

Article

How Rural Industry Revitalization Affects Farmers' Incomes in China

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Abstract: Low income is a common problem faced by farmers around the world. In order to promote agricultural development and increase farmers' incomes, China has implemented rural industrial revitalization (RIR). However, the following question remains unanswered: how does the RIR affect farmers' incomes? In this study, based on the theories of rural and development economics and panel data from 30 provinces in China between 2011 and 2020, an evaluation system consisting of four primary indicators and 10 secondary indicators was constructed. A dual fixed-effects model was used to measure the promoting effect of RIR on farmers' incomes. The results are as follows: The overall RIR level in China is rising; it significantly increases farmers' incomes and plays a more significant role in increasing income for low-income groups. RIR promotes agricultural scientific and technological progress, which further enhances the impact of RIR on farmers' incomes. Compared with the Midwest, the income-increasing effect is greater in the eastern region. The results of this study have important policy implications for implementing the RIR strategy and increasing farmers' income, and they provide a useful reference for similar countries or regions and global sustainable development. The innovations of this study include (1) exploring the mechanism of the impact of RIR on farmers' incomes by constructing a provincial-level RIR evaluation index system and (2) exploring the mechanism and policy implications of promoting the growth of farmers' incomes through industrial development, providing effective suggestions for solving farmers' incomes problems in countries or regions around the world.



Citation: Peng, H.; Yang, F.; Yue, O. How Rural Industry Revitalization Affects Farmers' Incomes in China. *Sustainability* **2024**, *16*, 9182. <https://doi.org/10.3390/su16219182>

Academic Editor: Jianming Cai

Received: 1 September 2024

Revised: 10 October 2024

Accepted: 17 October 2024

Published: 23 October 2024



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Keywords: farmers' income; rural industrial revitalization (RIR); rural industrial integration (RII); agricultural productivity; China

1. Introduction

A challenge faced by rural smallholder farmers is low income, which leads to high rates of malnutrition and poverty [1]. Rural farmers in Nigeria are small-scale operators, tenant farmers, or landless farmers, characterized by low incomes and poor nutrition [2], and 70% of farmers in India earn less than INR 15,000 per year [3]. The per capita disposable income of 20% of low-income rural residents was CNY 5024.6 in 2022 in China, accounting for about 25% of the per capita disposable income of rural residents. Increasing farmers' incomes is a difficult problem faced around the world in terms of economic and social development. In the agricultural sector, factors such as labor, land area, production costs, and farming technology affect farmers' incomes through agricultural production [4]. Therefore, the development of rural industries has a significant impact on farmers' incomes.

Low income for farmers and the decline of rural industries are coexisting issues in China. The concentration of production factors such as labor and capital in cities has led to the slow development of rural industries with the acceleration of urbanization. The development of rural industries still faces a series of problems, such as insufficient vitality

of industrial factors, short industrial chains, and weak industrial infrastructure [5]. To promote the modernization of agriculture, rural areas, and farmers and narrow the gap between urban and rural development, China started to implement the rural revitalization strategy in 2018, which includes five major targets of revitalization—industry, talent, culture, ecology, and organization—and uses policy instruments to guide agriculture, rural areas, and farmers to achieve sustainable and high-quality development. Its main goals and core tasks are the sustained and steady growth of farmers' incomes, which is of particularly practical significance to China's economic development and social stability [6]. As the basis of the rural revitalization strategy, rural industrial revitalization (RIR) means taking measures such as building high quality farmland to promote agricultural development; accelerating the construction of a modern agricultural industrial system, production system, and management system; improving agricultural innovation, competitiveness, and total factor productivity; and promoting the modernization of agriculture, rural areas, and farmers. RIR, which is a new strategy to promote rural industrial development in China, emphasizes the high quality and efficiency of agricultural development and an increase in farmers' incomes [7]. It requires the adoption of measures such as optimizing the layout of agricultural productivity, promoting agricultural structural adjustment, strengthening characteristic and advantageous industries, and ensuring the quality and safety of agricultural products to realize the sustainable and high-quality development of rural industries. The question is, how does RIR affect farmers' incomes? Clarifying this issue can enrich the theoretical research on the rural economy, provide an empirical basis for policymakers to promote the implementation of rural revitalization [8], and provide experience and a reference for similar countries or regions to increase farmers' incomes by promoting rural industrial development and global sustainable development.

To explore the mechanism of the impact of RIR on farmers' incomes, based on the theories of rural and development economics, this study used panel data from 30 provinces in China from 2011 to 2020 and drew on the specific indicators proposed in policy documents such as *The Rural Revitalization Strategic Plan (2018–2022)*, combined with existing research, to construct a provincial-level RIR evaluation index system and empirically test the impact of RIR on farmers' income. The research results show that RIR can effectively promote the growth of farmers' incomes by promoting the integrated development of rural industries, enhancing the comprehensive agricultural production capacity, promoting the development of rural characteristic industries, optimizing the interest linkage mechanism, and promoting agricultural technological progress. The benchmark regression results show that this impact is more pronounced for low-income farmers, and the heterogeneity test shows that there is also regional heterogeneity. After a series of robustness tests, the conclusions still hold.

The innovations of this study are as follows: (1) the mechanism of the impact of RIR on farmers' incomes is explored by constructing a provincial-level RIR evaluation index system, which is a new direction for research on the issue of farmers' incomes; (2) the mechanism and policy implications of promoting the growth of farmers' income are explored through rural industrial development, and effective suggestions are provided for solving the issue of farmers' income around the world. The remainder of this paper is organized as follows: Section 2 provides a literature review; Section 3 presents the theoretical analysis and the formulation of the research hypotheses; Section 4 provides the empirical research design; Section 5 reports the empirical results and discussion; and Section 6 provides conclusions, policy implications, and limitations.

2. Literature Review

A large number of rural farmers rely on family labor, local inputs, and personal instinct for productive income [2]. Some researchers have focused on the relationship between the development of rural industry and farmers' incomes. Rural industrial integration is conducive to increasing farmers' incomes [9]; the integrated development of agriculture and tourism [10] and the integration of the primary, secondary, and tertiary industries have

positive effects on the growth of farmers' incomes [11]. According to the comprehensive agricultural production capacity, industrial structure upgrading has a strong positive effect on farmers' income [6]. The mechanization level promotes farmers' income growth through factor-intensive utilization and quality improvement [12]. In terms of the development of rural characteristic industries, rich marginal farmers cultivate their land more intensively, allocating larger areas to high-value crops [3]. Farmers associated with the processing industry receive, on average, about 49% additional income compared to farmers in non-processing industrial areas [13]. China's rural non-agricultural industries are developing rapidly as a whole, and rural non-agricultural employment has a significant positive impact on comprehensive rural income [14]. Regarding the interest linkage mechanism, the degree of organization is positively related to farmers' incomes, for example, participating in contract farming, cooperative management, and farmer groups [15–18]. The total and agricultural operation incomes of farmers who participate in agricultural operation organizations are greater than those of farmers who do not [19]. Regarding technological advancements, mobile phone and internet technology usage (MPITU) has a significant impact on farmers' incomes [20]. Advances in agricultural technology have moderated the correlation between agricultural productivity and farmers' incomes [21].

