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Does Industrial Integration Development Drive Rural Innovation? An Empirical Study under the Perspective of Rural-urban Linkage

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Abstract: *Industrial integration development is an important feature of China's economic transformation and innovative development, and a key path to promote rural innovation and realize rural revitalization. Based on the panel data of 1,837 counties in China from 2014 to 2021, this paper applies the entropy value method and the coupled coordination degree model to measure the level of county industrial integration, and empirically explores the impact of county industrial integration on rural innovation and its role mechanism. The study finds that county industrial integration significantly improves the level of rural innovation. Mechanism analysis shows that county industrial integration promotes rural innovation by facilitating labor mobility. Heterogeneity analysis reveals that the promotion effect of county industrial integration on rural innovation is more significant in the eastern and central regions, while the effect is not significant in the western region. The findings provide theoretical support and practical basis for promoting the further development of county industrial integration and exploring the county path of rural revitalization.*

Keywords: *industrial integration, rural innovation, labor mobility*

1. Introduction

Innovation is crucial to comprehensively building a strong socialist modernization country and realizing the second hundred-year goal, so the core position of innovation is carried through all aspects of modernization construction. Promoting rural innovation can not only promote the development of rural society, but also stimulate the enthusiasm and creativity of the majority of farmers as well as all aspects, and play an important role in the implementation of the strategy of rural revitalization [1]. As a link between cities and rural areas, the county carries the main functions of developing the economy and safeguarding people's livelihoods [2]. However, the reality is that the rural innovation activity is not pleasant, so the state issued the "General Office of the State Council on supporting the entrepreneurship and innovation of people returning to their hometowns and promoting the integrated development of one, two, three industries in rural areas" (State Council [2016] No. 84), and the local authorities have responded to the central government to introduce policies that are conducive to rural innovation [3]. The introduction and implementation of this series of policies is based on the central government's great attention to the integrated development of rural primary, secondary and tertiary industries. Since 2015, the central "No. 1 document" clearly put forward the integrated development of one, two and three industries, to the central government issued the "General Office of the State Council on promoting the integrated development of one, two and three industries in rural areas" (State Council [2015] No. 93) to emphasize the integrated development of one, two and three industries, and then to the central government in 2024, "No. 1 document". "Document No. 1" continues to deepen the integrated development of one, two and three industries, in recent years, the central government has placed the integration of industry as one of the priorities of the 'three rural' work. So, with the central government attaching great importance to industrial integration, will it help the development of rural innovation? Is there any heterogeneity in the promotion effect in different regions? If industrial integration can vigorously promote rural innovation, what is the mechanism? Analyzing the above questions is of indisputable significance in exploring the ways to promote rural innovation from the county level.Why is this problem important?

As an important driving force for the development of the economy and the times, rural innovation

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has received widespread attention. Based on the frequency of the word “innovation” in the document, Liu Bin et al. [4] suggested that the position of rural innovation policy in the No.1 Document of the Central Government from 2004 to 2023 has become more and more important. Ruan Jianqing et al [1] constructed a comprehensive evaluation index system of rural innovation based on four dimensions: technological innovation, brand innovation, green innovation and digital innovation. Jia Nan and Li Yin [5] constructed an evaluation index system of Chinese innovation based on the concept and theory of innovation, with innovation environment, innovation input, innovation output, and innovation effectiveness. Promoting rural innovation injects a strong impetus for accelerating the integrated development of urban and rural areas as well as promoting common prosperity, which ultimately promotes the development of rural revitalization [6][7]. Yuan Tao [8] believes that rural innovation, as an important way to promote rural revitalization and achieve common wealth, can not only improve the income level of rural residents, but also effectively stimulate the vitality of the countryside and inject new momentum into the development of common wealth. At present, the main body of rural innovation faces financing difficulties and so on, and the government also has problems such as weak platform construction in the process of implementing rural innovation work [2]. Therefore, in the new era, we should strengthen the research on the cultivation of innovation subjects, solve the problems they encounter in the process of innovation, and provide more and higher-quality talents for innovation.

