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Can Rural Industrial Convergence Alleviate Urban–Rural Income Inequality?: Empirical Evidence from China

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Abstract: In many countries, the urban–rural income inequality affects healthy and sustainable economic development and is a pressing issue that requires immediate attention. As a new industrial development model, rural industrial convergence can provide new ideas and impetus for alleviating the urban–rural income inequality. This study, drawing on provincial panel data from China spanning 2010 to 2022, used the entropy method and Theil index to measure the rural industrial convergence and the urban–rural income inequality, respectively, and empirically tested the effect and mechanism of rural industrial convergence on the urban–rural income inequality. The results showed the following: (1) Rural industrial convergence had a notable impact on alleviating the urban–rural income inequality. (2) Rural industrial convergence could help reduce the urban–rural income inequality by increasing the scale of land operation. (3) The government attention to green development could positively moderate the impact of rural industrial convergence on the urban–rural income inequality; the deeper the government attention to green development, the greater the role rural industrial convergence played in alleviating the urban–rural income inequality. (4) There was a threshold effect in the alleviating effect of rural industrial convergence on the urban–rural income inequality, which was gradually strengthened when the growth of the digital economy and the enhancement of the business environment were beyond the threshold point. (5) Rural industrial convergence also had significant spatial spillover effects on adjacent regions. Overall, the findings of this study enrich the research on the impact of rural industrial convergence on the urban–rural income inequality and provide insights for other similar countries.

Keywords: rural industrial convergence; urban–rural income inequality; land operation scale; government attention to green development; digital economy; business environment

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1. Introduction

For a lengthy period, the urban–rural income inequality (URI) has been an economic and social issue of concern worldwide. This problem is particularly acute in developing countries [1]. In developing countries, cities are usually the centers of economic activities and have more industrial and service employment opportunities, as well as higher levels of educational resources, which promote higher income and stronger vocational competitiveness for urban residents. However, rural areas mainly rely on agriculture, with limited resources for education and skills training. The income level and growth potential of rural labor are relatively low. Simultaneously, during the initial period of development, developing countries typically prioritize industrial development in their growth strategies. In order to accumulate funds for the development of industries, many countries adopt a series of policies to concentrate the surplus of agriculture into the industrial field. For example, in China, one of the most important policies is the price scissors gap between industrial and agricultural products [2]. The Chinese government implemented this policy to suppress agricultural product prices, thereby forcing farmers to provide more resources for industrial development. As a result, farmers are unable to obtain fair returns for their labor, resulting in rural residents' actual income being considerably lower than that of urban inhabitants, which has contributed to the long-standing URI. Even after the reforms and opening up, the disparity between the prices of agricultural and industrial products has not been reduced, further exacerbating the URI, and the growing URI triggers a series of serious social problems. First, the URI exacerbates social inequality, especially for residents in rural areas whose living standards are usually lower than those of urban residents. Low-income groups have difficulty accessing high-quality education [3], healthcare, and infrastructure, which not only affects their quality of life but also limits their future development opportunities. The intergenerational transmission of poverty makes it difficult for these groups to break the cycle of poverty, hindering social equity and mobility [4,5]. Second, the growing URI may trigger social conflicts and dissatisfaction [6], especially during economic recessions or social change, where protests and demonstrations by low-income groups may increase. In addition, the growing URI has led to insufficient consumption capacity among low-income groups, affecting overall demand [7]. Keynesian economic theory points out that insufficient aggregate demand inhibits economic growth, limits the expansion and investment of enterprises, and reduces the endogenous growth momentum of the economy [8]. In the long run, this lack of demand may lead to slow or even stagnant economic growth. Meanwhile, the growing URI has increased the demand for public services in rural areas, but these services are often difficult to provide effectively. The insufficient services in rural areas such as healthcare, education, and transportation have increased the financial burden on the government. Therefore, alleviating the URI can improve social equity and make the distribution of resources and opportunities more balanced. A fair distribution reduces the tension between social classes, alleviates social dissatisfaction, and thereby enhances social cohesion and stability. Concurrently, the alleviating of income inequality reduces the differences in living conditions between different social classes [9], thereby reducing social division and opposition. In addition, the alleviation of income inequality has increased the purchasing power of rural and low-income groups, expanding consumer demand. This consumption growth has stimulated economic activity and boosted investors' confidence in investing. Stable market demand and economic growth prospects make investors more willing to invest funds, promoting a virtuous cycle of the economy. Overall, alleviating the URI is a key step toward achieving social equity and economic prosperity, as well as an important measure to optimize national governance and enhance social welfare levels.

In the past several years, governments worldwide have introduced a range of policy initiatives aimed at alleviating the URI, including strengthening rural infrastructure construction, increasing education investment, providing agricultural subsidies, and supporting rural entrepreneurship. However, these measures have encountered many challenges in practical operation, with results that do not meet expectations. First, the uneven allocation of resources remains a significant issue [10]. Although rural infrastructure has improved, overall resource investment is still insufficient compared with that in cities. Second, talent loss is also an important issue. Due to the abundant employment opportunities in cities, a large number of outstanding rural talents are flocking to cities, which severely restricts the innovation ability and development potential of rural areas. The brain drain not only weakens the economic vitality of rural areas but also exacerbates the URI [11]. In this regard, rural industrial convergence (RIC) has emerged as an effective solution to the aforementioned issues. RIC refers to integrating agriculture with other industries, such as tourism, manufacturing, and services to achieve diversified and comprehensive development of the rural economy [12]. This integration is important in alleviating the URI. From one perspective, the RIC helps promote the comprehensive utilization and optimized allocation of resources [13]. For example, combining agriculture with ecotourism can not only attract more investment and infrastructure construction but also improve the overall development environment of rural areas. This investment has compensated for the insufficient resource input and improved the economic development level of rural areas, effectively alleviating the URI. On the other hand, the RIC has broken the single economic structure of traditional agriculture. By introducing new industries such as agricultural product processing, rural tourism, and green energy, the rural economy can diversify and develop. This not only enhances the economy's vitality but also generates more job opportunities and sources of income for farmers. This diversification of income sources helps to directly alleviate the URI. What is more, cross-industry cooperation can promote information sharing, enhancing the market competitiveness and production efficiency of rural enterprises [14]. The circulation of information and the expansion of the market enable rural enterprises to better integrate into the market, increase the value-added benefits of agricultural products, and further reduce the URI. In summary, the RIC has a profound impact on the URI. Through what mechanism is this influence transmitted? What are the characteristics of this influence? Answering the above questions offers valuable theoretical and practical insights for alleviating the URI.

There are some studies on RIC and the URI, which have mainly concluded that RIC can alleviate the URI by increasing farmers' income and promoting urbanization [15]. The remaining related literature primarily examines the economic impacts of RIC, which primarily focuses on two aspects: income and output [16]. In terms of income, RIC can improve farmers' income by increasing wage and property income [17], reducing transaction costs [18], promoting the urbanization development level [19], improving agricultural science and technology levels [20], and providing more employment opportunities [21]. Rural transport infrastructure [22] and the development of fintech [23,24] will have a positive impact on the effect of RIC on farmers' income. Although RIC can promote the development of the rural economy, some scholars also believe that RIC may cause agricultural economic security problems [25]. In terms of output, RIC can improve agricultural resilience [26] and agricultural green TFP [27] to promote agricultural production. Some scholars also believe from a realistic perspective that RIC does not lead to an improvement in productivity but leads to a reduction in production efficiency [28].

In order to enrich the existing research, this study conducted an empirical analysis of how RIC affected URI, using China's provincial panel data. China was chosen as the research object mainly because it is a large agricultural country and a typical developing country. This study applied the fixed effects model to empirically assess the influence of RIC on URI. The findings indicated that RIC had a substantial impact in reducing URI. By replacing explanatory variables, changing the sample scope, and using the instrumental variable model for the robustness test, relatively consistent conclusions were obtained.

The following three aspects highlight the marginal contributions of this study: First, the existing research mainly analyzes the transmission mechanism of RIC on the URI from the perspectives of income and urbanization, while this article examines the transmission pathway from the standpoint of the scale of land operation and verifies the authenticity of the transmission path through the mediating effect model, enriching the existing research on transmission mechanisms. Second, this study introduces the concept of green development in the analytical framework from an external perspective. It verifies, through the moderating effect model, that the government attention to green development impacts the process of RIC, affecting the URI and providing a basis for relevant policy formulation. Third, considering the stage of digital economy development and the business environment, this study explores the threshold effect of RIC on the URI and expands the research on the characteristics of the impact of RIC on the URI.

The following sections of this study are organized as follows: The second section contains a theoretical examination of how RIC affects URI and puts forward research hypotheses. The third part explains the model setting, the source of study data, and the choice of variables. The fourth part empirically examines the impact of RIC on the URI and explores the mediating effect of land operation scale in this process, the moderating effect of the government attention to green development, the threshold effects of the digital economy development level and business environment, and the spatial spillover effect of RIC on the URI. The fifth section presents the key conclusions and policy suggestions derived from this study.