The literature also includes studies on other factors that affect farmers' incomes. Some institutional or policy innovations have significantly increased farmers' incomes, such as the thorough implementation of China's agricultural tax reform [22], the significant reform of the rural land property rights system [23], the reform of collective construction land leasing and housing [24], and rural financial support policies [25]. Certain novel production methods are also considered to be important factors affecting farmers' income growth, such as understory development [26], green production behaviors [27], the rice–fish co-culture system [28], sustainable manure management practices (SMMPs) [29], and environmental protection behavior [30]. Computer penetration in rural areas, the digital economy, digital rural construction, and e-commerce operations have a positive impact on farmers' incomes [31–34]. Various qualifications are also important factors in increasing farmers' incomes. The personal human capital investment of farmers has a positive impact on labor income and agricultural income [35]; human capital, material capital, financial capital, and social capital all have significant positive impacts on non-agricultural income [36].

The existing literature covers a wide range of influencing factors and provides a useful reference for studying the issue of farmers' income. Some of the literature studies the relationship between RIR and farmers' incomes. Generally, the integration of rural industries, improvements in comprehensive agricultural capabilities, the development of rural characteristic industries, and the organization of agricultural production play significant roles in increasing farmers' incomes. Based on the existing research, this paper will further empirically study the impact of RIR on farmers' incomes. Overall, RIR has promoted the growth of farmers' incomes. However, RIR may produce different effects in different regions. In order to determine whether some regions have made special contributions to farmers' income growth or whether there are regions that are contrary to the overall trend, the paper will consider the different income-increasing effects of RIR from a more detailed regional perspective and conduct a heterogeneity analysis, which illustrates variables that explain within-country variation of the degree to which RIR affects farmers' incomes.

3. Theoretical Analysis and Research Hypotheses

There are four main ways in which RIR affects farmers' incomes. One is promoting the development of rural industry integration (RII). There is a strong correlation between RII and farmers' incomes, and the higher the level of RII, the faster the growth of farmers' incomes [37]. RIR transforms agricultural production methods, extends the industrial and value chains, promotes integrated industrial development, and helps farmers find non-agricultural employment nearby, thereby promoting their income growth. The second is enhancing the comprehensive agricultural production capacity. RIR focuses on cultivating

efficient and intensive production methods, for example, mechanization [12], rationally allocating agricultural production resources, improving agricultural production efficiency, enhancing economic output per unit time and area, and, ultimately, increasing the unit product income of farmers. The third is promoting the development of rural characteristic industries, which are efficient rural industries with scale effects that have developed by combining advantages such as geographical location, resource endowment, the ecological environment, and agricultural technology in RIR. RIR improves the agricultural value chain, optimizes the agricultural industry structure, and promotes the growth of farmers' incomes [38]. The fourth is optimizing the rural interest linkage mechanism, which ensures that farmers participate in the production of rural enterprises, cooperatives, and other organizations and enjoy the added value of the industry. RIR promotes cooperation between farmers and enterprises; promotes shareholding cooperation, operational cooperation, and land transfer cooperation; improves the delivered price of agricultural products and the cost–profit ratio [15]; and improves the distribution of benefits in rural industries, thereby ensuring that the results of development benefit all farmers more. Therefore, Hypothesis 1 is presented.

Hypothesis 1 (H1). *Rural industry revitalization significantly promotes farmers' income growth.*

The effect of poverty alleviation through rural industries is significant in China, increasing the income of poor households to a certain extent [27]. RIR, with long-term and endogenous effects, promotes economic growth in rural areas and the local employment of farmers, continues to promote income growth in poverty-stricken areas and populations, and provides sustainable livelihoods for low-income people. However, urban industries can provide more employment opportunities for rural labor. People with relatively high incomes have a greater loss of opportunity costs of employment in rural areas, so they often choose to move to urban areas for employment. Therefore, the incomes of middle- and high-income farmers mostly come from industrial employment in urban areas, and RIR is of relatively little benefit to them. Therefore, Hypothesis 2 is presented.

Hypothesis 2 (H2). *The impact of rural industrial revitalization, on increasing farmers' income, is negatively related to farmers' wealth.*

Technological progress mainly lies in the growth of agricultural productivity [39]. Farmers with larger farm sizes are more willing to adopt new technologies and spend more time and money on acquiring agricultural knowledge [40]. RIR, which is committed to improving rural industrial productivity, provides a broader application scenario and market demand for agricultural science and technology innovation. The endogenous growth theory posits that technological progress is the source of income growth. Agricultural technological progress, which is an important driving force for promoting rural economic growth and alleviating rural poverty [41], usually means more efficient farming methods, better seeds, and more advanced machinery and equipment. It can directly increase the output per unit area and reduce production costs, thereby improving agricultural productivity and then helping farmers receive higher returns with the same investment in production factors. Therefore, the agricultural scientific and technological progress caused by RIR can further promote the increase in farmers' incomes. Therefore, Hypothesis 3 is presented.

Hypothesis 3 (H3). *Rural industrial revitalization promotes the increase in farmers' incomes by promoting agricultural scientific and technological progress.*

The level of rural revitalization in the eastern region is higher than that in the central and western regions [42]. The same is true for the RIR level in the three regions. The eastern region has a solid foundation, with rich experience in management and operation and a relatively complete industrial chain for rural industrial development. Therefore, its RIR level is relatively high, and it has a strong ability to drive the growth of rural

households' operating and wage incomes. Owing to the constraints of resource endowment and geographical position, the economic development level in the central and western regions is relatively low, and the foundation of rural industrial development is weak. As a result, their RIR levels are relatively low, and the ability to drive farmers to increase their incomes is limited. Therefore, Hypothesis 4 is presented.

