.164 *** (2.98)</td>
<td>0.318 *** (6.89)</td>
</tr>
<tr>
<td>Control</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Fix effect</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Observations</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.95</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Note: Number in the parentheses is robust standard error. *** represent statistical significance at 10%, 5%, and 1%, respectively. Adj. R² is the adjusted R².

5.4. Robustness Test

Digital economy development can promote rural revitalization, but the more developed the rural areas, the better the digital infrastructure. Thus, the relationship between the digital economy and rural revitalization is endogeneous because of reverse causality. This paper executes robustness tests to confirm the above conclusions by using instrumental variable regression, replacing the core explanatory variable, and using different estimating strategies. The results are displayed in Table 7.

<table>
<thead>
<tr>
<th>Variables</th>
<th>(1) lnRural</th>
<th>(2) lnRural</th>
<th>(3) lnRural</th>
<th>(4) lnRural</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnDigital</td>
<td>0.680 ** (2.21)</td>
<td>0.348 *** (5.78)</td>
<td>0.640 *** (3.48)</td>
<td></td>
</tr>
<tr>
<td>lnDIFI</td>
<td>0.337 *** (4.68)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumental Variable</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Control</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Pooled</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Regression</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Fix effect</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Random effect</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Observations</td>
<td>88</td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
</tbody>
</table>

Note: Number in the parentheses is robust standard error. **, and *** represent statistical significance at 10%, 5%, and 1%, respectively.

5.4.1. Instrumental Variable Regression

An eligible variable must be exogenous to the explained variable and correlate to the endogenous variable. Yi and Zhou (2018) constructed an instrumental variable for
the digital economy by using the product of lag term and first-order difference term (\(\ln\text{Digital}_{t-1} \times \Delta\ln\text{Digital}_{t-1}\)) [52]. This instrumental variable satisfies the exogenous requirements, because it cannot be influenced by the current period of rural revitalization levels. At the same time, the constructed instrumental variable will closely relate to the digital economy, because the lag term of the digital economy relates to the digital economy, considering that the digital economy develops continuously. Following Yi and Zhou (2018), this paper constructed the instrumental variable and used the TSLS method to estimate the results, shown in Column (1). The coefficient of the digital economy is 0.68 and is significant at the 5% significance level, implying the promotion effect of the digital economy on rural revitalization.

5.4.2. Replacing Core Variable

The core explanatory variable is replaced with the digital inclusive finance index (referred to as DIFI) released by the Digital Finance Research Center of Peking University. The results are shown in Column (2) of Table 7. The regression coefficient of the digital finance is 0.337 and it is significant at the 1% significance level. The results still support the conclusion that digital finance encourages rural revitalization.

5.4.3. Changing Estimation Method

We alter the estimation method by employing random effect regression and pooled regression, and the results are displayed in columns (3) and (4) of Table 7, respectively. The coefficient of the random effect estimation is 0.348, and the coefficient of pooled regression estimation is 0.64. Both the coefficients are significant at the 1% significance level. The results still support the promotion effect of the digital economy on rural revitalization.

6. Conclusions and Policy Implications

6.1. Conclusions

As the digital economy develops rapidly in China, understanding the link between the digital economy and rural rejuvenation is crucial for the long-term sustainability of rural areas. Based on samples from 11 prefecture-level cities in Zhejiang Province, this paper builds evaluation systems through the entropy method to quantify the development level of the digital economy, industrial upgrading, and rural revitalization. Then, the research used panel data regression to explore relationship between the digital economy and rural revitalization. The following empirical results are drawn: First, the digital economy promotes rural revitalization. This conclusion is still valid after a series of robustness tests, which include using instrumental variables, substituting the primary explanatory variable, and modifying the panel data estimating strategies. Second, industrial upgrading plays a crucial mediating role in which the digital economy promotes rural revitalization. Third, the effect of the digital economy on rural revitalization is regionally heterogeneous. Compared with the northeastern Zhejiang Province, the promotion effect of the digital economy on rural revitalization is higher in the southwestern Zhejiang Province.

6.2. Policy Implications

According to the empirical results, the following policy implications are provided. Firstly, the Chinese government should increase investment in rural digital infrastructure to promote rural rejuvenation. The Internet penetration and network quality in rural areas is essential to increasing the breadth of coverage of the digital economy. Therefore, the government should construct more rural digital infrastructure and provide digital upgrades for the traditional rural infrastructure. Specifically, the deployment of commercial 5G networks, big data, and artificial intelligence should be accelerated. Secondly, the Chinese government should guide the integration between digital technologies and rural industries. The digital economy promotes rural revitalization by the mediating mechanism of industrial upgrading. Digitalization will cultivate new industries, forms, and models for traditional rural industries. Thus, the government should accelerate the digital industrialization and
industrial digitalization process by cultivating the data element market and coordinating digital infrastructure layout. Thirdly, policymakers should implement distinctive digital development strategies for rural regions with different economic conditions. Developing the digital economy can promote rural revitalization in both poor and wealthy areas. Considering that regional heterogeneity exists in the effect of the digital economy on rural revitalization, it is necessary to implement differentiated strategies for rural areas with different economic conditions. Finally, the government should train people in rural areas to use the Internet and digital devices. Popularizing digital technology in rural areas is closely related to education. On the one hand, the Chinese government should encourage outstanding talents to join rural digitalization. On the other hand, local governments should provide personnel training for farmers to use digital devices.

6.3. Limitations and Future Research

This paper still has some limitations which can be improved from the following aspects in the future. First, the data are limited to Zhejiang Province, which is a developed region in China. It is not clear whether the conclusions hold or not in underdeveloped regions. Thus, samples in the future research can be extended to more provinces in China. Second, the measurement of rural revitalization is not comprehensive enough. Rural revitalization involves both economic and cultural development. In the rural areas of Zhejiang, there are a large number of ancient cultural elites, which represents traditional culture [53]. Future research should fully take into account ancient cultural factors. Moreover, better methods should be considered to measure level of the digital economy and rural revitalization. In addition, determining how to better overcome the endogeneity problem in the econometric model is also a future research direction.

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