At present, the research on industrial integration has been very rich. In terms of the connotation of industrial integration, Meng Qiuju [9] believes that agricultural industrial integration is based on agriculture, and the typical features include the extension of the industrial chain, the expansion of industrial functions and the formation of new business forms. It aims to optimize and reorganize rural resources, promote the organic integration of agriculture-related industries, and ultimately achieve the goals of agricultural efficiency, farmers' income and rural prosperity. Chen Jiahai [10], on the other hand, proposed that industrial integration is a blurring of the boundaries of industries based on the foundation of digital convergence, and broadened the concept of industrial integration to a wider field. Xiao Weidong and Du Zhixiong [11] believe that “tri-industrial integration” refers to a new type of agricultural organization and process in which various sectors within agriculture, as well as agriculture and the secondary and tertiary industries in the countryside, form a new type of agricultural industry, a new form of business and a new mode of organization through interpenetration and cross-reorganization. In terms of the role of industrial integration on the economy, industrial integration can promote economic development at the county level [12], and inter-regional industrial integration can also reduce regional economic differences. In addition, industrial integration and industrial structure upgrading can bring income increase for farmers or through the benefit linkage system [13][14].

There is a paucity of research on the relationship between industrial integration and rural innovation, and existing research focuses on the relationship between industrial integration and entrepreneurship, with Chen Yuying [15] suggesting that rural industrial integration can increase farmers' incomes by promoting entrepreneurial activities in the county. Li Xiaolong and Ran Guanghe [16], on the basis of constructing indicators of rural entrepreneurial activity, proposed that rural industrial integration can significantly enhance entrepreneurial activity in rural China.

Compared with existing studies, the main marginal contributions of this paper include the following: first, it is centered on rural innovation. Domestic academics seldom pay attention to rural innovation, this paper conducts a more detailed study, using the entropy value method and the coupled coordination degree model to measure the level of industrial integration Current research on the influencing factors of rural innovation seldom takes industrial integration into account, this paper can provide a new way of thinking for the promotion of rural innovation. Secondly, comparing with the existing studies, this paper not only analyzes in detail the regional heterogeneity of the impact of industrial integration on rural innovation, but also explores the role of industrial integration in influencing rural innovation, and puts industrial integration, labor mobility, and rural innovation into the same framework for analysis, which deepens the understanding of the impact of industrial integration on rural innovation, and provides policy suggestions with reference value for the further advancement of industrial integration and the promotion of rural innovation.

In conclusion, this paper measures the industrial integration index, and empirically analyzes the effect and mechanism of industrial integration on rural innovation by using the fixed effect model and the mediation effect model, so as to provide theoretical basis and decision-making reference for exploring effective paths to promote rural innovation.

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2. Research Hypotheses

2.1 The direct impact of industrial integration on rural innovation

Industrial integration development can directly promote rural innovation through three mechanisms: optimizing resource allocation, promoting technological innovation and application, and stimulating farmers' innovative vitality. First, industrial integration can promote rural innovation by optimizing resource allocation. Rural industrial integration can reduce the distortion phenomenon of factor allocation, allocate resources more effectively and thus enhance the total factor productivity of agriculture [17]. Industrial integration breaks the boundaries of traditional industries, enabling the rational flow and efficient allocation of resources among different industries. This includes key elements such as land, capital, talent, technology, etc., and their integration and sharing among different industries help to form new economic growth points and innovation power. This optimal allocation of resources not only improves the efficiency of resource use, but also provides more possibilities for rural innovation. Secondly, industrial integration can promote technological innovation and application for rural innovation. Industrial integration can not only optimize resource allocation, but also stimulate technological innovation, which in turn enhances overall competitiveness [18]. Industrial integration promotes cross-penetration and integrated innovation of technology. Through the introduction of new technologies, processes and equipment, agriculture has been able to develop in the direction of modernization and intelligence. For example, the application of modern information technologies such as the Internet of Things, big data, artificial intelligence and other modern information technologies in the field of agriculture has promoted the development of intelligent agriculture and improved the precision and efficiency of agricultural production. At the same time, these technologies also provide more innovative means for the processing and marketing of agricultural products, which helps to enhance the added value and market competitiveness of agricultural products. Finally, industrial integration can stimulate farmers' innovative vitality to promote rural innovation. Industrial integration not only helps sustained economic growth, but also injects more innovative power and vitality into the whole society [19]. Industrial integration provides more employment opportunities and entrepreneurial pathways for farmers. Farmers can obtain more sources of income and employment opportunities by participating in the development of new types of business. At the same time, industrial integration also promotes the scale and intensive operation of agriculture, and improves the efficiency of agricultural production and the added value of agricultural products. These changes have stimulated farmers' innovative vitality and entrepreneurial enthusiasm, making them more actively involved in rural innovation. As the main body of rural innovation, farmers' active participation and creation is an important guarantee for the sustainable development of rural innovation.