Hypothesis 4 (H4). *Compared with the Midwest, the impact of rural industrial revitalization on increasing farmers' incomes is greater in the eastern region.*

4. Empirical Research Design

4.1. Sample Selection and Data Sources

The research sample comprises panel data from 30 provinces of China between 2011 and 2020. The sample data mainly came from *The China Agricultural Yearbook*, *China Agricultural Products Processing Industry Yearbook*, *China Leisure Agriculture Yearbook*, *China Academy for Rural Development—Qiyang China Agri-research Database (CCAD)*, *Zhejiang University*, *China Rural Management Statistical Annual Report*, *National Bureau of Statistics of China*, and *Local National Economic and Social Development Statistical Bulletins*. The missing values were interpolated using the linear interpolation method.

4.2. Variable Selection and Data Description

4.2.1. Explained Variable

The explained variable is farmers' income (NI), which is reflected in the per capita disposable income of rural residents. To overcome the influence of heteroscedasticity, the logarithms of the variables that measure farmers' income were calculated. The data source for NI is *The China Statistical Yearbook*.

4.2.2. Core Explanatory Variable

The core explanatory variable in this paper is RIR. According to the policy documents *Rural Revitalization Strategy Plan (2018–2022)*, *National Rural Industry Development Plan (2020–2025)*, and *The 14th Five-Year Plan for Promoting Agricultural and Rural Modernization in China* and research by Juan W. (2021) [43], Li D. et al. (2022) [44], Jinhua Y. et al. (2022) [45], and Guoguang P. (2023) [46], taking into account the strategic goal of agricultural modernization and the scientific nature and availability of the data, an evaluation index system for China's RIR was constructed in four dimensions: the RII level, the comprehensive agricultural production capacity, the level of rural characteristic industry development, and the mechanism of rural interest linkage. Then, quantitative measurement was carried out (Table 1).

1. Integration Level of Rural Industries

RII is mainly achieved through the development of the agricultural product processing industry, leisure agriculture, and the agricultural service industry. In this paper, the proportions of agricultural product processing industry revenue, leisure agriculture revenue, and gross output value of service industry of agriculture, forestry, animal husbandry, and fisheries to the total output value of agriculture, forestry, animal husbandry, and fisheries are used to measure the RII level.

2. Comprehensive Agricultural Production Capacity

Factors such as labor and land affect farmers' incomes through production [4]. The labor output rate and land output rate are the main indicators for measuring the comprehensive production capacity of agriculture. In this paper, the ratio of total output value of agriculture, forestry, animal husbandry, and fisheries to the number of employed people in the primary industry is used to measure the labor output rate, and the ratio of the total output value of agriculture to the sowing area of crops is used to measure the land output rate.

Table 1. Evaluation index system for rural industry revitalization.

Dimension	Specific Indicators	Measurement Methods	Unit	Connotation	Weight	Data Sources
Integration Level of Rural Industries	Development Level of Agricultural Product Processing Industry	Operating income from agricultural product processing industry/total output value of agriculture, forestry, animal husbandry, and fisheries.	%	Reflects the degree of integrated development between agriculture and rural secondary industry.	0.15	<i>China Agriculture Yearbook, China Rural Statistical Yearbook, China Leisure Agriculture Yearbook, China Agricultural Products Processing Industry Development Report</i>
	Development Level of Leisure Agriculture	Leisure agriculture revenue/total output value of agriculture, forestry, animal husbandry and fisheries.	%	Reflects the degree of integrated development between agriculture and rural tertiary industry.	0.15	
	Development Level of Agricultural Service Industry	Gross output value of service industry of agriculture, forestry, animal husbandry, and fisheries/total output value of agriculture, forestry, animal husbandry, and fisheries.	%	Reflects the degree of integrated development between agriculture and rural service industry.	0.03	
Comprehensive Agricultural Production Capacity	Labor Productivity	Total output value of agriculture, forestry, animal husbandry, and fisheries/employment in the primary industry.	CNY 10,000/1 person	Reflects agricultural labor productivity.	0.04	<i>China Statistical Yearbook</i>
	Land Productivity	Total agricultural output value/crop sowing area.	CNY 10 000/1 hectare	Reflects agricultural land productivity.	0.10	
Development Level of Rural Characteristic Industries	Characteristic Agricultural Products	Number of geographical indications for agricultural products in China/rural population.	pieces /10,000 people	Reflects the development level of rural characteristic industries.	0.14	<i>China Rural Statistical Yearbook, CCAD Zhejiang University Carter Database</i>
	Demonstration Villages and Towns	Number of national “One Village, One Product” demonstration villages and towns/rural population.	pieces /10,000 people	Reflects the development level of rural characteristic industries.	0.13	
Rural Interest Linkage Mechanism	Professional Cooperation Level among Farmers	Number of farmer professional cooperatives/rural population.	pieces /10,000 people	Reflects the ability of agricultural cooperatives to connect and lead farmers.	0.08	<i>China Rural Management Statistical Yearbook, China Rural Cooperative Economy Statistical Yearbook, CCAD Zhejiang University Carter Database</i>
	Cooperation Level of Agricultural Enterprises	Number of national key leading enterprises in agricultural industrialization/rural population.	pieces /10,000 people	Reflects the ability of agricultural cooperatives to connect and lead farmers.	0.13	
	Land Transfer Level	Total area of household-contracted farmland transfer (mu)/farmland area under household contract management. (Household contract farming is the rural land use system in China, which means that land ownership belongs to the collective, and management rights belong to individuals. The household-contracted area refers to the rural land area contracted by Chinese farmers from the collective.)	%	Reflects the situation of agricultural scale land management.	0.05	

3. Development Level of Rural Characteristic Industries

The number of brands and the spatial agglomeration of rural characteristic industries are important indicators for measuring their development level. In this paper, the number of geographical indications for agricultural products per 10,000 people and the number of demonstration villages and towns for “One Village, One Product” per 10,000 people are used to measure the development level of rural characteristic industries. The geographical indication of agricultural products in China refers to a unique agricultural product logo that indicates that the agricultural products come from a specific region, have the unique natural ecological environment and historical and cultural factors of that region, and are named after the region. “One Village, One Product” in China refers to a village (or several villages) that has one (or several) leading product(s) and industry(ies) with great market potential, obvious regional characteristics, and high added value. “Demonstration villages and towns” of “One Village, One Product” refers to typical villages and towns that have been selected as worthy of reference for the development of “One Village, One Product” construction.

