How the Rural Digital Economy Drives Rural Industrial Revitalization—Case Study of China’s 30 Provinces

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Abstract: The Chinese government is implementing a rural revitalization strategy and speeding up rural modernization. The rapid development of the rural digital economy has become a new driving force for the revitalization of rural industries. By analyzing how rural industrial revitalization is driven by the rural digital economy, this study constructs a rural digital economy from the three dimensions of optimal allocation of rural resource elements, the effective connection of urban–rural markets, and the integrated development of rural industries. The entropy value method was used to assess the comprehensive level of development of the rural digital economy and industrial revitalization. Based on the agricultural and rural development data of 30 provinces in China from 2014 to 2019, we construct a dual fixed effect model to empirically analyze how the rural digital economy drives rural industrial revitalization. The results show that, first, the rural digital economy promotes the revitalization of rural industries through the following main approaches: optimal allocation and utilization of rural resources, effective connection of urban–rural markets, and industrial integration development. Second, using the benchmark regression test, it can be concluded that if the development level of the rural digital economy is increased by 1 percent, the development of rural industrial revitalization will increase by 0.066 percent, indicating that the development of the rural digital economy can significantly drive the revitalization of rural industries. Third, the driving effect of the rural digital economy on the revitalization of rural industries is heterogeneous in different regions and industrial structures. The effect of the rural digital economy on the revitalization of rural industries in the western region, the region with a high proportion of the output value of the primary industry, is higher than in the east and central regions, which have a low proportion of the output value of the primary industry.

Keywords: rural digital economy; rural industrial revitalization; driving force; heterogeneous driving effect

1. Introduction

The Chinese government proposed the “rural revitalization strategy” in October 2017 [1]. As the basis of this policy, rural industrial revitalization emphasizes the high quality and efficiency of agricultural development and increases the income of farmers. However, while China’s rural industries have boomed over the past four decades, existing problems need to be addressed. First, in terms of increased agricultural production, the low efficiency of agricultural production, the low utilization rate of rural resources, the unbalanced distribution of rural resources [2–4], and the severe loss of agricultural labor severely limit agricultural production capacity [5]. Second, from a rural value-added perspective, the overall efficiency of internet use among Chinese farmers is still at a low level [6], and the level of information in rural areas hardly supports the upgrading of rural industries [7]. Third, in terms of increasing farmers’ income, the difficulties in rural finances
and the unreasonable structure of rural industries have caused the profits of rural products to decline, severely limiting the growth of the rural economy and farmers’ income [8]. Therefore, finding the development momentum of rural industries is key to their revival.

The digital economy is a series of economic activities that use digital knowledge and information as key factors of production, modern information networks as important carriers, and effective use of information and communication technologies as important drivers to improve efficiency and optimize the economic structure [9]. Since 2018, the Chinese government has successively issued policy plans such as the Outline for the Development of Digital Countryside, the Plan for the Development of Digital Agriculture and Rural Development (2019–2025), and the Guide to the Construction of Digital Countryside 1.0, aiming to provide a new development path and overall ideas for the modernization of rural industries in various regions in the new era. Nowadays, the rural digital economy has gradually become a new driving force for rural economic development [10]. With the advantages of superior technology and intelligence, the rural digital economy has played a key role in improving the quality and efficiency of industrial development in rural areas [11–13]. Regarding the research on boosting rural industrial revitalization through the rural digital economy, Liu and Long believe that agricultural modernization can strengthen the optimal allocation of rural resource elements and then achieve agricultural sustainable development [14,15]. Fan proposed to strengthen the internet technology and the operation ability of the farmers, which will facilitate the effective connection between urban and rural markets [16]. Some scholars believe that the deep integration of the rural digital economy and the agricultural economy has become an important issue nowadays [17,18]. From the above analysis, we could find that scholars have conducted research on the impact of the rural digital economy from the aspects of optimal allocation of rural resources, effective connection between urban and rural markets, and integrated development of rural industries, which has laid a certain foundation for the research of the rural digital economy in promoting the revitalization of rural industries. However, most of the current research only focuses on one aspect of the rural digital economy’s impact on rural revitalization. Little research has been done to analyze the rural digital economy driving the revitalization of rural industries in a comprehensive way.

For the measurement of the rural digital economy and rural revitalization indexes, qualitative judgments of experts [19,20] and entropy methods [21] are mainly derived. While expert qualitative judgments are susceptible to individual subjective influences which are not easily convincing, the entropy method could reduce the bias caused by subjective judgments and more scientifically determine the different importance of indexes. Therefore, in this paper, we use the entropy method to measure the integrated index of rural industrial revitalization and rural digital economy development level. In terms of studying the relationship between the rural digital economy and rural industrial revitalization, there are mainly theoretical approaches [22,23], case analysis methods [24], and binary fixed effect models [18]. Among them, theoretical and case analysis methods are mainly qualitative, based on the subjective abilities of individuals, and lack objective and scientific quantitative analysis.