2. Theoretical Analysis and Research Hypotheses

2.1. Direct Effect of Rural Industrial Convergence on Urban–Rural Income Inequality

RIC primarily aims to alleviate the URI by enhancing the income of rural residents and improving the efficiency of resource allocation. First, RIC can diversify the income sources of rural residents. On one hand, it extends the agricultural industry chain; develops agricultural industrialization; and promotes the development of emerging industries such as agricultural product processing, leisure agriculture, and rural tourism [29], thereby creating more job opportunities and income sources. On the other hand, through RIC, the thorough processing and marketing of agricultural products can increase their market value, thus increasing farmers' income. By developing the agricultural product processing industry, farmers can participate in product processing, packaging, and sales, directly sharing the value-added benefits brought of these links. Boosting the earnings of rural residents, regardless of how urban residents' income changes, alleviates the relative URI. Second, RIC can enhance the efficiency of resource allocation [30]. RIC can enhance the efficient distribution of rural resources; improve the utilization efficiency of land, labor, water, and other resources; reduce waste; and enhance economic benefits. By combining agriculture and animal husbandry, as well as planting and breeding, it is possible to achieve the circular utilization of resources, improve production efficiency, and thus increase farmers' income. During the RIC, the introduction and promotion of technological innovation can significantly improve production effectiveness and product standards. This not only helps to enhance the market competitiveness of agricultural products but also provides farmers with more technical training and employment opportunities, thereby improving their income levels. Consequently, we put forward the following hypothesis.

Hypothesis 1. *RIC can alleviate the URI.*

2.2. Indirect Effect of Rural Industrial Convergence on Urban–Rural Income Inequality

RIC can alleviate the URI by promoting the expansion of the scale of land operation. First of all, the theory of economies of scale holds that expanding the production scale can reduce costs and improve efficiency improvement. In RIC, middle and downstream enterprises, especially those in the processing industry, usually need a stable and large supply of raw materials, encouraging farmers to expand the extent of production and operations to meet the needs of processing enterprises [31]. Furthermore, during the RIC, the utilization of land resources will become increasingly varied. For example, in addition to traditional food crop cultivation, specialty agriculture and agritourism can also be conducted. This diversified land use requires a larger land scale to cater to the needs of various industries, thus facilitating the growth of land-scale operations. The theory of transboundary innovation states that technology and innovation often occur at the intersection between different industries and fields. The technology, knowledge, and methods of different industries will generate new innovations in the integration process. RIC often involves combining knowledge and technology from different fields. This cross-border convergence enables technology and innovation in various fields to interact, thereby driving the birth of new technologies. For example, the integration of agriculture and digital technology has promoted the development of agricultural big data, smart sensors, and other technologies, but applying these technologies often requires a large upfront investment, including equipment procurement, installation, maintenance, and data analysis. In the case of small-scale land operation, these technologies cannot be better applied [32], while in the case of large-scale land operations, these fixed costs can be amortized on a larger area, thus reducing the technical cost per unit of land and improving economic benefits.

Increasing the scale of land operations often leads to the realization of economies of scale, that is, reducing unit costs and improving production efficiency through large-scale production [33]. The enlargement of the land operation scale is usually accompanied by an increase in land demand. Farmers can participate in more economic activities through land transfer and enterprise-oriented operations, thus increasing their income sources and alleviating the URI. The enlargement of the scale of land operation creates more employment opportunities. For example, large-scale agricultural production and the associated agricultural industry chain require a large amount of labor, thus creating additional job opportunities for rural workers [34]. This increase in employment opportunities will help reduce rural poverty and raise income levels, thus alleviating the URI. Therefore, we propose the following hypothesis.

Hypothesis 2. *RIC can alleviate the URI by expanding the scale of land operation.*

2.3. Moderating Effect of Rural Industrial Convergence on Urban–Rural Income Inequality

Due to the increasingly severe global environmental challenges and limited energy resources, as well as the need for energy security, green development has received increasing attention from the government. First, when the government pays high attention to green development, it usually provides more financial subsidies and investments [35]. These financial supports help enterprises and farmers related to RIC to reduce early investment and operating costs, reduce the financial pressure on enterprises and farmers, and promote RIC more smoothly. For example, governments may subsidize green agriculture programs to help farmers buy advanced water-saving irrigation systems and organic fertilizers, among other things. These financial aids can greatly lower the initial investment costs for farmers, alleviate the problem of capital shortage in the initial stage of rural industrial convergence, speed up the process of RIC, improve farmers' income, and effectively alleviate the URI. Second, the government's concentration on green development is usually accompanied by investment in technical support and training [36,37]. Providing technical training and knowledge support to farmers and related enterprises can significantly enhance their technical skills and management capabilities, providing technical and talent support for RIC, thus reducing the URI. Moreover, based on the marginal productivity theory, the wage level is determined by the marginal productivity of the laborer, which refers to the additional output created by increasing one unit of labor input. When workers improve their skills, their productivity increases, enabling them to create more value in a unit of time. Therefore, their marginal productivity increases, and companies are willing to pay higher wages to obtain these additional outputs. Providing technical training for farmers not only enhances their skills but also directly boosts their income, thereby helping to reduce the URI. In addition, the government's strong focus on green development contributes to the enhancement of the market mechanism. For example, by establishing a green certification system and promoting the expansion of the green product market, the government can enhance the market attractiveness of green projects. This improvement in the market mechanism enables RIC to obtain more market opportunities, further promoting the increase in income levels, thereby alleviating the URI. Therefore, we propose the following hypothesis.

Hypothesis 3. *The government attention to green development can positively moderate the impact of RIC on the URI.*

2.4. Nonlinear Impact of Rural Industrial Convergence on Urban–Rural Income Inequality

First, the digital economy is one where data serve as the primary production factor, and digital technology is the defining characteristic [38]. The digital economy can integrate and utilize various resource elements and scattered data [39], enhance the connectivity among all segments of the agricultural industry chain, foster the ongoing development of RIC, boost farmers' incomes, and reduce the URI. However, when the development level of the digital economy does not exceed a certain threshold, the effect of RIC on the URI is relatively weak. This is because in this period, the network, electricity, transportation, and other infrastructure in rural areas are relatively backward, limiting the wide application of digital technology in rural industries and making it difficult for rural industries to deeply integrate with the digital economy so that it is challenging to successfully facilitate the RIC and reduce the URI. In addition, in this period, technology popularization in rural areas is low, and the talent reserve is relatively insufficient, which leads to the digital economy facing technical problems and talent bottlenecks during the effort to advance the RIC. It is difficult to form effective competitiveness, thus affecting the improvement in the URI. When the digital economy surpasses a specific threshold, the impact of RIC on the URI increases. This is because with the increase in national investment in rural infrastructure, the network coverage, power supply, transportation, and other infrastructure in rural areas have been significantly improved so that the digital economy can more effectively facilitate the RIC. With the convergence of the industrial chain and value chain, rural industries can form a more complete industrial system and realize resource sharing and complementary advantages, which not only enhances the overall competitiveness of rural industries but also creates additional employment opportunities and income sources for farmers, thus helping to reduce the URI. Moreover, with the swift advancement of digital platforms, platform users can obtain data and break the "information island" [40]. Farmers can rapidly improve their agricultural skills through online learning, which offers robust technical assistance for the RIC and thus continuously improves the URI.

Second, RIC is intrinsically linked to the leadership of agriculture-related enterprises, and the growth of these enterprises is closely tied to the presence of a favorable business environment. However, a good business environment is affected by political, economic, legal, and other aspects. When the business environment does not exceed a certain threshold, the government may not be able to provide sufficient policy support and administrative services to promote the RIC, which may make it difficult for agriculture and rural-related industries to obtain the necessary resources, capital, and technical support, thus limiting their development potential and the reduction in URI. Concurrently, the poor business environment may also lead to high market access barriers and an unfair competitive environment, making it difficult for agriculture and rural-related industries to enter the market or obtain fair competition opportunities. This thus weakens their ability to boost farmers' earnings and mitigate the URI through industrial convergence. When the business environment exceeds a certain threshold value, the impact of RIC on reducing URI will continue to grow. On the one hand, optimizing the business environment can promote the improvement in the market system and the openness and transparency of government decision making [41]. It is conducive to reducing potential rent-seeking behaviors and institutional transaction costs, improving transaction efficiency, and further advancing the progress of RIC. Simultaneously, the sound development of agriculture-related enterprises will create more job opportunities, attract an inflow of rural labor, optimize the allocation of labor resources, and reduce the URI. On the other hand, the optimization of the business environment is conducive to enhancing the confidence of private investment [42], easing the financial challenges faced by businesses during the RIC process, enhancing industrial competitiveness, creating a supportive environment for the growth of the rural economy, boosting farmers' income, and alleviating the URI. Therefore, we propose the following hypothesis.

Hypothesis 4. *The negative impact of RIC on the URI has a threshold effect, and this negative impact will be enhanced when the development level of the digital economy and business environment exceeds the threshold value.*

2.5. Spatial Spillover Effect of Rural Industrial Convergence on Urban–Rural Income Inequality

RIC not only effectively alleviates the URI within the province but also positively impacts neighboring provinces through various mechanisms. First, according to the demand spillover effect theory, when the demand for a product or service increases, it not only drives the sales growth of the product or service itself but also triggers an increase in demand for other related products or services. When the province promotes RIC, it increases the demand for related goods and services. For instance, the province's thriving rural tourism industry attracts a large number of tourists, which not only enhances the province's tourism-related businesses but also boosts the demand for food, accommodation, and transportation services. Agricultural product suppliers and accommodation owners from neighboring provinces can participate in the provincial market by providing related products and services, thereby increasing their income levels. Second, new technologies and management models in RIC gradually spread to neighboring areas, promoting their economic development [43]. For example, during the process of RIC, new technologies and management models introduced by the province, such as smart agriculture and e-commerce platforms, gradually spread to neighboring provinces. The mechanisms of technology diffusion include technology transfer, training, and cooperation projects. For instance, the precision seeder and automation equipment used in the province's smart agriculture initially achieved success within the province. Then, these technologies were transferred to neighboring provinces through technical exchanges and support projects, significantly enhancing the agricultural production efficiency of these areas. This diffusion of technology and knowledge not only improves the industrial level and market competitiveness of neighboring provinces but also effectively promotes the economic growth of these areas, mitigates the URI, and fosters the coordinated development of the regional economy. Finally, the economic growth pole theory states that economic growth usually forms in certain growth pole areas and affects neighboring areas through diffusion effects. When the province forms an economic growth pole through RIC, for example, by developing efficient agricultural cooperatives or successful rural tourism areas, these growth poles attract investment and economic activities, radiating to neighboring provinces, thus promoting the economic growth of neighboring provinces and reducing the URI. Therefore, we propose the following hypothesis.