Based on this, this paper puts forward the following hypotheses:

H1:Industrial integration development can directly have a positive impact on rural innovation.

2.2 Industrial integration affects rural innovation through labor mobility

On the one hand, industrial integration is an important force for labor mobility, compared with the city, the countryside is facing great difficulties in terms of talent as well as farmers' development [20], and industrial integration can solve the problem of lack of talent as well as limited farmers' development, and promote industrial and rural modernization. Industrial integration promotes the free flow of labor between industrial sectors, and rural laborers can go to other industrial sectors. In addition, through industrial integration, industries promote each other, coordinate their development and extend the industrial chain, which broadens employment channels and promotes labor mobility. Labor mobility, especially the return of migrant workers, brings rich human capital accumulation to the countryside. On the other hand, labor mobility as a means of rural innovation. Not only can it promote the return of human capital, but also fully stimulate the spirit of innovation, providing a steady stream of power and support for rural innovation. Ordinary labor force and high-quality labor force mobility have different degrees of promotion effect on regional innovation, especially the return of high-quality labor force significantly improves the regional innovation capacity [21]. These returnees have accumulated experience in technology, market, management and other aspects outside, and become the backbone of rural innovation. Their innovative spirit, risk appetite and broader vision help fill the gaps of rural industries, enrich the innovation mode and enhance the innovation vitality of the countryside. Based on this, this paper puts forward the following hypotheses:

H2:Industrial integration development helps rural innovation by enhancing labor mobility.

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3. Econometric modeling and estimation methods

3.1 Model setup

According to the theoretical analysis above, the effect of industrial integration on rural innovation is linear, and in order to test this relationship, the following regression model is set up in this paper:

$$RI_{it} = \beta_0 + \beta_1 IC_{it} + ZControl_{it} + \sigma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where, the explanatory variable denotes the rural innovation index of region i in year t, the explanatory variable denotes the industrial integration index of region i in year t, denotes a series of control variables, including the level of economic development, government intervention, the level of financial development, the level of consumption, the level of education, and the level of medical care, denotes a region fixed effect, and denotes a time fixed effect, which is a randomized perturbation term, with subscripts i and t denoting the region and the time. Industrial integration can affect rural innovation through labor mobility, in order to test the mechanism of industrial integration on rural innovation, this paper draws on the research of Wen Zhonglin [22] to construct a mediation effect model.

$$M_{it} = \beta_0 + \beta_1 IC_{it} + ZControl_{it} + \sigma_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$$RI_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 M_{it} + ZControl_{it} + \sigma_i + \gamma_t + \varepsilon_{it} \quad (3)$$

where is the mediating variable, is labor mobility, and the rest of the variables have the same meaning as in equation (1).

3.2 Variable Setting and Measurement Methodology

3.2.1 Explained Variables

The explanatory variable in this paper is the rural innovation index, drawing on the comprehensive evaluation index system constructed by Ruan Jianqing and other scholars [1].

3.2.2 Core explanatory variables

The core explanatory variable of this paper is the industrial integration index, because the core of how to accurately assess the level of industrial integration lies in the construction of a reasonable evaluation index system, and there is no uniform standard for the measurement of industrial integration in existing studies. This paper refers to the studies of Chen Xueyun and Cheng Changming [23] and Wang Gangyi and Bai Lingxue [24], and constructs an index system for the degree of industrial integration in counties based on the development indexes of regional primary, secondary and tertiary industries. The specific indicators and their calculation methods are detailed in Table 1.