4. Rural Interest Linkage Mechanism

The development and formation of more cooperative societies among farmers will increase farmers’ incomes [2]. The rural interest linkage between farmers and enterprises is mainly manifested in the mechanism of farmers’ participation in rural industries. Farmers generally participate in industries through two modes, “Farmers + Leading Enterprises” and “Farmers + Professional Cooperatives”, and behaviors such as farmland transfer. In this study, the number of professional farmer cooperatives per 10,000 people, the number of national key leading enterprises in agricultural industrialization per 10,000 people, and the land transfer rate are used to evaluate the rural interest linkage mechanism. “National key leading enterprises in agricultural industrialization” in China refers to agricultural enterprises whose main business is the production, processing, or circulation of agricultural products that meet prescribed standards in terms of scale and operating indicators and are recognized by the China Agricultural Industrialization Joint Conference. Agricultural land transfer refers to the act of Chinese rural households transferring the management rights or use rights of their contracted land to other farmers or other economic organizations in a legal manner.

The entropy method is an objective assignment method commonly used in multi-indicator comprehensive evaluation. It uses the amount of information carried by the data to calculate weights, which can obtain more objective indicator weights. The entropy method was used to comprehensively calculate the weights of various secondary indicators of the RII level, the comprehensive agricultural production capacity, the rural characteristic industry development level, and the rural interest linkage mechanism, and the index of the primary indicators of RIR from 2011 to 2020. The following process was used.

First, the raw data are standardized. Each specific indicator has different dimensions or ranges of values, so the data are standardized to convert them to the same scale.

Second, the values are re-scaled across the entire sample into proportions for each indicator; the proportion is calculated using standardized data P_{it} , and the formula is as follows:

$$P_{it} = X_{it} / \sum_{i=1}^n X_{it}$$

Third, the extent to which the distribution has a left skew is measured for each indicator; the information entropy E_{it} is calculated using P_{it} , and the formula is as follows:

$$E_{it} = -\sum_{i=1}^n P_{it} \ln(P_{it})$$

Fourth, the weights are calculated for all indicators; the weight W_{it} is calculated using E_{it} , and the formula is as follows:

$$W_i = \frac{1 - E_{it}}{1 - \sum_{i=1}^n E_{it}}$$

Fifth, the weights are re-scaled to the range [0, 1]; the weight W_{it} is standardized. The formula is as follows:

$$W'_{it} = \frac{W_{it}}{\sum_{i=1}^n W_{it}}$$

Sixth, after calculating the re-scaled weights of each specific indicator, the linear weighting method is used to calculate the score of the primary indicator. The formula is as follows:

$$R_{it} = \sum_{i=1}^n W'_{it} X_{it}$$

Based on the weighting results of each specific indicator, the linear weighting method is used to calculate the RIR index for each province.

From Table 1, the top five indicators are the development level of the agricultural product processing industry, the development level of leisure agriculture, characteristic agricultural products, demonstration villages and towns, and the level of agricultural enterprise cooperation, with weights of more than 13%. Three secondary indicators play pivotal roles in RIR: the integration of primary, secondary, and tertiary industries; the development of characteristic agricultural products; and the integration of enterprises with agriculture.

Based on the calculation results of the RIR index for each province from 2011 to 2020, this paper learns from SUN Jiguo, SUN Yao [47] and uses four years as the time period. The kernel density estimation method was used to analyze the dynamic changes, distribution characteristics, diffusion trends, and polarization situation in 2012, 2016, and 2020, selected as time points (Figure 1). In terms of dynamic changes, the center of the overall distribution curve gradually shifts to the right, indicating that the RIR level in China has continued to improve. From the perspective of distribution characteristics, diffusion trends, and polarization, the height of the main peak gradually decreases, the width of the distribution gradually increases, and there is a noticeable right tail extension phenomenon. This indicates that, although the polarization phenomenon has generally decreased, there is still a gap, to some extent, between different regions.

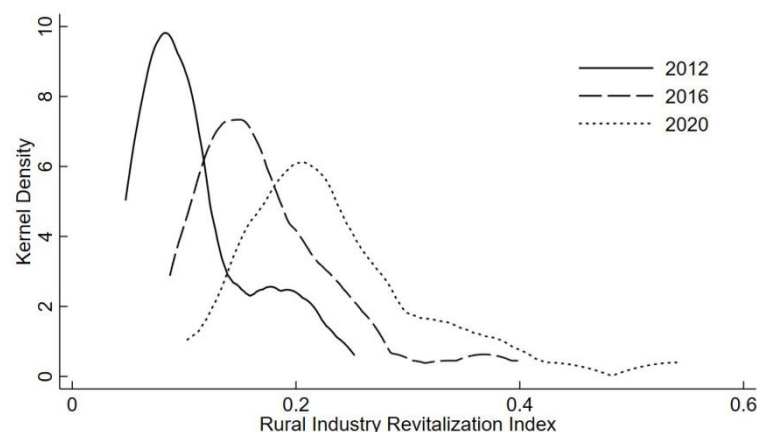


Figure 1. Rural industry revitalization's index kernel density curve.

4.2.3. Control Variables

Control variables were selected from the influencing factors of the composition of farmers' incomes, including property income, operating income, wage income, and transfer income. The control variables in this paper include (1) the level of regional economic development ($\ln GDP$), which comprehensively affects the above four types of farmers' incomes and is measured by taking the logarithm of the GDP of each region; (2) the level of urbanization ($\ln URL$), which mainly affects the property income, operating income, and wage income of farmers and is measured by taking the logarithm of the proportion of urban permanent residents in each region to the total population; (3) the level of rural human capital ($\ln HC$), which mainly affects the wage incomes of farmers and is measured

by calculating the average number of years of schooling using the following formula: average years of education = (number of illiterate people $\times$ 0 + number of people with primary school education $\times$ 6 + number of people with junior high school education $\times$ 9 + number of people with high school and technical secondary school education $\times$ 12 + number of people with college degree or above $\times$ 16)/total population; (4) the financial scale (FS), which mainly affects operating income and property income and is measured by determining the ratio of total rural deposits and loans to regional GDP. The above control variables have important impacts on the growth of farmers' incomes. Eliminating the interference of these factors from the model regression results can more accurately identify the role of rural industries in increasing farmers' income. The data sources for the control variables are the *China Statistical Yearbook*, *China Population and Employment Statistical Yearbook*, and *China Financial Yearbook*.