Hypothesis 5. *There is a positive spatial spillover effect of RIC on the URI.*

In summary, the influence mechanism of the RIC on the URI is shown in Figure 1.

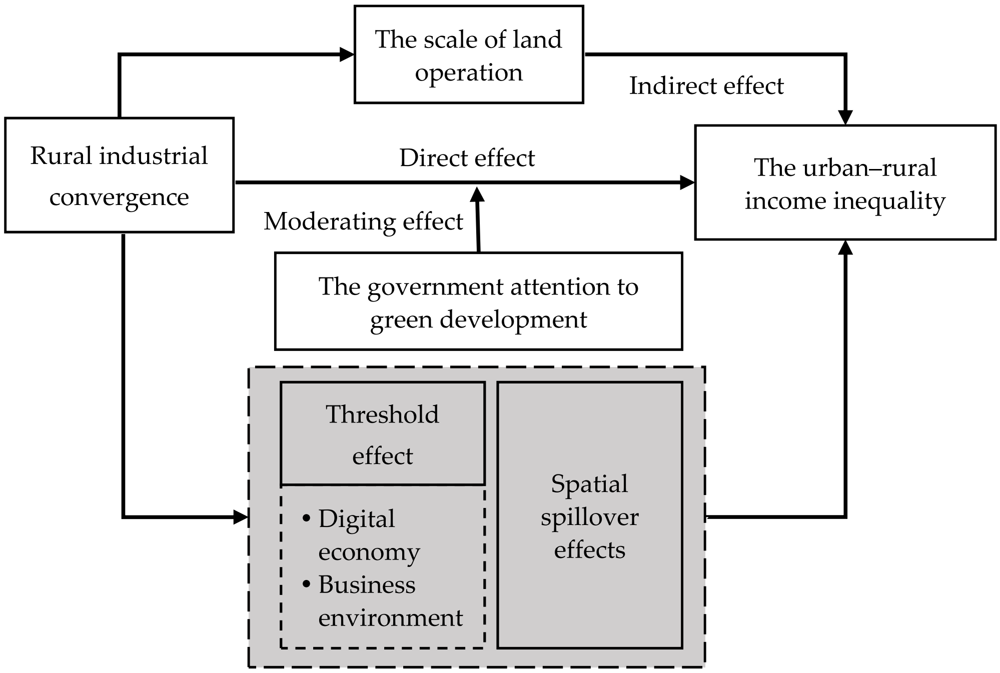

Figure 1. Research framework diagram.

3. Research Design

3.1. Model Setting

3.1.1. Benchmark Regression Model

This study categorized the effects of RIC on URI into direct and indirect impacts. It examined the direct effects of RIC on URI by developing a benchmark regression model, and formulated the following model:

$$URI_{it} = \alpha_0 + \alpha_1 RIC_{it} + \alpha_2 Control_{it} + \mu_i + y_t + \varepsilon_{it} \quad (1)$$

The explained variable URI_{it} represents the URI of province i in year t, and the core explanatory variable RIC_{it} represents the RIC of province i in year t. α_1 measures the relationship between RIC and the URI. α_1 is expected to be significantly negative, and α_0 is a constant term; $Control_{it}$ are control variables, μ_i is the provincial fixed effect, y_t is the time fixed effect, and ε_{it} represents the random error term.

3.1.2. Mediating Effect Model

From a theoretical analysis standpoint, the scale of land operation was chosen as the mediating variable, and the mediating model was established as follows:

$$M_{it} = \alpha_0 + \beta_0 RIC_{it} + \beta_2 Control_{it} + \mu_i + y_t + \varepsilon_{it} \quad (2)$$

$$URI_{it} = \alpha_0 + \alpha_1 RIC_{it} + \alpha_2 M_{it} + \alpha_3 Control_{it} + \mu_i + y_t + \varepsilon_{it} \quad (3)$$

where M_{it} is the mediating variable.

3.1.3. Moderating Effect Model

To further investigate the moderating effects of government focus on green development on the relationship between RIC and URI, interaction terms between government attention to green development and RIC are introduced individually.

$$URI_{it} = \alpha_0 + \beta_0 RIC_{it} + \beta_1 Adj_{it} + \beta_2 RIC_{it} * Adj_{it} + \beta_3 Control_{it} + \mu_i + y_t + \varepsilon_{it} \quad (4)$$

Here, Adj_{it} is the moderating variable, which refers to the government attention to green development.

3.1.4. Panel Threshold Model

To further explore whether there were nonlinear effects and the threshold conditions, the threshold regression model developed by Hansen (1999) was adopted to construct the threshold effect model of RIC on the URI.

$$\begin{aligned} URI_{it} = \alpha_0 + \beta_0 RIC_{it} \times I(Q_{it} \leq q) + \beta_1 RIC_{it} \times I(Q_{it} > q) + \beta_2 Control_{it} + \mu_i \\ + y_t + \varepsilon_{it} \end{aligned} \quad (5)$$

If only one threshold existed, then the single-threshold model (4) was used. RIC_{it} is the threshold dependent variable and the core explanatory variable, which refers to RIC. $I(\cdot)$ is the indicative function, Q_{it} is the threshold variable, q is the threshold value, β_0 is the influence coefficient of RIC on the URI when $Q_{it} \leq q$, and β_1 is the influence coefficient of RIC on the URI when $Q_{it} > q$.

$$\begin{aligned} URI_{it} = \alpha_0 + \beta_0 RIC_{it} \times I(Q_{it} \leq q_1) + \beta_1 RIC_{it} \times I(q_1 < Q_{it} \leq q_2) \\ + \beta_2 RIC_{it} \times I(Q_{it} > q_2) + \beta_3 Control_{it} + \mu_i + y_t + \varepsilon_{it} \end{aligned} \quad (6)$$

Here, q_1 and q_2 are two threshold values, and $q_1 < q_2$. These two threshold values divide the total sample into three intervals; β_0, β_1, and β_2 are the influence coefficients of RIC on the URI in three different intervals. If there are three or more thresholds, this method can be used to establish a multithreshold model.

3.1.5. Spatial Durbin Model

In order to examine the spatial spillover impact of RIC on the URI, the following model was developed:

$$\begin{aligned} URI_{it} = \beta_0 + \varphi W \times URI_{it} + \beta_1 RIC_{it} + \beta_2 Control_{it} + \eta_1 W \times RIC_{it} \\ + \sum \eta_j W \times Control_{it} + \mu_i + y_t + \varepsilon_{it} \end{aligned} \quad (7)$$

where w represents the spatial weight matrix.

3.2. Variable Selection

3.2.1. Explained Variable

This study used the Theil index to quantify the URI.

The Theil index and its calculation method were as follows:

$$Theil_{it} = \sum_{i=1}^{2} \left(\frac{I_{it}}{I_i} \right) ln \left(\frac{\frac{I_{it}}{P_{it}}}{I_i / P_i} \right) \quad (8)$$

where I_{1t} denotes the income of urban dwellers in year t, I_{2t} denotes the income of rural dwellers in year t, I_i represents the comparison of total income of urban populations to rural populations, and P_t represents the comparison of the total population of urban populations with that of rural populations.

3.2.2. Explanatory Variable

On the basis of existing relevant research [44,45], we selected 20 indicators from the six dimensions of the agricultural industry chain extension, agricultural multifunction expansion, integration of agriculture and service industry, farmers' economic income increase, and agricultural production increase to develop the evaluation index framework for assessing the level of RIC and applied the entropy method to determine the weight of each indicator. The agricultural industrial chain extension refers to the extension, intersection, and penetration of agriculture to secondary and tertiary industries. The expansion of the multifunction of agriculture refers to the integrated synergy of agricultural production with leisure tourism and resource and environmental protection in addition to stabilizing the food supply guarantee and economic and social functions of agriculture so as to give full play to the leisure and cultural functions and ecological protection functions of agriculture. The integration of agriculture and service industry refers to the integration, interaction, and coordinated development between the agriculture and the agricultural service industry, which provides intermediate services for agricultural pre-production, production, and post-production. The ultimate goal of RIC is to improve people's livelihoods, so the influence of RIC should concentrate on the increase in agricultural production and farmers' income. In rural areas, agriculture is primarily integrated with industries such as processing, tourism, and services. The processing industry includes different sectors like food, textiles, and wood processing. The tourism industry mainly encompasses agricultural sightseeing tourism, rural ecological tourism, and other related aspects. The service industry mainly includes financial services, technical services, and logistics and distribution services. The data in this study covered the convergence of agriculture with these industries, like the collaboration between agriculture and tourism (e.g., income from leisure agriculture), the collaboration of agriculture and the processing industry (e.g., revenue from agricultural processing industries), and the convergence of agriculture and the service industry (e.g., agricultural loans, agricultural insurance premium income, etc.). Table 1 displays the specific indicators.

Table 1. Evaluation index system of RIC level.