Table 1 Evaluation index system for the level of industrial integration development in counties

Primary Indicator (Weight)	Secondary Indicator	Unit	Weight (%)	Indicator Attributes
Primary Industry (1/3)	Primary Industry Output % of GDP	%	18.27%	Positive
	Value Added of Primary Industry	billions	31.03%	Positive
	Growth rate of primary sector value added	%	4.67%	Positive
	Grain production kilograms	kilogram (kg)	46.02%	Positive
Secondary Industry (1/3)	Secondary Industry Output % of GDP	%	8.33%	Positive
	Value Added of Secondary Industry	billions	39.63%	Positive

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	Growth rate of Secondary Industry value added	%	9.20%	Positive
	Grain production kilograms	kilogram (kg)	42.84%	Positive
Tertiary Industry (1/3)	Tertiary Industry Output % of GDP	%	9.69%	Positive
	Value Added of Tertiary Industry	billions	46.19%	Positive
	Growth rate of Tertiary Industry value added	%	9.67%	Positive
	Grain production kilograms	kilogram (kg)	34.45%	Positive

Note: Labor productivity = value added by industry/number of people employed

Based on the above index data, we adopt the coupled coordination model to measure the level of industrial integration in counties and form a comprehensive index of the level of industrial integration and development in each county, so that the interaction and coordination among the three industries in counties can be fully reflected. The specific calculation steps are as follows:

First, construct the comprehensive evaluation function of the first, second and third industries:

$$U_t = \sum_{i=1}^{n} W_i y_{ij} \quad (t = 1,2,3), \text{ where } \sum_{i=1}^{n} W_i = 1 \tag{4}$$

Eq. (4) where j is the number of indicators of a certain system; Wi is the weight of indicators; yij is the standardized value of the jth indicator of a certain i region; Ut is the development composite index of each system of the three industries.

Second, data standardization processing. In order to avoid the interference of different indicator scales on the assessment results, this paper adopts the normalization means to standardize each measurement indicator, thus ensuring that the indicators can be compared with each other. In addition, the normalized values are normalized by reassigning a positive minuscule value (0.001 is chosen as the shift), which is aimed at preventing possible errors in the logarithmic computation using the entropy method and incorporating this chosen minuscule quantity into the whole computational process.

$$y_{ij} = \frac{x_{ij} - x_{jmin}}{x_{jmax} - x_{jmin}} + 0.001 \tag{5}$$

$$y_{ij} = \frac{x_{jmax} - x_{ij}}{x_{jmax} - x_{jmin}} + 0.001 \tag{6}$$

In equations (5) and (6): refers to the normalized and normalized values; then represents the raw data of a specific region on the first indicator; and represents the maximum and minimum values of each indicator, respectively. For indicators showing positive characteristics, they are treated with equation (5); while for indicators with negative characteristics, we use equation (6).

Finally, the weights of the indicators are determined. In order to minimize the interference of subjective judgment, this paper adopts the entropy value method as the method of calculating the weight of each measurement indicator, and the specific implementation steps are as follows:

$$P_{ij} = y_{ij} / \Sigma_{i=1}^{m} y_{ij} \tag{7}$$

$$E_j = -(1/\ln m) \Sigma_{i=1}^{m} P_{ij} \ln P_{ij} \tag{8}$$

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$$F_j = 1 - E_j \tag{9}$$

$$W_j = F_j / \Sigma_{j=1}^{n} F_j \tag{10}$$

In Eq. (7) to Eq. (10), it represents the proportion occupied by the jth index in a certain i region; it is the information entropy value of the jth item; it is the information utility value of the jth item; and it is the weight coefficient of the jth index. Based on the comprehensive assessment of the development indexes of each industry, this paper draws on the multiple system coupling models proposed by Cong Xiaonan [25] and Zhang Xuchen and Zhao Min [26], and constructs the following coupling coordination degree model based on the internal linkages of the county industrial integration, especially the interaction mechanism between primary, secondary and tertiary industries:

$$C = 3 \times \left[\frac{U_1 \cdot U_2 \cdot U_3}{(U_1 + U_2 + U_3)^3} \right]^{1/3} \quad C \in [0,1] \tag{11}$$

$$T = eU_1 + fU_2 + gU_3 \tag{12}$$

$$D = \sqrt{C \times T} \tag{13}$$

In equations (11) to (13), C represents the degree of coupling between the three industries; it reflects the comprehensive assessment value of the primary, secondary and tertiary industries, respectively; T is the comprehensive coordination index, which embodies the contribution of the overall development level of the primary, secondary and tertiary industries to the degree of coordination; while D represents the degree of coupling coordination, i.e., the degree of industrial integration of counties that is calculated and studied in this paper; e, f, and g are coefficients to be determined , taking into account the mutual influence and promotion relationship that exists between the subsystems, their contribution to the industrial integration system is equally important, therefore, all three coefficients are set to 1/3.