Above all, there are two research gaps for the study of the rural digital economy’s impact on rural industry revitalization. First, how the rural digital economy drives rural industry revitalization is not comprehensively studied. Second, the quantitative analysis for the measurements of the rural digital economy, rural industry revitalization, and their relationship were not enough. To fill these research gaps, on the one hand, we build a model of how the rural digital economy drives rural industry revitalization. On the other hand, the entropy method was used to measure the integrated index of the development level of the rural digital economy and industrial revitalization, and a binary fixed effects model was constructed to calculate how the rural digital economy drives rural industrial revitalization. The main contributions of this paper are as follows. First, we built the model of how the rural digital economy drives rural industry revitalization. That is, the rural digital economy promotes industrial development in rural areas from three dimensions: the
optimal allocation of rural resources, the effective link between urban and rural markets, and integrating the development of three industries. Second, we used data related to agriculture in 30 Chinese provinces from 2014 to 2019 as an empirical analysis. Then, according to the findings, this paper proposes targeted countermeasures and proposals for rural industrial revitalization driven by the rural digital economy.

2. Theoretical Analysis and Hypotheses

This study establishes the logical framework system of rural industry revitalization driven by the rural digital economy from three aspects: the optimal allocation of rural resource elements, effective connection of urban–rural markets, and the integrated development of rural industries. The corresponding logical framework is shown in Figure 1.

![Figure 1. Logical framework for the rural digital economy driving rural industrial revitalization.](image)

As a new series of economic activities, the digital economy leads digital knowledge and information technology to penetrate deeply into rural industries through modern information networks. We think that the digital economy drives rural industrial revitalization through a series of digital changes in rural industries, such as the optimal allocation of rural resource elements, the effective connection of urban–rural markets, and the integrated development of rural industries, and achieves agricultural production increase, adds rural value, and increases farmers’ income.

(1) Optimal allocation of rural resource elements.

As rural resources are limited, using the rural digital economy can improve the allocation of rural resources so that elements of rural resources can be efficiently allocated and utilized. First, data elements are deeply integrated with traditional rural resource elements, amplifying the functional value of rural resource elements, such as ecological leisure, tourism, culture, and education, thus giving birth to new business forms such as leisure agriculture and rural e-commerce. As a result, the utilization rate of resource elements can be improved [25]. Second, the rural digital economy accelerates the accumulation of urban talent, materials, capital, and technology to rural areas, and accelerates the flow of rural primary means of production and agricultural products to urban areas [26]. The smooth circulation chain of urban and rural resources allows the supply and demand
of resource factors to be better matched and optimizes resource allocation. Accordingly, it is proposed that:

**Hypothesis 1 (H1). The rural digital economy drives the revitalization of rural industries by optimizing the allocation of rural resources.**

(2) Effective connection of urban–rural markets.

The effective connection of urban–rural markets is the connection of rural products with farmers with urban markets [27]. The rural digital economy can effectively build a bridge between rural and urban areas, help expand the depth and width of market transactions, remove all kinds of obstacles to the improvement of efficiency, and effectively solve the problems of overcapacity caused by the mismatch between the supply and demand of agricultural products and the lack of price comparison rights or bargaining rights of agricultural products caused by the asymmetry of urban–rural market information. First, digital technologies such as big data and “artificial intelligence + algorithm” can accurately match the supply and demand of agricultural products’ variety, quality, and quantity, breaking the organizational barriers of the non-integration of urban and rural markets. Second, urban–rural market information can be disseminated and shared in real time through the network, eliminating the information asymmetry caused by traffic, location, and other factors between urban and rural areas and providing a viable path for the intensification and scaling up of agricultural products [28,29]. Accordingly, it is proposed that:

**Hypothesis 2 (H2). The rural digital economy drives the revitalization of rural industries by effectively connecting urban and rural markets.**

(3) Integrated development of rural industries.