Primary Indicators	Secondary Indicators	Indicator Attribute
Agricultural industry chain extension	The primary industry's output makes up a part of regional GDP	−
	The tertiary industry's output makes up a part of the regional GDP	+
	The primary industry's workforce made up a percentage of total employment	−
	The tertiary industry's workforce made up a percentage of total employment	+
	Ratio of operating income of agricultural processing industry to output value of primary industry	+
Agricultural multi-function expansion	Operating income of agritourism	+
	Intensity of agricultural fertilizer application	−
	Comprehensive management of soil erosion area	+
	Facility agriculture area	+

Table 1. *Cont.*

Primary Indicators	Secondary Indicators	Indicator Attribute
Integration of agriculture and service industry	Agricultural loans	+
	Expenditure on agricultural, forestry, and water affairs	+
	Insurance depth	+
	Total power of agricultural machinery	+
	Rural power consumption	+
Farmers' economic income increase	Disposable income of rural residents	+
	Per capita consumption of rural residents	+
	Engel's coefficient for rural residents	−
Agricultural production increase	Total output value of agriculture, forestry, animal husbandry, and fishery	+
	Total grain output	+
	Grain yield per unit	+

Note: + signifies a positive correlation between the index value and the level of RIC, and − signifies a negative correlation between the index value and the level of RIC.

3.2.3. Mediating Variable

This study used the scale of land operation (Lan) as the mediating variable. It was measured by the area of cultivated land contracted by households. The cultivated land area contracted by households directly represents the actual land scale operated by farmers. A larger area of cultivated land usually means a wider scale of operation.

3.2.4. Moderating Variable

This study used the government attention to green development (Gre) to represent the moderating variable. Drawing on the practice in the existing literature [46], this study combined the work reports issued by the Chinese government to extract keywords related to green development to create a vocabulary related to the government's focus on green development and used the text analysis method to count the frequency of green development keywords in the government work reports to measure the government attention to green development (see Table 2).

Table 2. Thesaurus of the government attention to green development.

Ammonia Nitrogen	Energy Consumption	Master of the Lake	Lake Chief System	PM10
Pollution prevention and control	Environmental governance	Clear waters and green mountains	Waste residue	Ecology
Chief of river	River chief system	VOCs	The circular economy	Blue sky and white clouds
The ecological city	The cycle	Pollution	Intensive	Dirty and scattered
Coordinated pollution control	Local legislation	Green manufacturing	Returning farmland to forest	Fall of dust
Livable	Pure land	Water environment	Collaboration for conservation	Collaboration between departments
Household waste	Collaborative governance	Air	Transfer of funds	Joint defense
High energy consumption	Low carbon economy	Sulfur dioxide	Soil and water conservation	Clean energy

Table 2. *Cont.*

Ammonia Nitrogen	Energy Consumption	Master of the Lake	Lake Chief System	PM10
Joint governance	Low carbon	Green space	Sustainable	Win–win cooperation
Environmental inspectors	Sewage treatment	Green development	Green	Share
Emission	particulate matter	Environmental crime	Environmental quality	Afforestation
Ecological environment	Forest	Environment	Water quality	Renewing
Saving irrigation	Air quality	Environmental penalties	Greenhouse gases	Exhaust
Save	Consume	Coal to gas	Green economy	Green consumption
Air pollution	Chemical oxygen demand	Fugitive dust	Blue sky	Tree planting
Water security	Regional cooperation	Forest restoration	Industrial water saving	Environmental regulatory mechanism
Control pollution	Stay green	COD	Aquatic ecology	Ecological protective screen
Ecological damage	Environmental cases	Comprehensive watershed management	Clear water	Energy
Black odor	Pollutant	Complementary advantages	Pollution control	pollution treatment
Agricultural non-point source pollution	Virescence	Water consumption	Reduction	Reuse
Jointly promote	Central heating	Energy saving and emission reduction	Regional coordinated development	Environmental protection
Smog	Develop	New energy	Toilet revolution	Joint prevention and control
Nitrogen oxide	Illegal coal burning environment	Cut down the consumption	Afforestation	Joint control
Natural forests	Carbon dioxide	Green governance	Public participation	Ecological civilization demonstration
Waste	Natural resources	Green	Coal to electricity conversion	Environmental collaboration
Ecological protection	Environmental protection	Harmless treatment of household waste	Message	Exhaust gas
Pollution discharge	Beijing-Tianjin-Hebei	SO_2	Water conservation	Border area
Environmental impact assessment of sewage treatment	Soil	Recycle	Haze control	PM2.5
CO_2	Collaborative development	Green travel		

3.2.5. Threshold Variable

The threshold variables are the digital economy (Dig) and business environment (Bus). Based on the existing research [47–49], we selected 22 indicators from the four dimensions of digital infrastructure construction, digital industry development, industrial digitization, and digital environment construction to establish the assessment index system for the level of digital economy development (see Table 3). Digital infrastructure construction is a crucial foundation for advancing the digital economy. Digital industry mainly includes information equipment manufacturing, information software, and other related industries and services. Industrial digitization can offer a foundation for the digital transformation of economic society. Creating a digital environment provides a good supporting environment for developing the digital economy. This study calculated the weight of each indicator using the entropy method.

Table 3. Evaluation index system of digital economy.

Primary Indicators	Secondary Indicators	Tertiary Indicators	Indicator Attribute
Digital infrastructure construction	Digital network construction	Number of domain names	+
		Number of pages	+
	Construction of digital facilities	Fiber optic cable length	+
		Quantity of mobile phone base stations	+
		Internet broadband access port	+
	Digital penetration	Quantity of Internet broadband access users	+
		Mobile phone penetration rate	+
Digital industry development	Digital industry construction	Software business revenue/GDP	+
		Software products revenue/GDP	+
		Information transmission, software and information technology services Employment in urban units	+
		Total volume of telecommunication service/GDP	+
	Digital R&D investment	Number of high-tech R&D projects	+
		Funds for high-tech R&D projects	+
		Full-time equivalent of high-tech R&D personnel	+
Industrial digitization	Digitizing transactions	E-commerce sales	+
		E-commerce purchase amount	+
	Digital application	Quantity of computers used per 100 people in an enterprise	+
		Quantity of websites per 100 enterprises	+
		Proportion of enterprises with e-commerce transactions in the total number of enterprises	+
Digital environment construction	Digital skills environment	Total transaction amount of technology contracts	+
		Quantity of patent applications	+
	Digital financial environment	Digital financial inclusion index	+

Note: + signifies a positive correlation between the index value and the level of digital economy development.

Drawing on the practice in the existing literature [50–52], the business environment evaluation index system constructed in this study followed the relevant requirements in China's Regulations on Optimizing Business Environment; took the construction of a market-oriented, law-based, and international business environment as the basic principle; selected 14 indicators from the four dimensions of market environment, public service environment, internationalization environment, and legal environment; and constructed the business environment evaluation index system (see Table 4). This study calculated the weight of each indicator using the entropy method.

Table 4. Business environment evaluation index system.

Primary Indicators	Secondary Indicators	Tertiary Indicators	Indicator Attribute
Market environment	Economic development	Gross regional product	+
	Factor of labor	Total employed persons	+
		Total number of people insured for pension, unemployment, and work-related injury	+
		Total average salary of employed persons	+
	Level of technological innovation	Number of invention patent applications authorized	+
		Technical transaction volume	+
	Level of capital power	Year-on-year increase in investment in fixed assets (excluding rural households)	+
Public service environment	Traffic situation	Total cargo volume	+
	Status of education	Average number of higher education students per 100,000 population	+
	Medical condition	Quantity of beds in medical institutions per 10,000 people in urban and rural zones	+
Internationalization environment	Opening up to the outside world	Foreign-invested enterprises	+
		Total foreign investment	+
Legal environment	Judicial civilization	Number of lawyers	+
	Degree of intellectual property protection	Ratio of technology market turnover to GDP	+

Note: + signifies a positive connection between the index value and the business environment.

3.2.6. Control Variable

This study selected five control variables: (1) Rural human capital (Rur) was quantified by the average years of schooling in China. (2) Labor productivity (Lab) was expressed by the proportion of the gross product in the primary industry relative to the number of employees. (3) The degree of local government intervention (Gov) was expressed by the ratio of local fiscal expenditure to GDP. (4) The degree of marketization (Mar) was expressed by technology market turnover. (5) The upgrading of the industrial structure (Upg) was based on the percentage of the output value from the primary, secondary, and tertiary industries within the regional GDP.

3.3. Data Source and Variable Description

3.3.1. Data Sources

Taking into account the accessibility and consistency of comprehensive data, this study utilized data on agricultural and rural development, as well as URI, from 30 provinces (excluding Tibet, Hong Kong, Macao, and Taiwan) in China spanning the years 2010 to 2022. The data were chiefly sourced from the China Rural Statistical Yearbook, the National Bureau of Statistics, the China Leisure Agriculture Yearbook, the China Agricultural Product Processing Yearbook, and the provincial statistics bureau. In the process of gathering and analyzing data, the missing indicators of some years in some regions were supplemented using linear interpolation.

3.3.2. Descriptive Statistics of Variables

The variable description is shown in Table 5. There were obvious differences in the URI in different regions, and the inequality between the maximum and minimum levels of RIC was large, indicating serious regional differentiation.

Table 5. Variable description.

Name of Variable	Meaning of Variable	N	Mean	Sd	Min	Max
Variable explained	URI	390	0.0917	0.0450	0.0171	0.236
Explanatory variable	RIC	390	0.258	0.109	0.0694	0.542
Mediating variable	Lan	390	47.01	32.32	1.664	130.0
Moderating variable	Gre	390	57.21	19.47	6	124
Threshold variables	Dig	390	0.121	0.103	0.00523	0.590
	Bus	390	0.203	0.160	0.0192	0.759
Control variables	Rur	390	9.352	0.904	7.399	12.70
	Lab	390	3.272	1.762	0.506	11.45
	Mar	390	539.1	1032	0.570	7948
	Upg	390	1.125	0.647	0.494	5.297
	Gov	390	0.251	0.105	0.106	0.758

Figure 2 illustrates the findings related to RIC and URI across 30 provinces from 2010 to 2022. Throughout the study period, URI decreased in most regions, while RIC exhibited a consistent upward trend in most regions.