3.2.3 Control variable

Factors affecting rural innovation are complex, and this paper sets control variables such as the level of economic development, government intervention, financial development level, consumption level, education level, and medical level. The level of economic development plays an important role in rural innovation, so this paper uses the logarithm of real per capita gross regional product to measure the level of economic development [27]. Government intervention will actively promote rural innovation, while government subsidies rational allocation of resources will also promote rural innovation, so this paper adopts the ratio of the general budget expenditure of government finance to the gross regional product [28]. The level of financial development will have an impact on rural innovation by affecting consumption and investment, so this paper uses the ratio of the end-of-year balance of loans from financial institutions to regional GDP to measure [28]. Consumption is measured by total retail sales of consumer goods per capita; education is measured by the number of primary and secondary school students enrolled in school; and health care is measured by the logarithm of the number of beds in hospitals and health centers.

3.2.4 Mechanism variables

Labor force mobility is selected as the mechanism variable for this paper's variables, and this paper draws on Zhang Hui et al [29], where labor force mobility is measured by the amount of the total population minus the total household population at the end of the year.

3.3 Data sources and description

The research object of this paper is the 1,837 counties (excluding city districts, excluding counties and cities with serious missing data and incomplete years) in China from 2014 to 2021. The data used in this paper are obtained from the published data of China Population and Employment Statistics Yearbook and China County Statistics Yearbook in the corresponding years. For the remaining small

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amount of missing data, linear interpolation and regression filling are utilized. In order to more effectively minimize the potential interference of outliers on the estimation results, this paper performs the shrinkage treatment of 1% before and after for all variables. For details on the main variable measures and their descriptive statistical analyses, see Table 2.

Table 2 Measures of the main variables and their descriptive statistics

Variable	Measurement method	Mean value	Standard deviation	Maximum value	Minimum value
Rural Innovation Index	Comprehensive Evaluation Indicator System	19.965	9.486	47.882	0.902
Industrial integration index	Evaluation index system + coupling coordination measure	0.406	0.083	0.668	0.274
Labor mobility Total	population minus household population at the end of the year	-2.712	7.084	9.6	-37.7
Level of economic development	Gross regional product/total population at the end of the year, logarithmic	10.437	0.621	12.180	9.037
Government intervention	General budget expenditure of local finances/GDP	0.348	0.313	1.770	0.070
Level of financial development	Balance of loans from financial institutions at the end of the year/Gross Regional Product	0.751	0.390	2.215	0.185
Consumption level	Total retail sales of consumer goods/total population at the end of the year	9.251	0.745	10.982	7.093
Education level	Number of primary and secondary school students in school, logarithmic	10.514	0.990	12.333	7.677
Level of medical care	Number of beds in hospitals and health centers, logarithmic	7.221	0.965	8.914	4.277

4. Estimation results and analysis

4.1 Baseline regression results

In order to test the impact of industrial integration on rural innovation, this paper adopts the fixed effect model to regress rural innovation, and the regression results are shown in Table 3. Among them, column (1) is the fixed effect model without adding control variables, while column (2) is the fixed effect regression results after adding control variables. From column (1), it can be seen that the core explanatory variable industrial integration is significant at the 5% level, indicating that the development of industrial integration can significantly promote rural innovation. And from column (2), the core explanatory variable industrial integration is significant at the 10% level after adding other control variables that affect industrial integration. This indicates that after controlling the effects of other variables, the promotion of industrial integration on rural innovation is still significant. This preliminarily verifies Hypothesis 1.