Industrial integration refers to the process of interpenetrating and intermingling between or within industries to realize new industries [30]. This is compared with industrial integration in the traditional sense, where industries are closely connected in space. The rural digital economy enabled rural industries to break through industrial boundaries and transform an industrial organization from separation to integration. On the one hand, in driving the revitalization of rural industries, the rural digital economy expands the depth and width of the division of labor and cooperation through intelligent agricultural production and processing technology. It makes this impact throughout the whole process of the agricultural industry chain, promoting the extension of the rural industry chain [31]. On the other hand, the rural industrial cluster, with the digital agricultural industrial park as the carrier, breaks through the spatial barrier of enterprise cluster development, expands the width and depth of the division of labor and cooperation among enterprises, further promotes the integrated development level of rural industries, and improves the total factor productivity [32]. Accordingly, it is proposed that:

**Hypothesis 3 (H3). The rural digital economy drives the revitalization of rural industries through the integration development of rural industries.**

### 3. Materials and Methods

#### 3.1. Data

Agricultural and rural development statistics from 2014 to 2019 in 30 provinces, except for Tibet, were selected as the main study subjects. Most of the information comes from the China Rural Statistical Yearbook and from research conducted by the Ali Institute, the National Bureau of Statistics, and the official website of the Ministry of Agriculture and Rural Affairs of China. In data collection statistics, linear interpolation supplements the absence of certain indicators in certain regions. To reduce the impact of regional resource endowment differences such as initial attributes, this paper is on individual data for
specific processing, such as rural per capita retail sales ($10^3$ yuan/people), power resources utilization for per capita electricity consumption ($10^3$ KWH/people), per capita forestry tourism, and leisure industry tourism income (yuan/people) [33].

3.2. Model Construction
3.2.1. Entropy

In this study, the index data of rural industrial revitalization and the rural digital economy development level were processed using the entropy method, and an integrated index was obtained as empirical research data. The entropy method is widely used, and its computational steps have been analyzed and demonstrated in many studies, which will not be repeated in this study [21,34].

3.2.2. Model Setting

This study examines the impact of the level of development of the rural digital economy on rural industrial revitalization using a dual fixed effects model with a control region and time. The model can be formulated as follows:

\[ RIR_{it} = \beta_0 + \beta_1 DE_{it} + \beta_2 X_{it} + \mu_i + \sigma_t + \epsilon_{it} \]  

where the subscripts \( i \) and \( t \) represent regions and years, respectively. \( RIR_{it} \) and \( DE_{it} \) are indicators for measuring the rural industrial revitalization and digital economic development levels of each province, respectively. \( X_{it} \) comprises a series of control variables, including the level of agricultural modernization, gross national product, agricultural infrastructure level, urbanization rate, and industrial structure. \( \beta_0 \) is an intercept term that does not vary between individuals. \( \mu_i \) and \( \sigma_t \) represent locality and time fixed effects, respectively. \( \epsilon_{it} \) is a random disturbance term.

3.3. Variables and Descriptive Statistics

The definitions and designs of the variables in this paper are given in Table 1.

3.3.1. Explanation Variable: Rural Industrial Revitalization (RIR)

According to the CASS Rural Development Index, agricultural production increases, rural value added, and farmer income increases were used as explanatory variables in this study. They are measured by the yield of major crops per unit area (MC), the total output value of the primary industry (PI), and the per capital disposable income of rural households (DI).

3.3.2. Explanatory Variables: The Rural Digital Economy (DE)

According to the above analysis of the rural digital economy driving the rural industrial revitalization, this study selects specific indicators from the rural resource optimal allocation (RROA), the urban and rural markets effective connection (URMC), and the rural industries integration development (RIID) as follows:

- Rural resource includes water resources, land resources, labor resources and electricity resources [35];
- Effective connections between urban and rural markets include mail delivery, Taobao Villages, broadband access, and rural retail sales [36];
- The development of rural industries’ integration includes rural tourism, leading enterprises, grain and oil processing enterprises, and leisure villages [37].
<table>
<thead>
<tr>
<th>Variable Type</th>
<th>Variable Meaning</th>
<th>First-Level Indicators</th>
<th>Second-Level Indicators</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explained variable</td>
<td>rural industrial revitalization</td>
<td>Agricultural production increase</td>
<td>Yield per unit area of major crops</td>
<td>$10^2 \text{T/m}^2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rural value added</td>
<td>The total output value of the per capita primary industry</td>
<td>$10^3 \text{yuan/person}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Farmer income increase</td>
<td>Per capita disposable income of rural residents</td>
<td>\text{yuan/person}</td>
</tr>
<tr>
<td></td>
<td>Rural resource optimal allocation</td>
<td>Water resource utilization rate: agricultural output value/agricultural water consumption</td>
<td>$10^3 \text{yuan/m}^3$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land resource utilization rate: total agricultural output value/cultivated land area</td>
<td>$10^3 \text{yuan/person}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The utilization rate of labor resources: gross output value of the primary industry/number of employees working in primary industry</td>
<td>$10^3 \text{yuan/person}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power resource utilization rate: rural electricity consumption/rural population</td>
<td>$10^3 \text{KWH/person}$</td>
<td></td>
</tr>
<tr>
<td>Explanatory variable</td>
<td>The development level of the rural digital economy</td>
<td>Rural Internet penetration rate</td>
<td>$10^5 \text{household/pcs}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban and rural markets’ effective connection</td>
<td>Rural per capita retail sales</td>
<td>$10^3 \text{yuan/person}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The average number of deliveries per week in rural areas</td>
<td>freq</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The number of Taobao villages</td>
<td>pcs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rural industries integration development</td>
<td>The total industrial output value of grain and oil processing enterprises</td>
<td>$10^8 \text{yuan}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of key leading enterprises</td>
<td>pcs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Per capita forestry tourism and leisure industry tourism income</td>
<td>\text{yuan/person}</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The number of most beautiful leisure villages</td>
<td>pcs</td>
<td></td>
</tr>
<tr>
<td>Variable Type</td>
<td>Variable Meaning</td>
<td>First-Level Indicators</td>
<td>Second-Level Indicators</td>
<td>Unit</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------</td>
<td>------------------------------------------------</td>
<td>-------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Control variables</td>
<td></td>
<td>Agricultural modernization Index</td>
<td></td>
<td>——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urbanization rate</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Industrial structure</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gross domestic product</td>
<td>$10^8$ yuan</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level of agricultural infrastructure construction</td>
<td>——</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total power force of rural machinery</td>
<td>$10^5$ KW</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Cont.
3.3.3. Control Variables