4.2.4. Mechanism Variable

The mechanism variable is the agricultural scientific and technological progress contribution rate (AT). The intermediary effect of agricultural technological progress is manifested by rural enterprises, as the main body, conducting research and innovation in agricultural production, operation, management, and other aspects, accelerating agricultural scientific and technological progress, and thereby achieving farmers' income increase, which is also a basic requirement of endogenous growth theory. Therefore, the logarithm of the contribution rate of agricultural technological progress is set as a specific proxy variable, denoted by AT, which is measured using the standardized indicators and their measurement methods proposed by the former Ministry of Agriculture of China in 1997. The data sources of AT are the *China Rural Statistical Yearbook* and *China Provincial Statistical Yearbook*.

4.3. Descriptive Statistics

As observed in the two-dimensional scatter plot of the RIR level and the income level of farmers in Figure 2, as the RIR level improves, the income level of farmers in the region gradually increases. This clearly reveals a positive correlation between the RIR level and rural income; that is, RIR promotes the growth of farmers' incomes. Table 2 presents the descriptive statistical results.

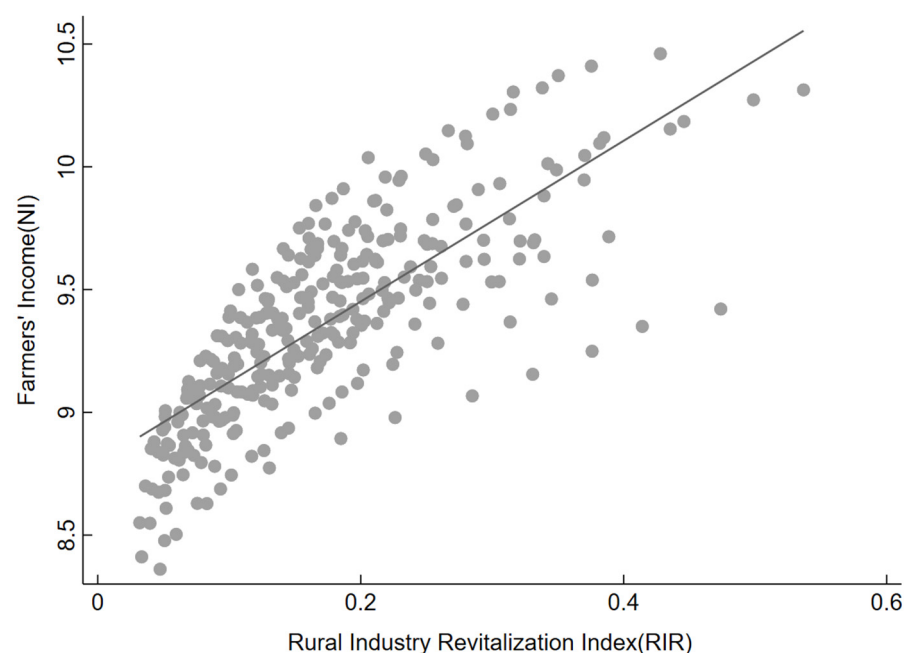


Figure 2. Two-dimensional scatter plot of rural industry revitalization level and farmers' incomes.

Table 2. Descriptive statistical results of sample variables.

Variable	Variable Symbols	Observations	Average Value	Standard Deviation	Minimum Value	Maximum Value	Average for Eastern Region	Average for Central Region	Average for Western Region
Farmers' income	NI	300	9.366	0.399	8.361	10.460	9.679	9.326	9.209
Rural industry revitalization level	RIR	300	0.174	0.094	0.031	0.536	0.210	0.148	0.156
Regional economic development level	lnGDP	300	9.833	0.856	7.420	11.618	10.302	9.982	9.599
Urbanization level	lnURL	300	10.530	0.760	8.196	12.077	4.222	4.021	3.975
Rural human capital level	lnHC	300	2.043	0.078	1.766	2.268	2.090	2.067	2.019
Financial scale	FS	300	1.436	0.952	0.1291	15.825	1.553	1.132	1.378
Agricultural scientific and technological progress contribution rate	AT	300	4.597	2.315	1.756	13.581	6.292	3.41	3.750

As shown in Table 2, the logarithmic average disposable income of rural residents is 9.366. The standard deviation is 0.3991, the extreme difference is 2.099, and the data dispersion is average. The RIR level varies greatly, with the maximum value being more than ten times the minimum value, indicating that the development level of rural industries in different regions is uneven. By comparing the relevant variables in the eastern, central, and western regions, it is found that the income level of farmers in the eastern region is significantly higher than that in the central and western region, and the RIR level is also significantly higher than that in the central and western regions.

4.4. Model Setting

To empirically test the impact of RIR on farmers' income, a benchmark regression model was constructed as follows:

$$NI_{it} = \alpha_0 + \alpha_1 RIR_{it} + \alpha_2 X_{it} + \lambda_i + \eta_t + \mu_{it}$$

To further verify whether the contribution rate of agricultural scientific and technological progress plays a significant mediating role between RIR and farmers' income increase, the following mediating-effects model was constructed:

$$NI_{it} = \gamma_0 + \gamma_1 RIR_{it} + \gamma_2 X_{it} + \lambda_i + \eta_t + \mu_{it}$$

$$AT_{it} = \beta_0 + \beta_1 RIR_{it} + \alpha\beta_2 X_{it} + \lambda_i + \eta_t + \mu_{it}$$

$$NI_{it} = \delta_0 + \delta_1 RIR_{it} + \delta_2 AT_{it} + \delta_3 X_{it} + \lambda_i + \eta_t + \mu_{it}$$

NI_{it} represents farmers' income, RIR_{it} represents the constructed RIR index, AT_{it} represents the agricultural scientific and technological progress contribution rate; X_{it} represents a series of control variables, with subscripts i and t representing the region and year, respectively; and μ_{it} is a random error term. A dual-fixed-effects model was used for benchmark regression, which controls for both regional fixed effects (λ) and time fixed effects (η).

4.5. Correlation Analysis

Table 3 shows the correlation analysis of the data to test the reliability of the variables. The correlation between NI and RIR is above 0.75, indicating a significant positive correlation. The correlations between NI and lnGDP, lnURL, lnHC, and FS were 0.553, 0.832, 0.526, and 0.249, respectively, and all passed the significance test at the 1% level. It was demonstrated that there was a significant positive correlation between the explained variable and all control variables. The results of correlation analysis show that the selection of variables is effective. However, the correlation does not indicate the causal relationship between the growth of farmers' incomes and other variables, so further regression analysis is needed.

Table 3. Pairwise correlations.