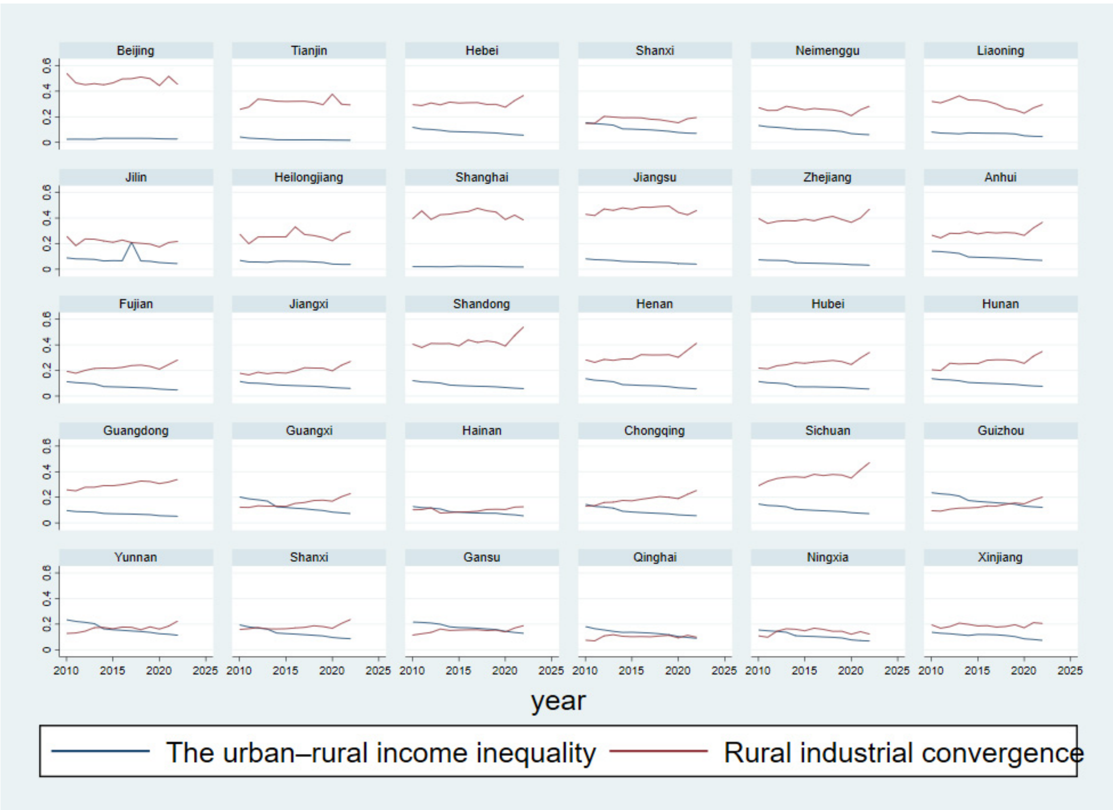

Figure 2. Trend graph of the URI and the RIC.

4. Empirical Results and Analysis

4.1. Benchmark Regression

Table 6 displays the outcomes of the benchmark regression analysis. With a regression coefficient of −0.14633, RIC showed a statistically significant negative influence on URI, passing the 1% significance test. Thus, Hypothesis 1 was verified.

Table 6. Benchmark regression.

	URI
RIC	−0.14633 *** (0.03532)
Rur	−0.00354 (0.00462)
Lab	0.00137 (0.00168)
Tec	0.00001 *** (0.00000)
Upg	0.00009 (0.00111)
Gov	0.07719 ** (0.03392)
_cons	0.17327 *** (0.04325)
N	390
R^2	0.765

Note: *** $p < 0.01$, ** $p < 0.05$; standard errors are in parentheses.

4.2. Robustness Test

4.2.1. Replacing the Explained Variable

The disposable income ratio of urban residents to that of rural residents was utilized as a substitute for the Theil index, with the findings presented in column 1 of Table 7. The coefficient of RIC was significantly negative at the 10% level and consistent with the conclusions above, indicating that this robustness test was passed.

Table 7. Robustness test.

	(1)	**(2)**	**(3)**
	URI	**URI**	**URI**
RIC	−0.43100 * (0.24611)	−0.15688 ** (0.05712)	−0.14604 *** (0.03652)
_cons	2.68849 *** (0.16253)	0.24675 *** (0.03699)	0.16534 *** (0.04266)
Control variables	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
N	390	338	390
R^2	0.900	0.794	0.765

Note: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$; standard errors are in parentheses.

4.2.2. Excluding Municipalities

Unlike other prefecture-level cities, China's municipalities are directly managed by the central government and have special urban function orientation and priority support policies. To eliminate the potential influence of administrative levels on the results, this study excluded the four municipalities of Beijing, Chongqing, Tianjin, and Shanghai and performed a re-estimation test. The results are shown in column 2 of Table 7, which shows that the coefficient of RIC was still significant.

4.2.3. Winsorization Test

In the regression process, the abnormal distribution of values may have a certain impact on the estimated results. To maintain the integrity of the regression results, the main explanatory variable was winnowed at the level of 1%, and the remaining data were regressed again. The findings are presented in column 3 of Table 7. The coefficient of RIC was significantly negative at the 1% level, meaning that the estimation results were robust and unaffected by abnormal data.

4.3. Endogeneity Test

The benchmark regression analysis reveals that RIC aided in addressing URI, yet the result may be influenced by endogenous bias. First, there may be missing variables in the estimation, which may lead to bias in the estimation results. Second, there was some reverse causality between the two. Considering the omitted variables and reverse causality problems in the estimation, instrumental variables were used to conduct the endogeneity test.

Drawing on the relevant literature [16], this study used the lagged one-period RIC (L.RIC) as an IV fulfilled the relevance requirement through its connection with RIC. At the same time, the explanatory variable with a first-order lag had already occurred and was not correlated with the current error term, thus meeting the exogeneity requirement of the instrumental. Table 8 presents the results obtained from the re-regression conducted using the 2SLS method. The regression results showed that the effect of RIC on alleviating the URI was established and significant at 1%. The p values of Kleibergen–Paaprk LM statistics were 0.000, indicating that the hypothesis that instrumental variables were not identifiable was strongly rejected. The values of the Kleibergen–Paaprk Wald F statistics were 35.68, which was greater than 16.38, indicating that weak instrumental variables did not exist. The findings from the tests above confirming that the RIC alleviated the URI were still valid, and the selected instrumental variables were reasonable and effective.

Table 8. Endogeneity test.

	(1) **RIC**	**(2)** **URI**
RIC		−0.21389 *** (0.06097)
L.RIC	0.54337 *** (0.05525)	
_cons	0.14295 (0.10311)	0.05465 (0.06382)
Kleibergen–Paaprk LM		31.78 (0.0000)
Kleibergen–Paaprk Wald F		35.68 (16.38)
Control variables	Yes	Yes
Province fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
N	390	390
R^2	0.973	0.929

Note: *** $p < 0.01$; standard errors are in parentheses.

4.4. Indirect Effects Analysis

The results of the regression analysis are presented in Table 9. The coefficient of RIC in column 1 of Table 9 was significantly positive at the level of 1%, indicating that RIC could promote the expansion of the scale of land operation. According to the regression results, the coefficient of the scale of land operation in column 2 of Table 9 is significantly negative at the level of 1%, indicating that the scale of land operation was an important path by which RIC could influence the URI. The regression results validated Hypothesis 2.

Table 9. Indirect effect test.

	(1) Lan	(2) URI
RIC	68.83632 *** (17.30796)	−0.11440 *** (0.03773)
Lan		−0.00046 *** (0.00016)
_cons	16.25973 (33.03800)	0.17281 *** (0.04076)
Control variables	Yes	Yes
Province fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
N	390	390
R^2	0.439	0.778

Note: *** $p < 0.01$; standard errors are in parentheses.

To enhance the robustness of the mediating effect results, a bootstrap test was conducted, and the findings presented in Table 10 confirmed the mediating effect of the scale of land operations.

Table 10. Bootstrap test.

	Lan
_bs_1	[−0.0488335, −0.0137244]
_bs_2	[−0.1732048, −0.0569011]
N	390

4.5. Moderating Effect Analysis

The interaction terms of RIC and the government attention to green development were significantly positive at the significance level of 10% in Table 11, indicating that the government attention to green development could strengthen the reduction in URI driven by RIC, which confirmed Hypothesis 3.

Table 11. Moderating effect test.

	URI
RIC	−0.13149 *** (0.03966)
RIC × Gre	0.00310 * (0.00164)
Gre	−0.00016 ** (0.00006)
_cons	0.28906
Control variables	Yes
Province fixed effect	Yes
Time fixed effect	Yes
N	390
R^2	0.734

Note: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$; standard errors are in parentheses.

4.6. Heterogeneity Analysis

4.6.1. Time Heterogeneity Analysis

In 2015, the State Council issued the Guiding Opinions on Promoting Rural industrial convergence, according to which this study divided the samples into those before and after the policy promulgation. In order to ensure the number of samples, this study introduced the interaction term between RIC and virtual variables (Soe) and conducted regression. Among them, the virtual variables were 0 and 1, set to 0 when the time was before 2015 and set to 1 when the time was after 2015. Table 12 shows that after the introduction of the policy, the interaction term's coefficient between RIC and virtual variables was 0.08157, indicating that the policy could strengthen the reduction in URI driven by RIC. This was because before the introduction of the policy, RIC lacked a clear definition and policy guidance, and RIC was mostly in the stage of spontaneous exploration, and all aspects were not mature enough. After the policy was issued, the strong support policies issued by the central government and the strong implementation of local governments helped to accelerate the speed of RIC and improve the depth and breadth of integration. Therefore, the influence of RIC on URI would be more significant after the introducing the policy.