This paper selects the following control variables:

- The modern Agricultural Modernization Index (modern) measured by the total power of rural machinery [38];
- Urbanization rate (urban);
- Industrial structure, measured by the proportion of the primary industry (industrial);
- Gross Domestic Product (GDP);
- Agricultural infrastructure level (infra), measured by agricultural meteorological observation business;
- Rural Machinery Total Power (machine).

3.3.4. Instrumental Variable

This paper uses the “total amount of post and telecommunications business” in historical years as a tool variable for the development level of the rural digital economy. On the one hand, the total number of post and telecommunications businesses in the historical period will have a strong impact on the level of development of the rural digital economy. On the other hand, however, the post and telecommunications business in the historical year is not highly correlated with industrial development in rural areas today. Thus, it meets the requirements of the instrumental variables.

4. Results and Discussion

4.1. Entropy Method Results

The comprehensive index of rural industrial revitalization and the rural digital economy in each region are shown in Figures 2 and 3. Overall, both exhibit several clear traits: First, there is a serious imbalance in development between the provinces. The development of some provinces in China has reached the forefront, while lower-ranking provinces are lagging. Second, the level of development varies across regions. Most of the higher indices were in the eastern region, where recent advances in agricultural technology have changed how crops can be produced and supplied [39]. Most of the indices in the western region were relatively low. Overall, the declining trend is from east to west, with significant development gaps between regions. Third, the level of revitalization of rural industries and the development of the rural digital economy are closely related to the economic level. The level of urban development has an influential impact on the revitalization of rural industries and the development of the rural digital economy.

![Figure 2. Comprehensive Index of rural industrial revitalization and development level.](image-url)
A comprehensive index of rural industrial revitalization is shown in Figure 2. The MC area varies the most among the areas, according to the overall trend, but the DI is relatively stable. First, regarding important crops, the Guangxi province had the highest yield per unit area. The fundamental reason is that Guangxi has developed modern agriculture and e-commerce [40], promoting rural informatization [41]. Second, the provinces of Heilongjiang and Hainan had the highest PI. This is because the traditionally agricultural province of Heilongjiang has ample supply and output capacities. Additionally, there is a sizable grassland region and a high level of animal husbandry development [42,43]. Due to its abundant and unique tropical island tourist resources, quickly boosted the tropical fruit industry’s development in Hainan [44]. Third, the DI is only high in economically developed provinces, such as Beijing, Shanghai, and Zhejiang, while disparities between other provinces are minimal. This demonstrates that raising economic development levels is the only way to raise people’s incomes and standard of living.

Figure 3 shows the comprehensive index of the development level of the rural digital economy. The trends for RROA, URMC, and RIID are roughly the same, showing differences only in individual provinces. First, Shanghai showed high RROA and URMC, while RIID showed low levels. One potential reason for this is Shanghai’s high level of agricultural science and technology. However, the amount of productive agricultural land available has steadily declined. Therefore, Shanghai has limited agricultural resources [45]. Second, the Guangdong province was found to have the highest RIID index because the place attaches importance to enhancing the regional business environment [46]. Additionally, the rural agricultural financial support efficiency has been on the frontier over the years [47]. Third, the URMC index peaked in Zhejiang, far ahead of other provinces. This is mainly because the province serves as the headquarters of the Alibaba Group, which has greatly fueled the emergence of the Taobao village phenomenon and the growth of rural e-commerce [48]. Fourth, Shaanxi has a low development index in URMC and RIID but a high one in RROA. Due to the arid climate and water shortage, the region has actively developed water-efficient agriculture and promoted efficient use of rural water resources [49,50].