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Table 3 Benchmark regression results

Variables	(1)	(2)
	Rural Innovation	
Industrial integration	3.173**	5.852***
	(2.232)	(3.314)
Level of economic development		-0.371
		(-1.406)
Government intervention		-0.859*
		(-1.915)
Level of financial development		0.631***
		(2.712)
Level of Consumption		-0.520***
		(-3.063)
Level of education		1.509***
		(3.513)
Level of health care		0.724***
		(3.242)
Constant term	18.676***	5.005
	(32.286)	(0.997)
Individual fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
N	14696	14696
R^2	0.838	0.839
F	4.981	8.568

Note: ***p<0.01, **p<0.05, *p<0.10; t-values in parentheses

4.2 Robustness test

In order to verify the reliability of the results, this paper carries out the robustness test by shortening the regression year and shrinking the tail treatment.

4.2.1 Reduced return year

The outbreak of the new crown epidemic had a profound impact on the economy and society, and the urban and rural development status changed significantly as a result. In order to eliminate the possible bias of this unexpected event on the research results, this paper draws on the methodology of existing literature [30] and decides to remove the data directly affected by the New Crown Epidemic during the period of 2020-2021, and selects the data of 2014-2019, and re-runs the regression analysis in order to verify the robustness of the results. The regression results are detailed in column (1) in Table 4. The analysis shows that industrial integration still has a positive effect on promoting rural innovation and development at the 5% significance level, even after excluding the years affected by the epidemic.

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4.2.2 Tailoring

To address the problem of possible outliers, this paper applies a 3% bilateral shrinking tail treatment to all variables, and the empirical results are shown in column (2) in Table 4. The correlation results do not change significantly compared with the benchmark regression, indicating that the correlation between industrial integration and rural innovation is not due to a small number of outliers, and the empirical findings are robust to 10%.

Table 4 Robustness test results

Variables	(1) Shortened regression years	(2) Reduced-tailed 3 percent
Industrial Integration	5.608**	4.603*
	(2.146)	(1.800)
Control variables	Controlled	Controlled
Constant term	-0.540	6.326
	(-0.069)	(0.926)
Individual fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
N	11022	14696
R^2	0.850	0.832
F	6.066	4.562

Note: ***p<0.01, **p<0.05, *p<0.10; t-values in parentheses

4.3 Heterogeneity estimation results

4.3.1 Regional heterogeneity

Due to the differences in geographic location, natural environment, infrastructure, economic base and other objective factors, each county will show its own unique characteristics in the process of rural innovation, and thus there will be heterogeneity in the impact on rural innovation. Therefore, this paper refers to the regional classification standard of the National Bureau of Statistics to divide the sample into three major regions: east, central and west, to further test the regional heterogeneity of industrial integration to promote rural innovation, and the results are shown in Table 5.The results of columns (1) to (3) show that the coefficients of the east, central and western regions are all positive, and the east passes the test of significance at the 1% level, while the central region passes the test of significance at the 5% level, suggesting that industrial integration has a positive impact on the promotion of rural innovation. , which indicates that industrial integration still has a positive effect on promoting rural innovation. It is worth noting that the regression coefficients of the three regions show a decreasing trend of "East (25.228) > Central (5.521) > West (2.590)", which means that there is a difference in the effect of industrial integration on the promotion of rural innovation in the three regions. The reason for this is mainly due to two points: firstly, the eastern region has a strong economic foundation, which can provide sufficient funds and resources, and the industrial structure is also more complete, and the development speed and development level of industrial integration is much higher than that of the central and western regions, so it has the strongest promotional effect; secondly, compared with the central region, the eastern region receives significantly better policy support and human capital than that of the central and western regions. The impact of industrial integration on rural innovation in the western region does not pass the significance test, which mainly stems from the fact that the county economy in the western region is underdeveloped, the industrial structure upgrading is still in a relatively rough stage, and the degree of industrial integration is relatively low, which has not yet reached the level that can significantly affect rural innovation, and there is still more room for development.

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Table 5 Regression results of regional heterogeneity analysis

Variables	(1) Eastern	(2) Central	(3) Western
Industrial Integration	25.228***	5.521**	2.590
	(4.676)	(2.137)	(1.040)
Control variables	Yes	Yes	Yes
Constant term	-39.582***	-17.008*	27.146***
	(-3.399)	(-1.880)	(4.275)
Individual fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
N	3624	4576	6496
R^2	0.875	0.821	0.805
F	13.565	6.089	1.288

Note: ***p<0.01, **p<0.05, *p<0.10; t-values in parentheses

4.4 Test of intermediary effect

Combined with the theoretical analysis above, this paper introduces labor mobility as a mediating variable to construct the mediating effect model, and analyzes the role mechanism of industrial integration affecting rural innovation.