Variables	(1) NI	(2) RIR	(3) lnGDP	(4) lnURL	(5) lnHC	(6) FS
(1) NI	1.000					
(2) RIR	0.774 ***	1.000				
(3) lnGDP	0.553 ***	0.095	1.000			
(4) lnURL	0.832 ***	0.684 ***	0.354 ***	1.000		
(5) lnHC	0.526 ***	0.232 ***	0.411 ***	0.578 ***	1.000	
(6) FS	0.249 ***	0.374 ***	−0.099	0.272 ***	−0.008	1.000

Note: *** represent significance at the 1% significance levels.

The collinearity test results show that the maximum VIF value is 3.08, which is far lower than the empirical threshold of 10, above which values are generally considered to indicate multicollinearity problems. Simultaneously, the average VIF value is 1.90, which is also far lower than the generally considered warning line of 3. Therefore, there are no significant multicollinearity problems among the variables involved in this study.

5. Empirical Results and Discussion

5.1. Baseline Regression

This empirical study used balanced short-term panel data. Given that pooled regression may lead to biased results, fixed-effects regression (FE) and random-effects regression (RE) were used to address heterogeneity problems so as to perform regression analysis and test the model. The p-values for both the F-test and the Hausman test were 0.0000; therefore, it was appropriate to choose a fixed-effects regression model. In addition, to avoid autocorrelation and heteroscedasticity issues, a dual fixed-effects model that controlled for provinces and years was used. The empirical analysis was conducted using Stata 17.0, and the regression results are detailed in Table 4.

Table 4. Benchmark regression results.

Variable	Benchmark Regression		Quantile Regression			
	(1)	10th Percentile (2)	25th Percentile (3)	50th Percentile (4)	75th Percentile (5)	90th Percentile (6)
RIR	0.213 *** (0.030)	1.485 *** (0.201)	1.334 *** (0.293)	0.695 *** (0.167)	0.620 *** (0.170)	0.483 * (0.261)
lnGDP	0.092 *** (0.008)	0.184 *** (0.012)	0.165 *** (0.018)	0.113 *** (0.010)	0.130 *** (0.010)	0.160 *** (0.016)
lnHC	0.118 *** (0.037)	0.217 (0.144)	0.411 * (0.210)	0.522 *** (0.119)	0.685 *** (0.121)	0.834 *** (0.187)
lnURL	0.320 *** (0.026)	0.433 *** (0.082)	0.548 *** (0.119)	0.878 *** (0.068)	0.838 *** (0.069)	0.891 *** (0.106)
FS	6.516 *** (0.133)	4.751 *** (0.261)	−0.005 (0.014)	−0.010 (0.008)	0.088 *** (0.008)	0.186 *** (0.013)
Constant Term	0.213 *** (0.030)	1.485 *** (0.201)	4.181 *** (0.380)	3.295 *** (0.216)	2.905 *** (0.220)	2.081 *** (0.338)
Regional Fixed Effects	Control	Control	Control	Control	Control	Control
Time Fixed Effects	Control	Control	Control	Control	Control	Control
N	300	300	300	300	300	300
R2	0.998	0.737	0.719	0.741	0.753	0.770

Note: *** and *, respectively, represent significance at the 1% and 10% significance levels. The standard errors are in parentheses.

The regression results of RIR on farmers' income are presented in Table 4. According to column (1), the variable of the RIR level is significant, and the regression coefficient is positive, indicating that the higher the RIR level, the higher the farmers' incomes. The regression coefficient for benchmark regression is 0.213, indicating that for every unit increase in the RIR level, farmers' incomes increase by 0.213%. Therefore, Hypothesis 1 was validated.

The study examines the impact of the RIR level on farmers' incomes at different quantiles through quantile regression. The regression results are shown in columns (2)–(6) of Table 4. The highest regression coefficient is at the 10th percentile, and for every unit increase in the RIR level, farmers' income increases by 1.485%, indicating that RIR significantly promotes income growth for low-income groups. RIR has a significant poverty

alleviation effect, narrowing the income gap among farmers. As the percentile increases, the effect of RIR in increasing farmers' incomes weakens and shows a downward trend. The regression coefficient at the 50th percentile is much lower than that at the 10th percentile. For every unit increase in the RIR level, farmers' income increases by 0.695%, indicating that the role of RIR in increasing the income of middle-income farmers is very limited. The regression coefficient at the 90th percentile is the lowest. For every unit level increase in RIR, farmers' income increases by 0.483%, indicating that the role of RIR in promoting income growth for high-income farmers is relatively weak. In summary, the level of RIR promotes an increase in farmers' incomes, with the most significant effect on low-income farmers, followed by middle- and high-income farmers. The impact of RIR on increasing farmers' income is positively correlated with farmers' wealth. Therefore, Hypothesis 2 was validated.

5.2. Endogeneity Analysis

Although fixed-effects models were used in benchmark regression to mitigate the potential impact of endogeneity issues on the estimation results, it is still necessary to recognize that endogeneity issues may exist. These endogeneity issues mainly stem from unobserved variables and other factors, which may lead to omitted variables. In other words, some factors that affect farmers' incomes may not have been taken into account in the model.

When endogeneity issues arise, such as a correlation between explanatory variables and error terms, common linear regression models may have inconsistent estimates. If instrumental variables are used, consistent estimates can still be obtained. Therefore, the instrumental variable method was used to test the endogeneity problem of the model, and the average nighttime light, which reflects the intensity of economic activities in the region and the level of development of local rural industries, was selected as the instrumental variable of the model. This choice meets the correlation requirements between instrumental variables and explanatory variables. In fact, average nighttime lighting, as an economic input variable, does not directly affect farmers' income but only works through its conversion into output. Assuming that nighttime lighting directly affects farmers' income through its ornamental value, the income generated is extremely limited because rural areas only display lights and decorations on specific holidays, and non-commercial places do not have bright lights all night. The regression analysis results in column (2) of Table 5 indicate that instrumental variables cannot directly affect farmers' income but indirectly affect it by influencing the RIR level, satisfying the exclusivity constraint. The F-value in the first stage of instrumental variable testing is greater than 10, indicating that there is no weak instrumental variable problem. The p-value of the LM statistic is significant at the 10% significance level, rejecting the hypothesis of the insufficient identification of instrumental variables. The selection of instrumental variables is valid. Due to not considering the impact of all omitted variables, there are still certain limitations in the selection of instrumental variables, which can only test endogeneity issues to a certain extent.

Using the Hausman test to compare the dual-fixed-effects model with the instrumental variable method, the calculation results showed that, if the p-values are greater than 0.1, the null hypothesis cannot be rejected, so the estimates of the two models are consistent, and there is no endogeneity issue. In the first stage of regression, the instrumental variable coefficient had a positive value at the 1% significance level, indicating a strong correlation between instrumental variables and the RIR level. In the second stage of regression, after correcting for endogeneity issues, the explanatory variable remained positive at the 1% significance level, indicating that the results remained robust even after considering endogeneity issues.