4.6.2. Regional Heterogeneity Analysis

RIC is built on agriculture, and the natural environment and economic development are important factors affecting agricultural production. In this study, according to the natural climatic conditions, geographical location, and economic development, China was categorized into two regions: the eastern region and the midwestern region. The regression results are shown in Table 13, we can see that compared with the eastern regions, the RIC in the midwestern regions had a greater effect on reducing URI. This was because the eastern region is highly populated and economically developed, and its development pays greater attention to the secondary and tertiary industries. In addition, the population quality in economically developed areas is relatively high, and the urban–rural income inequality is not as large as in other areas. Therefore, the effect of RIC on bridging the URI was somewhat limited. Compared with the eastern regions, the economic base of the midwestern regions was comparatively underdeveloped, where traditional agriculture occupied an important position and the marginal effect of economic benefits and income growth brought about by RIC was more obvious. At the same time, the midwest regions had rich natural resources, such as land and minerals, which offered a solid material foundation for RIC. Through rational development and utilization of these resources, it contributed to advancing the development of RIC, increasing farmers' income and reducing the URI. In addition, in recent years, the state and local governments have also increased their attention to the development of the midwestern regions. By implementing a range of preferential policies and measures, it helps create a favorable policy environment for RIC and fosters its development in the central and western regions, thereby reducing the income disparity between urban and rural areas.

Table 12. Time heterogeneity test.

	URI
RIC	−0.19378 *** (0.03400)
RIC × Soe	0.08157 *** (0.02212)
_cons	0.19763 *** (0.03483)
Control variables	Yes
Province fixed effect	Yes
Time fixed effect	Yes
N	390
R^2	0.788

Note: *** $p < 0.01$; standard errors are in parentheses.

Table 13. Regional heterogeneity test.

	East	Midwest
	URI	**URI**
RIC	−0.05208 (0.03977)	−0.16696 * (0.07952)
_cons	0.00087 (0.04803)	0.23695 *** (0.05227)
Control variables	Yes	Yes
Province fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
N	143	247
R^2	0.817	0.795

Note: *** $p < 0.01$, * $p < 0.1$; standard errors are in parentheses.

4.6.3. Regression of Quantiles

In Table 14, the results are provided, with columns 1–5 presenting the regression results at the 10%, 25%, 50%, 75%, and 90% quantiles, respectively. The impact of the RIC on the URI presented different results under different quantiles. With the increase in quantiles, the reducing effect of the impact of RIC on the URI showed an inverted "U"-shaped feature that first increased and then decreased. The possible reason for this was that in areas with low levels of RIC, the development of rural secondary and tertiary industries was relatively lagging, and the reduction effect of RIC on the URI was inhibited. In areas where RIC was at a high level, resource utilization often reached a relatively stable state, and the influence of RIC in alleviating the URI became weak. Therefore, in regions with a mid-range level of RIC, RIC played the greatest role in alleviating URI.

Table 14. Quantile regression results.

	(1) URIQ10	(2) URIQ25	(3) URIQ50	(4) URIQ75	(5) URIQ90
RIC	−0.03324 *** (0.01103)	−0.09610 *** (0.02448)	−0.09627 *** (0.03049)	−0.06167 ** (0.02723)	−0.03400 (0.04601)
_cons	0.05051 ** (0.02134)	0.06544 (0.04736)	0.07937 (0.05899)	0.08077 (0.05268)	0.13217 (0.08901)
Control variables	Yes	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
N	390	390	390	390	390

Note: *** $p < 0.01$, ** $p < 0.05$; standard errors are in parentheses.

4.7. Threshold Result Regression

The threshold effect was tested through the bootstrap method. Stata 17 statistical software was used to repeat the sampling 500 times, and the single-, double-, and triple-threshold tests were carried out successively. The threshold effect test results are shown in Table 15.

Table 15. Threshold effect test results.

Variable	Number	F Value	p Value	Critical Value		
				1%	5%	10%
Dig	Single	57.89	0.0600	48.9150	35.7967	28.1693
	Double	13.54	0.1900	36.7157	28.8245	23.7774
	Three	7.20	0.9240	35.2223	25.7029	21.2802

Table 15. *Cont.*

Variable	Number	F Value	*p* Value	Critical Value		
				1%	5%	10%
Bus	Single	22.23	0.0980	39.2870	26.5931	22.2019
	Double	6.30	0.8040	39.2855	25.2045	20.8984
	Three	6.32	0.8000	37.5281	24.9295	20.5879

It can be seen from the above table that when digital economy and business environment were used as threshold variables, the conclusions derived from this were as follows: in the single-threshold model, the F statistic was significant at least at the level of 10%, that is, the *p* value was less than 0.10, so there was a single threshold value in the model, and Table 16 shows the threshold value estimation results.

Table 16. Threshold value estimation results.

Variable	Threshold Value	Con	95% Confidence Interval
Dig	0.0534	−0.91540	(−0.1947464, −0.0653961)
Bus	0.0971	−1.12942	(−0.2024430, −0.0702375)

Figure 3 shows the LR diagram with the digital economy as the threshold variable, and Figure 4 shows the LR diagram with the business environment as the threshold variable. The lowest point of the LR statistic corresponds to the true threshold value, and the dotted line below refers to the threshold interval corresponding to the critical value under the significance level of LR less than 5%.

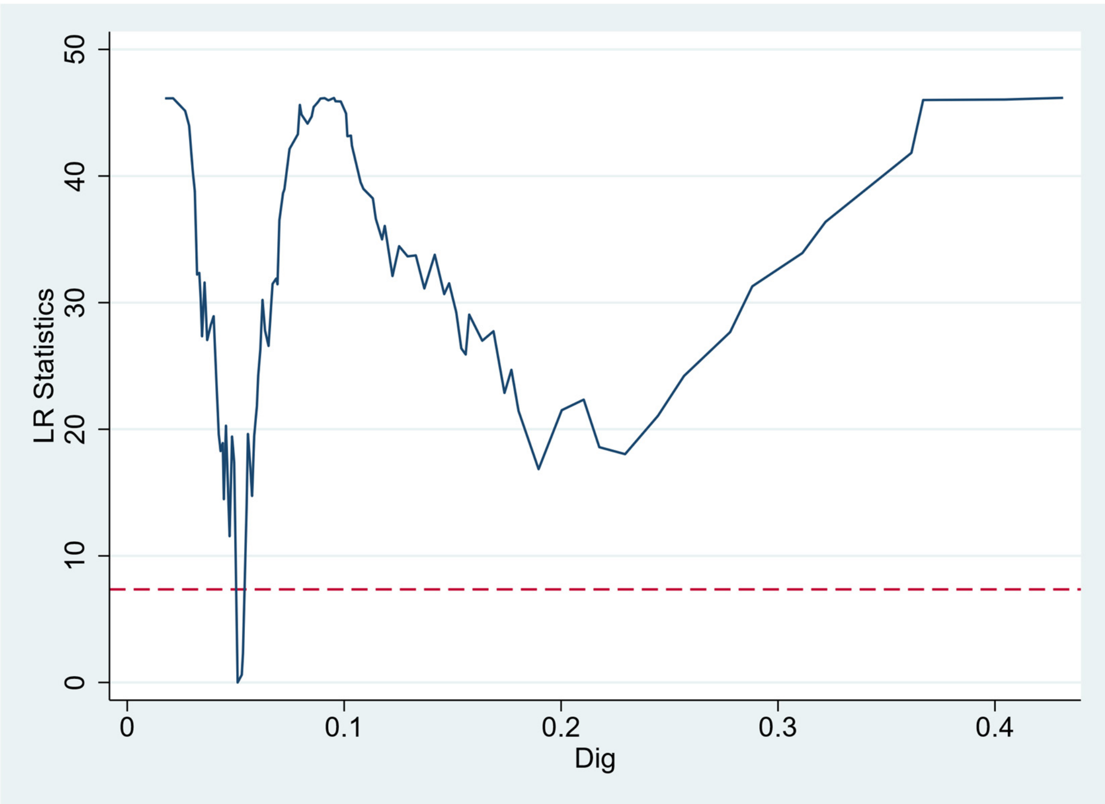

Figure 3. LR diagram of the digital economy.

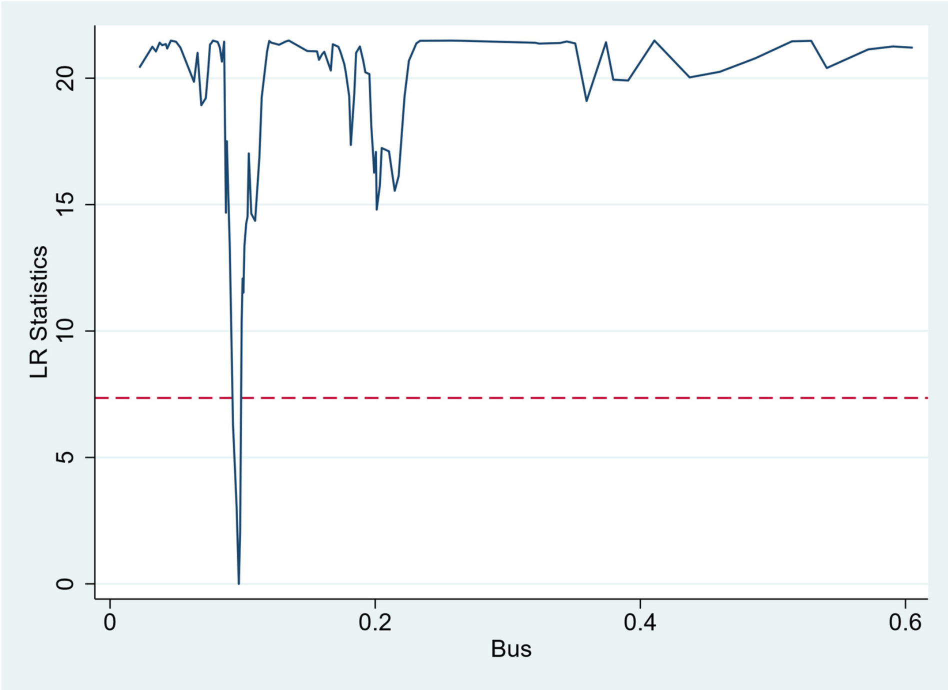

Figure 4. LR diagram of business environment.