The regression of (1) has been verified above, and then (2) and (3) are regressed to explore the mechanism of industrial integration on rural innovation, and the results are shown in Table 6.The first step is to test the effect of industrial integration on labor mobility, and column (1) of Table 6 shows that the coefficient of influence of industrial integration on it is significantly positive, which suggests that it has a driving effect on labor mobility.

In the second step, the effect of each mediating variable on rural innovation is tested. Column (2) of Table 6 demonstrates the regression results of equation (3), and the coefficient of labor mobility is significantly positive, which indicates that there is a positive and promoting relationship between labor mobility and rural innovation, and combined with the test results of the first step, the mediating effect of labor mobility has been preliminarily tested. Industrial integration broadens the boundaries between industries, prompts labor to be able to move freely, and also promotes the return of labor to bring advanced technology and experience to enhance the vitality of rural innovation, hypothesis 2 is verified.

Table 6 Results of the mediation effect test

Variables	(1) labor force mobility	(2) Industrial integration index
Industrial Integration	15.681***	5.510***
	(8.148)	(3.103)
labor force mobility		0.022***
		(2.592)
Control variables	Yes	Yes
Constant term	143.047***	1.884

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	(27.678)	(0.361)
Individual fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
N	14696	14696
R^2	0.705	0.839
F	367.201	8.335

Note: ***p<0.01, **p<0.05, *p<0.10; t-values in parentheses

5. Conclusion and Policy Recommendations

This paper constructs a more reasonable rural innovation evaluation index system and analyzes the linear relationship between industrial integration and rural innovation based on the panel data county panel data of 1,837 counties (cities and flags) in 28 provinces across China from 2014 to 2021. The study shows that: first, industrial integration has a direct driving effect on rural innovation, that is, industrial integration significantly improves the level of rural innovation. Second, there are regional differences in the direct effect of industrial integration on rural innovation. In the eastern and central regions with relatively high levels of economic development, industrial integration has a linear effect on rural innovation, while the effect is not significant in the western region. Third, industrial integration has a linear effect mechanism on rural innovation by promoting labor mobility.

Based on the above conclusions, the following policy recommendations are put forward: first, promoting rural innovation through the development of industrial integration, through the optimization of industrial structure, strengthening scientific and technological innovation, promoting cross-border integration, cultivating innovative main bodies, strengthening the construction of infrastructure, and promoting the income of farmers and other aspects of efforts, can effectively promote the development of industrial integration in the countryside, and then promote rural innovation. Second, promote rural innovation according to local conditions. There is regional heterogeneity in the level of rural innovation across the country, so it is necessary to formulate differentiated policies to synergistically promote rural innovation. Supporting the development of specialty agriculture and strengthening infrastructure construction in the western region; improving the industrial chain in the eastern and central regions to strengthen regional cooperation.

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References

[1] Ruan Jianqing,Yang Qiming,Ye Wuwei,et al. Innovation and entrepreneurship development in rural China: index construction and measurement analysis[J]. Economy and Management,2024,38(05):9-18.
[2] WU Zhixiang,KEI Xiaoqing,XU Zeqing. Regional Integration and the Vitality of County Economic Development-A Quasi-Natural Experiment Based on the Expansion of the Yangtze River Delta[J]. East China Economic Management,2024,38(01):14-25.DOI:10.19629/j.cnki.34-1014/f.230831019.
[3] Zhong Z, Kong XZ. Rural Innovation and Entrepreneurship in the New Era:Mechanism, Situation and Strategy[J]. Journal of Jianghai,2020,(02):98-106.
[4] LIU Bin, TANG Chengli, ZHOU Guohua, et al. Characteristics of Rural Innovation Policy Evolution and Implications for Rural Development-Analysis Based on the No.1 Document of the Central Government from 2004 to 2023[J]. Economic Geography, 2024,44(03):147-159. DOI:10.15957/j.cnki.jjdl.2024.03.015.
[5] National Bureau of Statistics, Department of Social Sciences and Culture, "China Innovation Index (CII) Research" group, Jia Nan, Li Yin,. Research on China's innovation index[J]. Statistical Research,2014,31(11):24-28.10.19343/j.cnki.11-1302/c.2014.11.003.
[6] KAM YJ. Research on rural innovation and entrepreneurship in the context of rural revitalization