Table 5. Endogeneity analysis results.

Variable	Phase 1 RIR (1)	Exclusiveness NI (2)	Phase 2 NI (3)
IV	0.011 *** (0.001)	−0.001 (0.001)	
Predicted Values of the RIR Index		0.210 *** (0.030)	2.468 *** (0.232)
Constant Term	−2.812 *** (0.228)	6.566 *** (0.145)	3.784 *** (0.850)
Control Variable	Control	Control	Control
Regional Fixed Effects	Control	Control	Control
Time Fixed Effects	Control	Control	Control
N	300	300	300
R2	0.747	0.998	0.945

Note: *** represent significance at the 1% significance levels.

5.3. Robustness Test

To verify the reliability of the benchmark regression results on the impact of RIR on farmers' income, robustness tests were conducted from the following aspects:

1. Replacement of the explained variable. The explained variable, farmers' income, was measured using the disposable income of rural residents in the previous construction, and this was replaced with the net income of rural residents;
2. The exclusion of samples from municipalities directly under the central government. Since the economic development level and agricultural development foundation of the four municipalities of Beijing, Tianjin, Shanghai, and Chongqing are different from those of other provinces, interference caused by samples from these four cities was eliminated to measure the robustness of the results;
3. Shrinking treatment. The core explanatory and control variables were Winsorized at the 5% level, and the regression analysis was repeated after controlling for fixed effects.

The robustness test results indicated that the regression coefficients of the core explanatory variable, RIR, were significantly positive, with only differences in the coefficient size or significance, indicating the robustness of the benchmark regression analysis results (Table 6).

Table 6. Robustness test results.

Variable	Replacement of the Explained Variable (1)	The Exclusion of Samples from Municipalities Directly Under the Central Government (2)	Shrinking Treatment (3)
RIR	0.221 *** (0.069)	1.462 *** (0.211)	0.216 *** (0.035)
Constant Term	4.647 *** (0.267)	4.169 *** (0.393)	6.572 *** (0.135)
Control Variable	Control	Control	Control
Regional Fixed Effects	Control	Control	Control
Time Fixed Effects	Control	Control	Control
N	300	260	300
R2	0.993	0.912	0.998

Note: *** represent significance at the 1% significance levels.

5.4. Mechanism Analysis

RIR has direct and indirect effects in increasing farmers' income. The direct effect was measured previously. Next, the effect of RIR on agricultural scientific and technological progress and the indirect effects in further increasing farmers' income will be discussed.

RIR may improve agricultural production efficiency and promote the growth of farmers' incomes through agricultural scientific and technological progress. The regression results of Baron and Kenny's stepwise regression method are shown in Table 7. According to column (1), the regression coefficient of RIR to NI is 1.135 and is significant at the level of 1%, indicating that RIR has a promoting effect on farmers' income. According to column (2), the regression coefficient of RIR to AT is 15.632 and is significant at the level of 1%, indicating that RIR can significantly promote agricultural scientific and technological progress. According to column (3), the regression coefficient of RIR to NI decreased from 1.135 to 0.938 after the introduction of AT, which was significant at the level of 1%, indicating that a mediating effect existed, and agricultural scientific and technological progress played a partial mediating role in RIR to promote farmers' incomes. In order to further test the mediating effect, the Sobel test was performed. In Table 7, the Sobel values are all significant at the 1% level, indicating that a mediating effect exists. Therefore, RIR can more effectively increase farmers' incomes by enhancing the contribution rate of agricultural scientific and technological progress (AT). Therefore, Hypothesis 3 was validated.

Table 7. Mechanism analysis results.

Variable	NI (1)	AT (2)	NI (3)
RIR	1.135 *** (0.160)	15.632 *** (2.593)	0.938 *** (0.168)
AT			0.013 *** (0.004)
Constant Term	6.7695 *** (0.1180)	−13.1090 *** (4.1643)	3.498 *** (0.205)
Control Variable	Control	Control	Control
Regional Fixed Effects	Control	Control	Control
Time Fixed Effects	Control	Control	Control
N	300	300	300
Sobel Z		3.025 ***	

Note: *** represent significance at the 1% significance levels. Data sources of AT: National Earth System Science Data Center and China-like DMSP-OLS Light Data 1992–2023 Corrected Version.

5.5. Regional Heterogeneity Analysis

There are significant regional differences in the impact of RIR on farmers' incomes. Firstly, construct a regional dummy variable "region", including east = 0 in eastern region and Midwest = 1 in central and western regions of China. (The eastern region of China includes 12 provinces (regions, cities), including Beijing, Liaoning, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi, and Hainan; the Midwest includes 18 provinces (regions, cities) in Shanxi, Inner Mongolia, Heilongjiang, Jilin, Anhui, Henan, Jiangxi, Hubei, Hunan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Sichuan, Chongqing, Yunnan, Guizhou, and Xizang.) Secondly, the cross term between regional dummy variables and RIR is added to the benchmark model, with the eastern region as a reference, to examine the differential impact of RIR on farmers' incomes in different regions. The model is divided into two time intervals of 2011–2015 and 2016–2020 to examine their stage changes. The specific regression results are shown in Table 8.

The regression results of regional heterogeneity show that the income-increasing effect of RIR is greater in the eastern region. The impact of RIR on increasing farmers' incomes in the Midwest was 79% lower than that in the eastern region from 2011 to 2020. In the eastern region, the level of economic development is relatively high, which creates a favorable environment for the development of rural industries and a wide range of sources for farmers' incomes. Therefore, the effect is more significant. The geographical environment in the Midwest is relatively complex, with many mountainous and hilly areas, and the benefits of developing agriculture are not high. The natural resource endowment limits the improvement of the RIR level, thereby weakening the impact of RIR on farmers' income

growth. Therefore, the income-increasing effect of RIR is lower than that of the eastern region. Through phased discussions, it was found that the impact of RIR on increasing farmers' incomes in the Midwest was 132.5% lower than that in the eastern regions from 2011 to 2015, and decreased to 67.8% from 2016 to 2020. The gap in income-increasing effects of RIR between regions has significantly narrowed, which proves the effectiveness of RIR, especially in promoting the regional balanced development and increasing farmers' incomes. The regional heterogeneity regression results further validated the robustness of the baseline regression. Therefore, Hypothesis 4 was validated.

Table 8. Regression results by region.