Table 17 provides the single-threshold regression outcomes with the level of digital economy development and business environment as threshold variables. When the level of digital economy development was less than 0.0534, the impact of RIC on the URI was not significant. However, when the level of digital economy development was greater than 0.0534, the coefficient value was −0.12824, which was significant at the 1% level, indicating that as the level of digital economy development continued to increase, the role of RIC in alleviating URI gradually increased. Similarly, when the level of the business environment was less than 0.0971, the coefficient value was −0.05317, which was significant at the 10% level. When the level of the business environment was greater than 0.0971, the coefficient value was −0.13419, which was significant at the 1% level, indicating that as the business environment improved, the role of the RIC in the URI also gradually increased. The regression results verified Hypothesis 4.

Table 17. Threshold regression results.

	(1) URI	(2) URI
RIC × I (Dig ≤ 0.0534)	−0.06654 (0.03990)	
RIC × I (Dig > 0.0534)	−0.12824 *** (0.03261)	
RIC × I (Bus ≤ 0.0971)		−0.05317 * (0.02907)
RIC × I (Bus > 0.0971)		−0.13419 *** (0.03342)
_cons	0.43718 *** (0.05793)	0.48453 *** (0.05360)
Control variables	Yes	Yes
Province fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
N	390	390
R^2	0.667	0.662

Note: *** $p < 0.01$, * $p < 0.1$; standard errors are in parentheses.

4.8. Spatial Effect Analysis

Table 18 displays the results. Moran's I of RIC and the URI in each province under the adjacency distance weight matrix and economic geography matrices was positive, and all passed the significance test at the level of 5%, indicating that there was an obvious spatial correlation between RIC and the URI in each province. Thus, it was reasonable to select the spatial econometric model for empirical research.

Table 18. Moran's I.

Year	RIC			URI			RIC			URI		
	I	Z	*p*	I	Z	*p*	I	Z	*p*	I	Z	*p*
2010	0.386	3.441	0.001	0.544	4.710	0.000	0.147	5.179	0.000	0.187	6.296	0.000
2011	0.390	3.444	0.001	0.537	4.654	0.000	0.135	4.809	0.000	0.181	6.124	0.000
2012	0.420	3.668	0.000	0.538	4.666	0.000	0.158	5.418	0.000	0.180	6.108	0.000
2013	0.355	3.139	0.002	0.538	4.671	0.000	0.145	5.052	0.000	0.179	6.082	0.000
2014	0.374	3.296	0.001	0.540	4.708	0.000	0.143	5.020	0.000	0.180	6.140	0.000
2015	0.375	3.310	0.001	0.558	4.846	0.000	0.141	4.967	0.000	0.179	6.101	0.000
2016	0.334	2.981	0.003	0.555	4.824	0.000	0.126	4.532	0.000	0.176	6.022	0.000
2017	0.365	3.239	0.001	0.302	2.808	0.005	0.130	4.655	0.000	0.070	3.054	0.002
2018	0.344	3.073	0.002	0.544	4.747	0.000	0.121	4.403	0.000	0.171	5.908	0.000
2019	0.333	2.987	0.003	0.529	4.640	0.000	0.108	4.056	0.000	0.170	5.897	0.000
2020	0.388	3.405	0.001	0.496	4.380	0.000	0.135	4.779	0.000	0.166	5.789	0.000
2021	0.274	2.502	0.012	0.496	4.382	0.000	0.099	3.767	0.000	0.165	5.752	0.000
2022	0.260	2.383	0.017	0.490	4.340	0.000	0.087	3.433	0.001	0.160	5.617	0.000

The following formula was used to calculate the global Moran's I:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\left(Y_i - \overline{Y}\right)\left(Y_j - \overline{Y}\right)}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \tag{9}$$

where I is the index; S^2 represents the sample variance; Y_i and Y_j represent the URI or the level of RIC in the ith and jth regions, respectively; $\overline{Y}$ is the mean value; n represents the entire number of regions; and W_{ij} represents the spatial weight matrix. If Moran's I was significant, i_t proved that this variable had global spatial correlation.

Then, the optimal model for evaluating the spatial effect of RIC on the URI was determined using Lm, Hausman, LR, Wald, and fixed effect LR tests. As illustrated in Table 19, first, the *p* values after the LM test and robust LM test all passed the 10% significance level test, indicating the existence of a spatial error effect and spatial lag effect and initially selecting the spatial Durbin model. Second, as the Hausman test value rejected the null hypothesis at the level of 1%, it was preliminarily determined that the selected model was a fixed effect model. Then, based on the fact that both LR and Wald test values significantly rejected the null hypothesis at the level of 1%, it was further determined that SDM was the selected basic spatial model, and SDM could not degenerate into the SAR model or SEM model. Finally, it was determined that the null hypothesis was significantly rejected by the LR test values of fixed effects at the level of 1%, and the dual-fixed spatial SDM was the final selected spatial model.

Spatial Durbin model regression analysis was performed using the adjacency distance weight matrix and economic geography matrices, and the outcomes are detailed in Table 20. Columns 1–6 represent the direct effect, indirect effect, and total effect, respectively, of the influence of RIC on the URI. Among them, columns 1–3 are regression based on the adjacency distance weight matrix, while columns 4–6 are regression based on economic geography matrices. In columns 3 and 6, the rho coefficient is 0.38859 and 0.42904, indicating that there was a significant spatial relationship between RIC and the URI. Regarding the direct effect and the total effect, the impact of RIC on the URI was significantly negative at the level of 1%, indicating that RIC had an alleviating effect on the URI in this province and the whole country. The coefficient of RIC in columns 2 and 5 was negative at the significance level of 1%, indicating that the RIC in this province had a significant impact on the URI in surrounding provinces and cities. Thus, Hypothesis 5 was confirmed.

Table 19. Test results of spatial effect model selection.

Method of Inspection	Value of Statistics	*p*	Value of Statistics	*p*
LM test, no spatial error	54.083	0.000	22.669	0.000
Robust LM test, no spatial error	12.846	0.096	11.663	0.001
LM test, no spatial lag	109.698	0.000	14.584	0.000
Robust LM test, no spatial lag	68.461	0.000	3.577	0.059
Hausman	326.92	0.000	24.27	0.0001
Wald test for SAR	29.18	0.0000	20.75	0.0004
Wald test for SEM	48.70	0.0000	50.85	0.0000
LR test for SDM-SAR	29.47	0.0000	36.71	0.0000
LR test for SDM-SEM	47.96	0.0000	48.55	0.0000
LR test both ind	63.69	0.0000	39.54	0.0000
LR test both time	629.89	0.0000	598.82	0.0000

Table 20. Spatial effect test results.

	URI			URI		
	(1)	(2)	(3)	(4)	(5)	(6)
	Direct Effect	Indirect Effect	Total Effect	Direct Effect	Indirect Effect	Total Effect
RIC	−0.08043 *** (0.02786)	−0.41135 *** (0.07599)	−0.49178 *** (0.08418)	−0.12236 *** (0.02915)	−1.01198 *** (0.34316)	−1.13434 *** (0.35418)
rho			0.38859 *** (0.05918)			0.42904 *** (0.12410)
sigma2_e			0.00010 *** (0.00001)			0.00011 *** (0.00001)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	390	390	390	390	390	390
R^2	0.060	0.060	0.060	0.416	0.416	0.416

Note: *** $p < 0.01$; standard errors are in parentheses.

5. Discussion

This study used China's inter-provincial panel data from 2010 to 2022 to measure RIC and URI using the entropy method and the Theil index, respectively, and empirically tested the influence of RIC on the URI and its mechanisms. Similar to previous studies, the research findings confirmed that the RIC contributed to alleviating the URI [53]. Additionally, previous studies have suggested that the influence of RIC on enhancing farmers' earnings [30,54,55] and alleviating URI exhibits spatial effects. This study demonstrated the existence of spatial effects in the alleviation of URI through RIC, consistent with previous research. However, compared with prior studies, which have primarily concentrated on factors such as urbanization [19] and technological advancement [56] in path analysis, this study took the perspective of land factors and verified that by expanding the scale of land operation, RIC effectively promoted the improvement in agricultural production efficiency, thereby reducing the income disparity between urban and rural regions. It is noteworthy that the government held an important position in the process of alleviating URI through