Therefore, at the resource element level, it is necessary to promote the efficient use of rural resources through data connectivity and rely on advanced technology to achieve precise agricultural production. For example, arid regions such as Shanxi and Gansu could follow the example of Shaanxi and develop water-efficient agriculture to improve water resource utilization efficiency. Traditionally agricultural provinces, such as Jilin and Anhui, should improve their agricultural intelligence and scientific and technological capabilities to enable farmers to use agricultural resources efficiently. At the market connection level, far-flung regions in the interior where e-commerce has emerged later should take a cue from provinces with strong e-commerce levels, such as Zhejiang. To ensure that supply
and demand for agricultural products are effectively matched, the government should adopt support programs to help farmers grow rural e-commerce [8]. Finally, at the level of industrial integration, regions with low levels of industrial integration, like Shanghai and Tianjin, should note the development lessons learned from Guangdong Province’s industrial integration and hasten the penetration and integration of contemporary digital technology into various agricultural industry sectors.

4.2. Descriptive Statistics

Table 2 shows a severe imbalance between rural industrial revitalization and the rural digital economy in different Chinese provinces. Standard deviation (Sd) can reflect the fluctuation of data. The standard deviations of rural digital economy and rural industrial revitalization are 0.040 and 0.187, respectively, indicating that the regional differences of the rural digital economy are more significant. This is because of the obvious “digital divide” between the Midwest regions and eastern rural areas in terms of digital infrastructure construction [51,52]. The implementation of China’s economic policies, such as “The rise of the central region” and “China’s western development strategy”, narrowed the gap in agricultural modernization between the east, central, and western regions [53,54]. Thus, the rural industry’s development level difference between regions compared to the rural digital economy development level was negligible.

Table 2. Descriptive statistics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>Mean</th>
<th>Sd</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIR</td>
<td>180</td>
<td>0.172</td>
<td>0.040</td>
<td>0.100</td>
<td>0.251</td>
</tr>
<tr>
<td>DE</td>
<td>180</td>
<td>0.424</td>
<td>0.187</td>
<td>0.143</td>
<td>0.886</td>
</tr>
<tr>
<td>modern</td>
<td>180</td>
<td>1.005</td>
<td>0.543</td>
<td>0.436</td>
<td>3.981</td>
</tr>
<tr>
<td>urban</td>
<td>180</td>
<td>59.260</td>
<td>11.350</td>
<td>40.010</td>
<td>89.600</td>
</tr>
<tr>
<td>industrial</td>
<td>180</td>
<td>9.354</td>
<td>5.034</td>
<td>0.300</td>
<td>23.40</td>
</tr>
<tr>
<td>lnGDP</td>
<td>180</td>
<td>9.916</td>
<td>0.839</td>
<td>7.742</td>
<td>11.590</td>
</tr>
<tr>
<td>lninfra</td>
<td>180</td>
<td>2.966</td>
<td>0.771</td>
<td>0.000</td>
<td>3.850</td>
</tr>
<tr>
<td>lnmachine</td>
<td>180</td>
<td>7.682</td>
<td>1.128</td>
<td>4.543</td>
<td>9.499</td>
</tr>
</tbody>
</table>

4.3. Analysis of the Benchmark Model Estimation Results

Table 3 shows the results of the OLS estimation of the impact of the rural digital economy on rural industrial revitalization. For a better comparative analysis, the first column only shows the regression results for the core explanatory variables. The control variables are added in column (2) to control additional factors affecting the rural industrial revitalization. The results of the double fixed effect model of control time are shown in column (3).

Table 3 shows that the rural digital economy has a very strong impact on rural industrial revitalization, which is always significantly positive at the 1% level, regardless of whether control variables are included. The results show that the development level of the rural digital economy increased by 1%, and the rural industrial revitalization increased by 0.134%. This paper adds a series of control variables to avoid missing variables on the regression results’ deviation. According to column (2), the results show that the development level of the rural digital economy increased by 1%, and the revitalization of rural industries increased by 0.115%. After controlling the time, the regression results are as follows (3). The rural digital economy positively affects rural industrial revitalization at a significant level of 1% and increasing the rural digital economy by 10% can increase rural industrial revitalization by 0.066%. From column (1) to column (2) to column (3), the coefficient of the rural digital economy (DE) is gradually smaller. This shows that there are other factors that affect the revitalization of rural industries. Therefore, it is necessary to add control variables and control time in this paper, which can more accurately and effectively reflect the net impact of the development level of the rural digital economy on
the revitalization of rural industries. The above empirical analysis results show that the rural digital economy can effectively drive rural industrial revitalization.