Variable	2011–2020	2011–2015	2016–2020
RIR	1.209 *** (0.138)	2.541 *** (0.354)	1.076 *** (0.191)
Midwest*RIR	−0.790 *** (0.076)	−1.325 *** (0.176)	−0.678 *** (0.092)
lnGDP	0.109 *** (0.009)	0.099 *** (0.013)	0.113 *** (0.014)
lnHC	0.165 (0.101)	0.271 ** (0.137)	0.191 (0.155)
lnURL	0.771 *** (0.056)	0.165 (0.137)	0.774 *** (0.115)
FS	0.002 (0.007)	−0.012 (0.032)	−0.001 (0.007)
Constant Term	4.443 *** (0.201)	5.150 *** (0.291)	4.647 *** (0.341)
N	300	150	150
R2	0.941	0.931	0.909

Note: *** and **, respectively, represent significance at the 1% and 5% significance levels.

6. Conclusions, Policy Implications, and Limitations

6.1. Conclusions and Policy Implications

This study is based on relevant data from 30 provinces in China from 2011 to 2020. According to the theories of rural and development economics, starting from theoretical analysis and empirical testing, a dual fixed-effects model was used to empirically analyze the impact of RIR on farmers' incomes. The following conclusions were drawn: (1) According to the measurement and analysis of the RIR level in 30 provinces, the overall RIR level in China is rising, and the polarization phenomenon has been alleviated, but a gap remains between different regions. This shows that China's rural industries are developing rapidly, which provides valuable experience for the global rural industries. (2) The benchmark regression results show that RIR can significantly increase farmers' incomes, and the promotion effect on the incomes of low-income farmers is more significant. The income-increasing effect on middle- and high-income farmers needs to be improved. This is particularly important for underdeveloped countries or regions to solve the problem of farmers' incomes. (3) The mechanism analysis shows that RIR can promote agricultural scientific and technological progress and further enhance the impact of RIR on farmers' incomes. Therefore, promoting rural scientific and technological progress can strengthen the impact of rural industries on farmers' income. (4) Heterogeneity analysis shows that RIR has greater positive effect on farmers' incomes in the eastern region than that in the Midwest. It indicates that the macroeconomic environment affects the impact of rural industries on farmers' incomes.

Based on the empirical research results in this paper, the following policy suggestions are proposed.

First, promote the deep integration of rural industries and enhance the comprehensive agricultural production capacity. In promoting RIR, guided by market demand, promote the integrated development of agriculture with the secondary and tertiary industries to

build a full-industry, full-chain rural industrial system. Guide enterprises to carry out targeted fine processing of agricultural products [48]; tap into the advantageous resources of rural areas and improve and refine the rural leisure industry; vigorously develop key areas, such as agricultural variety research, organic production, and the standardization of agricultural machinery operations; and improve the service capacity of the agricultural service industry.

Second, develop rural characteristic industries in RIR and expand the premium space for agricultural products. Based on the resource endowment, rationally distribute the characteristic industries across the whole county region and improve the characteristic industrial chain in rural areas; guide leading agricultural enterprises and farmer cooperatives to jointly create agricultural product brands and accelerate the construction of the agricultural brand system, dominated by regional public brands, regional characteristic brands, and bulk agricultural product brands; utilize digital technology to strengthen agricultural product brand promotion and enhance brand awareness and influence; and connect with various e-commerce platforms, widely adopt new sales models, such as live streaming and direct supply, and expand the sales scope of characteristic agricultural products, thereby expanding their revenue space.

Third, improve the interest linkage mechanism in RIR between farmers and enterprises. Collective action can improve farmers' incomes [49], and new agricultural management models, such as "Farmers + Professional Cooperatives", "Farmers + Industrialized Agricultural Enterprises", large professional households, and family farms, could be developed. Make policies to guide the establishment of stable order and contract relationships between agricultural enterprises, which reduce the efficiency loss and product waste caused by farmers individually buying and selling. Improve the profit distribution mechanism of agricultural joint-stock cooperative enterprises and ensure that farmers can obtain more value-added benefits from industry extension and strong chain supplementation.

Fourth, promote the deep integration of RIR and agricultural scientific and technological progress. A strategic approach to integrating technological advances into agriculture can create a sustainable path for agro-industrial growth [50]. Taking advantage of the opportunity of RIR, develop smart agriculture; use technologies such as the Internet of Things, big data, and artificial intelligence to optimize agricultural production, management, and marketing; and promote rural industries to improve efficiency, reduce costs, and expand sales. Strengthen cooperation between local governments and universities and vigorously cultivate agricultural science and technology talent in rural industries through supply-and-demand docking. Increase vocational skills training, improve farmers' skills and knowledge levels, and enhance their ability to increase income.

Finally, implement differentiated strategies to enhance the effect of regional RIR on farmers' income growth. The eastern region could summarize and promote its advanced experience, accelerate RIR, and achieve the spatial diffusion and spillover effects of rural industries on a larger scale. The Midwest could actively learn and draw on the substantial development experience in the eastern region, such as the advanced experience of Zhejiang's "Qian Wan Project", and combine regional characteristics to develop rural industrial demonstration parks with distinctive features to promote faster and better rural industrial development and drive farmers to increase their incomes and grow their wealth.

6.2. Limitations

However, there are still some shortcomings in this study. Due to limited data availability, only provincial panel data were used, and there is a lack of analysis of regional data at the city and county levels and below. In the future, a more comprehensive indicator system can be constructed based on more granular city and county data or farmer data, and, combined with typical case analysis and spatial econometric analysis, the effect of RIR on farmers' incomes can be further explored to promote the sustained and stable growth of farmers' incomes.

Author Contributions: Conceptualization, H.P. and F.Y.; methodology, H.P.; validation, H.P. and F.Y.; formal analysis, F.Y.; investigation, H.P.; resources, O.Y.; data curation, O.Y.; writing—original draft preparation, H.P.; writing—review and editing, H.P.; visualization, O.Y.; supervision, F.Y.; project administration, F.Y.; funding acquisition, H.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research is based on work funded and supported by 2023 Sichuan Provincial Philosophy and Social Science Fund Project of China [Grant No. SCJJ23ND244]; National Ethnic Affairs Commission Ethnic Studies Self-Raised Fund Project of China [Grant No. 2021-GMD-044]; and Sichuan Provincial Key Laboratory of Philosophy and Social Sciences for Monitoring and Evaluation of Rural Land Utilization Project of China [Grant No. NDZDSD2023003].

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used in this study can be requested from the authors.

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

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