RIC. Direct government support for RIC enhanced its influence on alleviating the URI. Second, regarding the analysis of regional heterogeneity, previous studies have divided China into the eastern, central, and western regions and have suggested that the influence of RIC in alleviating the URI is smaller in the eastern region, greater in the central region, and the smallest in the western region [16]. However, since this study used provincial-level data, dividing China into eastern, central, and western regions would result in too small a sample size, potentially undermining the validity of the empirical results. Moreover, the central and western regions share similar characteristics in terms of economic development level, industrial structure, and urban–rural income inequality. Therefore, combining the central and western regions is reasonable. While it is not possible to directly compare the eastern, central, and western regions, a comparison between the eastern region and the combined central–western region still provides insights into the varying effects of RIC on the URI. This study found that the influence of RIC on the URI was more pronounced in the midwestern region. Even if the midwestern region lacks economic and geographical advantages, it can still compensate for this disadvantage through human factors. This study suggests that the influence of RIC on the URI in China's midwestern region cannot be separated from strong government support. Countries like Saudi Arabia and Kazakhstan, which have economic and geographical conditions similar to those in China's midwestern region, can take a central role in steering the development of RIC, thereby enhancing farmers' earnings and alleviating URI. In addition, previous studies have suggested that the spatial spillover effect of RIC on the URI is influenced by geographical factors. This study revealed that the spatial spillover effect of RIC on the URI was influenced not only by geographical factors but also by economic factors. With the dual influence of geography and economy, the spatial spillover effect of RIC on the URI becomes more pronounced. This study suggests that promoting RIC requires coordinating various resources, integrating geographical and economic advantages, and leveraging spatial spillover effects to achieve higher agricultural income growth and alleviate URI. Building on previous research, this study also conducted further analysis and enrichment. First, the effect of RIC had a threshold effect. With the development of the digital economy and the optimization of the business environment, this threshold effect gradually increased. However, this threshold effect could only be realized when the digital economy and business environment reached a certain "critical point". The digital economy relies on the widespread coverage of infrastructure, particularly the proliferation of technologies like the internet, smart devices, and the Internet of Things (IoT). In rural areas, the internet and smart devices provide farmers with access to digital platforms, while IoT applications can help agriculture achieve precision management, thus promoting RIC. The widespread coverage of digital infrastructure lays the foundation for the threshold effect. However, the mere deployment of digital infrastructure does not necessarily trigger the threshold point. The extent of digital economic applications and the speed of digital technological innovation play a vital role in this process. Only when the breadth of digital applications covers all aspects of agriculture can a fundamental transformation in agricultural production methods be achieved, fostering cross-sector integration between agriculture, manufacturing, services, and other industries. This, in turn, triggers the threshold point, enhancing the role of RIC in alleviating URI. The speed of digital technological innovation determines whether rural areas can engage with the digital economy and integrate into its ecosystem at an early stage. If digital technological innovation proceeds rapidly, rural areas will gain early access to new technologies, enabling them to trigger the threshold effect sooner, leading to deeper convergence of rural industries and driving economic benefits, thus alleviating the disparity in income between urban and rural areas. The optimization of the business environment, on the other hand, depends more on the transparency of government policies, the fairness of regulatory enforcement, and the optimization of administrative procedures. The stability and transparency of government policies are crucial for investments in agricultural enterprises. When government policies are stable, transparent, and long-term, these enterprises are more inclined to invest resources in promoting rural industrial convergence, laying the foundation for triggering the threshold point. Furthermore, simplified administrative procedures and low transaction costs are key factors in triggering the "threshold point" of the business environment. RIC often involves multiple sectors, and simplified approval processes can accelerate cross-sector collaboration between agriculture, manufacturing, and services, removing investment barriers and triggering the threshold point, thus enhancing the role of RIC in alleviating URI. In regions with more advanced digital infrastructure and mature market mechanisms, the digital economy and a favorable business environment can trigger the threshold point earlier. However, in areas with relatively lagging digital infrastructure and technology adoption, as well as poor business environments, the threshold effect may require more policy intervention and time accumulation to be activated. Therefore, policies should adopt different strategies based on the stage of development of digital economy and business environment in different regions. In the early stage, the focus should be on building infrastructure, popularizing digital technologies, enhancing the digital skills of farmers and enterprises, and simplifying approval processes. In the later stages, greater emphasis should be placed on accelerating the innovation and implementation of digital technologies, while continuing to optimize the business environment to ensure the stability and transparency of policy execution. Through this multi-stage policy approach, different regions can smoothly trigger the "threshold effect" at different stages of development. Second, the government attention to green development can positively moderate the impact of RIC on the URI. Green development policies not only promote environmental protection and resource utilization efficiency but also enhance the skills level of rural residents, which to some extent enhances the alleviating effect of RIC on the URI. Overall, this research enriches the study of the relationship between RIC on the URI, providing valuable empirical evidence for policy formulation.

6. Conclusions and Policy Recommendations

Based on the balanced panel data of 30 provinces in China from 2010 to 2022, this study empirically tested the impact of RIC on the URI and its mediating, threshold, and spatial spillover effects. The main conclusions are as follows: (1) RIC has a significant effect on alleviating URI. (2) The scale of land operation is an important mechanism of transmission for RIC to alleviate URI. (3) The government attention to green development can positively moderate the impact of RIC on the URI. (4) The alleviating effect of RIC on the URI has a nonlinear relationship. As the digital economy continues to evolve and the business environment continues to optimize, the role of RIC in alleviating URI has gradually strengthened. (5) RIC has significant spatial spillover effects on adjacent regions. RIC can alleviate the URI not only in a single province but also in surrounding provinces. Based on the above research conclusions, in order to give full play to RIC and continuously alleviate URI, this study proposes the following policy recommendations.

First, RIC is a valuable way to increase the financial resources of farmers, and we should improve the level of RIC in various ways to tap into the potential of farmers' income growth. First, we should continue to consolidate rural infrastructure construction; strengthen rural transportation, energy, water conservancy, and communication infrastructure construction; and lay a foundation for RIC to improve efficiency and quality. At the same time, we should rationally distribute rural cultural and recreational facilities to create an ecological and livable environment. We will build high-quality specialty products and regional brands; develop moderately large-scale production and operation; guide farmers to obtain property income through land equity under the organization of cooperatives; encourage farmers to take part in the processing and production of enterprises; and obtain wage income through employment, expand farmers' income channels, and constantly alleviate URI.

Second, differentiated RIC policies should be formulated based on regional characteristics. In the eastern regions, policies should focus on improving the quality of industrial convergence; enhancing the deep integration of rural industry; and opening up more income channels through emerging industries such as agricultural branding, rural e-commerce, and agricultural tourism, thereby alleviating URI. In the central and western regions, the policies should prioritize infrastructure development, resource utilization, and industrial diversification. First, there should be increased investment in infrastructure to improve economic links between rural and urban areas and external markets, enhancing RIC and increasing farmers' incomes. Second, the government should promote industries that integrate local resources, such as green agriculture and ecological tourism, to increase agricultural added value, create employment opportunities, and alleviate URI.

Third, the government's focus on green development can positively moderate the impact of RIC on the URI, reflecting the important role of green development strategies in promoting balanced economic development between urban and rural areas. To utilize this strategy more effectively, the government can take the following measures: First, formulate and improve green industry policies, clarify the direction of green industry development, and develop green industry development plans that are in line with local conditions by combining the resource endowments and ecological environment characteristics of rural areas. This can clarify development priorities and support areas, promote RIC, and further alleviate the URI. Second, the government can strengthen policy advocacy and guidance and popularize the concept of green development: the latter can be achieved through media publicity, education and training, etc., to improve farmers' and all sectors of society's understanding and recognition of green development. This can expand farmers' market scope and increase income, thereby alleviating URI.

Fourth, the digital economy and business environment produce the alleviating effect of RIC on the URI. Policies should be tailored to the development stages of the digital economy and business environment in different regions. In the early stage, the government should focus on investing in rural internet infrastructure to ensure that farmers and agricultural enterprises can access digital platforms. Additionally, the government should streamline the registration and approval processes for agricultural enterprises, providing green channels to reduce administrative barriers, further promoting RIC, and enhancing farmers' income growth potential, thereby alleviating URI. In the later stages, policies should strengthen support for the digital transformation of the entire agricultural value chain, improving agricultural production efficiency and the added value of products, thereby increasing farmers' income and alleviating URI. At the same time, the government should continue to optimize the business environment by simplifying administrative approvals, reducing tax burdens, and attracting external capital and venture investments into the agricultural sector. This will promote deeper integration of rural industries with modern industries, create more employment opportunities, and help farmers increase their income through both employment and entrepreneurship, further alleviating URI.

Finally, RIC will have spatial effects on the URI in the province and surrounding areas. The agglomeration effect of areas with high levels of RIC should be fully utilized, the mechanism for sharing benefits through cross-regional cooperation should be improved, and the diffusion effect of RIC activities within the region on other regions should be enhanced. Simultaneously, it is important to enhance the RIC between regions. Multiple provinces, regions, and cities can jointly create a batch of famous regional characteristic brands, improve product awareness and influence, provide farmers with more full employment opportunities and entrepreneurial conditions, broaden income channels, and alleviate income inequality.

This study confirms the role of RIC in alleviating URI, which has important practical significance. However, there are still some issues worthy of further research in this study. First, the overall research idea of this article was still to increase farmers' income and alleviate the URI. The URI provides not only a comparison of total income but also a comparison of growth rates. This study did not study this comprehensively enough. Second, the analysis of the intermediary mechanism was not comprehensive enough. Although this study revealed that RIC alleviated the URI by expanding the scale of land operation, the discussion on the specific path and detailed process of this mechanism was still insufficient. In addition, factors include capital, labor, etc., while this study only analyzed the land factor and did not investigate other possible intermediary mechanisms, which limited the understanding of the comprehensive mechanism of RIC from the perspective of factors. Third, the exploration of the mechanism of spatial spillover effect was insufficient. Although RIC had a positive spatial spillover effect on the URI, the specific mechanism and manifestation of this effect still require further research. In future research, a more detailed theoretical model can be constructed, and various empirical methods can be adopted to comprehensively analyze the intermediary mechanism of RIC in alleviating the URI. In particular, the role of capital and labor factors in this process can be explored to reveal a more complex action chain. Second, future research can further explore the spatial spillover effect, especially how this effect works through resource flow, market linkage, and technology diffusion between regions.

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