Table 3. Benchmark regression results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) RIR</th>
<th>(2) RIR</th>
<th>(3) RIR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DE 0.134 *** (5.42)</td>
<td>DE 0.115 *** (4.75)</td>
<td>DE 0.066 *** (2.87)</td>
</tr>
<tr>
<td></td>
<td>modern −0.006 (−1.44)</td>
<td>modern −0.005 * (−1.96)</td>
<td>modern 0.002 ** (2.29)</td>
</tr>
<tr>
<td></td>
<td>urban −0.001 (−1.38)</td>
<td>urban 0.0002 ** (−1.38)</td>
<td>urban 0.0002 ** (2.29)</td>
</tr>
<tr>
<td></td>
<td>industrial 0.002 * (1.90)</td>
<td>industrial 0.003 *** (3.24)</td>
<td>industrial 0.003 *** (3.24)</td>
</tr>
<tr>
<td></td>
<td>lnGDP 0.029 ** (2.33)</td>
<td>lnGDP 0.046 *** (3.86)</td>
<td>lnGDP 0.046 *** (3.86)</td>
</tr>
<tr>
<td></td>
<td>lninfra −0.001 (−0.07)</td>
<td>lninfra 0.020 ** (2.47)</td>
<td>lninfra 0.020 ** (2.47)</td>
</tr>
<tr>
<td></td>
<td>lnmachine 0.017 *** (3.94)</td>
<td>lnmachine 0.015 *** (3.24)</td>
<td>lnmachine 0.015 *** (3.24)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.115 *** (10.92)</td>
<td>−0.259 ** (−2.50)</td>
<td>−0.586 *** (−4.58)</td>
</tr>
<tr>
<td>Ind</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>180</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>R²</td>
<td>0.420</td>
<td>0.577</td>
<td>0.677</td>
</tr>
</tbody>
</table>

Note: *** , ** , * indicate the significance levels of 1%, 5%, and 10%, respectively; the t value of regression coefficient test is in parentheses.

Among the control variables, it can be seen from column (3) that the regression coefficients of urbanization rate (urban), industrial structure (industrial), gross domestic product (GDP), agricultural infrastructure level (infra), and total power of rural machinery (machine) are all significantly positive. This indicates that urbanization rate, industrial structure, GDP, agricultural infrastructure level, and total power of rural machinery as control variables have a certain promoting effect on the revitalization of rural industry. However, the coefficient of the agricultural modernization index (machine) is negative, probably because the average modernization index of China is not high. Therefore, the modernization indexes in underdeveloped areas still have room for improvement and have a poor effect on the revitalization of rural industries. From the perspective of the coefficient, the coefficient of GDP is 0.046, which has the greatest impact on the revitalization of rural industry, followed by the agricultural infrastructure level and the total power of rural machinery, with coefficients of 0.020 and 0.015. On the other hand, the coefficients of the rural modernization index, urbanization rate, and industrial structure are only 0.005, 0.002, and 0.003. These had a limited impact on the revitalization of rural industries. Therefore, to raise the level of agricultural modernization, the government should invest more money in rural machinery. In addition, more highly qualified personnel should be hired to assist farmers in enhancing the use of digital agricultural technologies to increase agricultural output efficiency [55]. To overcome the challenge of funding deficits, it is also crucial to maintain the steady and healthy growth of the national economy and provide financial support for the operation of rural industries. Then, it is recommended to keep the reform of inclusive rural finance [56] and improve the digitalization of inclusive finance with the help of digital technologies [57]. Finally, it is necessary to raise the level of the agricultural meteorological observation business. By doing so, we can effectively manage the complex and unstable climatic environment during agricultural production and reduce production risks [58,59].
4.4. Robust Analysis

4.4.1. Replace the Explained Variable

In order to verify the validity of the benchmark regression, this study also uses total grain output, total agricultural output, and the per capita consumption level of residents to replace the original explained variables for the variable substitution model estimation. From the test results in column (1) in Table 4, the rural digital economy significantly affects rural industrial revitalization at the 1% level, with a coefficient of 0.037.

Table 4. Robust analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) Replace the Explained Variable</th>
<th>(2) Change Explanatory Variables</th>
<th>(3) Eliminate the Outlier Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE</td>
<td>0.037 **</td>
<td>0.122 ***</td>
<td>0.079 ***</td>
</tr>
<tr>
<td></td>
<td>(2.560)</td>
<td>(2.990)</td>
<td>(4.950)</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Ind</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>180</td>
<td>180</td>
<td>138</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.351</td>
<td>0.661</td>
<td>0.738</td>
</tr>
</tbody>
</table>

Note: "***" and "**" indicate the significance levels of 1% and 5%, respectively; the t value of regression coefficient test is in parentheses.

4.4.2. Replace the Explanatory Variables

This study continues to replace the explanatory variables to further verify that the rural digital economy can promote rural industrial revitalization. The effective irrigation area, rural delivery routes, and sales revenue of grain and oil processing enterprises were used to replace the original explanatory variables, water use efficiency, average weekly delivery times in rural areas, and the total industrial output value of grain and oil processing enterprises. From the test results of column (2) in Table 4, the rural digital economy can still promote rural industrial revitalization after replacing explanatory variables. A 1% increase in the rural digital economy will promote the revitalization of rural industries by 0.122%.

4.4.3. Eliminate the Outlier Variables

Owing to the large differences in resource endowment and economic development levels among regions, the data of these regions may have outliers, which may interfere with the research results. Therefore, we eliminated data from the four municipalities and the three provinces of Guangdong, Zhejiang, and Jiangsu with higher levels of economic development and conducted a regression analysis to verify the reliability of the study [60]. The regression results are shown in column (3) of Table 4. The results show that there is still a significant positive relationship between the rural digital economy and rural industrial revitalization, indicating that the results of this study are relatively robust and effective. A 1% increase in the rural digital economy will promote the revitalization of rural industries by 0.079%.

4.4.4. Heterogeneity Analysis

(1) Heterogeneity analysis by region

It is important to examine regional differences in the impact of the rural digital economy on rural industrial revitalization, which can be a reference and help in government policy formulation. The paper divides the country into three regions: eastern, central, and western, according to the NBS division criteria. The results are shown in Table 5. The impact of the rural digital economy on rural industrial revitalization also shows considerable differences among the three regions. The rural digital economy in the eastern and western regions is significantly positive, with coefficients of 0.062 and 0.055, respectively, indicating that the rural digital economy in these regions can effectively promote rural industrial
revitalization. The coefficient for the rural digital economy in the central region is positive, but not significant. Here are the potential causes: First, the eastern region enjoys advantages in terms of resources, policy environment, and economic level. Because the rural digital economy is in a fast development phase, it can more effectively use digital technology to support rural industrial revitalization [61]. Second, the central region, which includes the Henan, Hubei, and Hunan provinces, is traditionally agricultural. These regions have high overall agricultural production capacity and quality, but insufficient integration of digital technology with traditional agricultural production models. So far, the rural digital economy has not had a significant enough impact on traditional agriculture. Third, due to its remote location and poor resource endowment, the western region has historically had relatively low levels of agricultural development. The growth of the rural digital economy in rural areas can support agricultural industry structural optimization, boost western agriculture, and support the revival of rural industries [62].

Table 5. Heterogeneity analysis by region.

<table>
<thead>
<tr>
<th>Variable</th>
<th>East (1)</th>
<th>Central (2)</th>
<th>West (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE</td>
<td>0.062 *</td>
<td>0.028</td>
<td>0.055 ***</td>
</tr>
<tr>
<td></td>
<td>(1.920)</td>
<td>(0.470)</td>
<td>(2.290)</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Ind</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>66</td>
<td>48</td>
<td>66</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.734</td>
<td>0.744</td>
<td>0.800</td>
</tr>
</tbody>
</table>

Note: *** and * indicate the significance levels of 1% and 10%, respectively; the t value of regression coefficient test is in parentheses.

Therefore, in the eastern region, it is necessary to optimize the mode of agricultural production and operation, improve the overall competitiveness of rural industries, and give preferential policies and resources to some remote and backward areas in the east to promote coordinated development within the region. In the central region, the digital dividend should be fully utilized to attract human, capital, and technological elements into the traditional agricultural sector, increase the integration of the rural digital economy with rural industries, and cultivate new industries. In the western region, it is necessary to accelerate the pace of digital economic infrastructure construction, increase the input of financial assistance to agriculture, and raise the enthusiasm of farmers and agricultural enterprises in agricultural production to enhance the diversity of the industrial chain and agricultural products.

(2) Heterogeneity analysis by industrial structure

Industrial structure plays a significant role in mediating the relationship between the rural digital economy and regional economic development [63,64]. As a result, the driving force behind rural industrial revitalization varies depending on the industrial structure of the region. The sample was divided into two regions with low and high primary industry output values based on the proportion of output values in each region for that industry. For each of the two locations, benchmark regressions were performed, and the results are shown in Table 6. The findings demonstrate that, regardless of industrial structure, the amount of rural digital economy growth contributes to rural industrial revitalization. However, it is not significant in low-proportion areas, while it is significant at the 1% level in high-proportion areas; for every 1% increase in rural digital economy in high-proportion areas, the revitalization of rural industries will increase by 0.064%. The underlying cause of this may be found in the fact that the districts where the value of the output of the primary industries is high are, to a considerable extent, agricultural provinces. These provinces, heavily dependent on agriculture, not only value and promote its development but also exploit the combination of agriculture and other industries to create distinctive economies.
As a result, agricultural productivity levels have increased thanks to the strong drive of the rural digital economy, which has successfully encouraged rural industrial revitalization. More emphasis has been placed on growth in manufacturing, services, and other sectors in areas with a low proportion of primary industry output. They have made meager investments in primary industries, money keeps going to other businesses, and support for agricultural development is lacking. As a result, the rural digital economy has not significantly impacted agriculture in the region.

Table 6. Heterogeneity analysis by industrial structure.

<table>
<thead>
<tr>
<th>Variable</th>
<th>The Proportion of Output Value of the Primary Industry Is High (1)</th>
<th>The Proportion of Output Value of the Primary Industry Is Low (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DE 0.064 *** (3.520)</td>
<td>0.071 *(1.780)</td>
</tr>
<tr>
<td></td>
<td>Controls Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Ind Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Year Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N 90</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>R² 0.774</td>
<td>0.607</td>
</tr>
</tbody>
</table>

Note: "***" indicate the significance levels of 1%; the t value of regression coefficient test is in parentheses.

Therefore, for the regions where the output value of the primary industry accounts for a low proportion, it is necessary to increase the investment in the rural industries and improve the agricultural production capacity with advanced digital technology to improve the output value of the primary industry. On the other hand, for the regions with a high proportion, the characteristics of the primary industry should be continuously explored, and the characteristic agriculture should be developed using digital technology to maintain the stable development of the primary industry.

(3) Endogeneity test
(4) Although the influencing factors of rural industrial revitalization, such as agricultural modernization level and gross domestic product, were controlled for in this study, there are still additional potential effects that could result in endogenous issues. The reasons for this are as follows.

- Variables are missing: in addition to the aforementioned evaluation indicators, other possible factors, including the farming skills of farmers and their ability to acquire and apply digital technologies, have an impact on the industrial and rural digital economy in rural areas.
- Error in measurement: Measurement error refers to the error in the measurement of the key variables, which leads to the difference between it and the real data. In this study, a linear interpolation method was used to fill in the missing data, which can lead to data bias.
- Bidirectional causality: The development of the rural digital economy can promote the revitalization of rural industries, which in turn can raise the level of the national economy and thus promote the development of the rural digital economy. In order to alleviate the impact of endogenous problems, this paper uses the “total volume of post and telecommunications business” in historical years as the instrumental variable to carry out 2SLS regression, and the results are still consistent with those above. Thus, the conclusion that the rural digital economy promotes rural industrial revitalization is further verified.

5. Conclusions

Based on data on agricultural and rural development from 2014 to 2019 in 30 Chinese provinces, the study measured a comprehensive index of the development level of the rural digital economy and industrial revitalization. We then discussed how the rural digital
economy drives the revitalization of rural industries and we conducted empirical analysis. The major conclusions of this study are as follows:

(1) The rural digital economy promotes industrial development in rural areas in three dimensions: optimal allocation of rural resource elements, effective connection of urban–rural markets, and integrated development of rural industries.

(2) Through the entropy method to measure the comprehensive index of rural industrial revitalization and rural digital economy in various regions, it was found that there is a serious imbalance between different provinces and regions. In addition, the revitalization of rural industries and the development level of rural digital economy are closely related to the economic level.

(3) Third, the increase of 1% in the rural digital economy will promote the revitalization of rural industries by 0.66, which is significant at the level of 1%, and has become a new driving force for the revitalization of rural industries in the future. Among the control variables, GDP has the greatest impact on the revitalization of rural industries, and industry has the smallest impact.

(4) Fourth, the driving effect of the rural digital economy on the revitalization of rural industries has regional and industrial structure heterogeneity. The results of regional heterogeneity show that the eastern and western regions significantly promote the revitalization of rural industries at the level of 10% and 1%, respectively, while the central region is not significant. The regression results of industrial structure heterogeneity show that the rural digital economy can effectively promote the revitalization of rural industries in areas with a high proportion of primary industry output value, while the opposite is true in areas with a low proportion of primary industry output value.

Although this paper empirically tested how the rural digital economy drives rural industrial revitalization, there are deficiencies in the study. On the one hand, the data on indicators to measure the rural digital economy and rural industrial revitalization are, in this paper, from a relatively macro-level perspective and mainly at the provincial level. However, there are significant differences in policy effects and levels of economic development between provinces and municipalities, which cannot be measured specifically for comparison. On the other hand, this paper only discussed the policy effect from 2010 to 2020. It is necessary to further investigate the long-term effect of the pilot policy of the rural digital economy on rural industrial revitalization development in the future.

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