ISSN 2616-5902 Vol. 7, Issue 4: 21-33, DOI: 10.25236/AJBM.2025.070403

strategy[J]. Theory Exploration,2021,(06):99-106.
[7] YIN Ximing, CHEN Jin, ZHANG Yueyao. Research on the Path and Mechanism of Rural Innovation System to Promote Rural Revitalization[J]. Tianjin Social Science,2020,(03):103-109.
[8] YUAN Tao, SONG Jashan, SUO Dani, HUANG Huan. Digital economy empowers common wealth: based on the perspective of rural innovation and rural entrepreneurship[J]. Statistics and Decision Making, 2024,40(18):46-51.
[9] Meng Qiuju. Research on the connotation of rural industrial integration[J]. Journal of Sichuan Institute of Technology (Social Science Edition),2018,33(02):76-83.
[10] Chen Jiahai. Industrial integration:The connotation of the narrow concept and its generalization[J]. Shanghai Economic Research,2009,(11):35-41+96. DOI:10.19626/j.cnki.cn31-1163/f.2009.11.006.
[11] Xiao Weidong,Du Zhixiong. Integration of rural primary, secondary and tertiary industries: Connotation, development status and future thoughts[J]. Journal of Northwest Agriculture and Forestry University (Social Science Edition),2019,19(06):120-129.
[12] Xu Wei. Rural Industrial Integration and County Economic Growth-Empirical Evidence Based on Pilot Policies of Rural Industrial Integration Development[J]. World Agriculture,2023,(07):98-111.
[13] Li Mingxian,Liu Chenven. Research on Rural One, Two and Three Industries Integration Benefit Linkage Mechanism Driving Farmers' Income Increase--Taking Farmers' Specialized Cooperative Driven Industrial Integration as an Example[J]. Hunan Social Science,2019,(03):106-113.
[14] Cao Fei,Nie Ying. Industrial Integration, Upgrading of Agricultural Industry Structure and Farmers' Income Growth-An Empirical Analysis Based on County Panel Data in Hainan Province[J]. Agricultural Economic Issues,2021,(08):28-41.
[15] Chen Yuying. Rural industrial integration, county entrepreneurial activities and farmers' income[J]. Journal of Shanxi University of Finance and Economics,2024,46(05):73-83.
[16] Li Xiaolong,Ran Guanghe. Research on the entrepreneurial effect of rural industrial integration development--an empirical test based on inter-provincial heterogeneity[J]. Statistics and Information Forum,2019,34(03):86-93.
[17] Ye Feng,Ma Jinggui,Hu Qin. Empirical evidence on the impact of industrial integration development on agricultural total factor productivity[J]. Statistics and Decision Making, 2020,36(10):87-91. DOI:10.13546/j.cnki.tjyjc.2020.10.018.
[18] Jianxun Shi,Danning Lu. Research on sound system to enhance the resilience and security level of industrial chain supply chain[J]. Research on Financial Issues,2024,(11):3-17. DOI:10.19654/j.cnki.cjwtyj.2024.11.001.
[19] SUN Shaoyong,LI Shi. The Logical Purpose and Driving Direction of Numerical Intelligence for Cultivating and Developing New Quality Productivity[J]. Review of Political Economy, 2024, 15(06):101-114.
[20] U. Wu Yun, Zhu Hongyan. Theoretical Logic, Realistic Bottleneck and Development Path of Rural Industry Revitalization Empowered by New Quality Productivity[J]. Journal of North Minzu University, 2024,(04):31-38.DOI:10.20076/j.cnki.64-1065/G4.2024.04.004.
[21] Zhou M.M.,Feng H.B.. Local public service competition, factor mobility and regional innovation[J]. Local Finance Research,2024,(07):16-28.
[22] WEN Zhonglin, YE Baojuan. Mediation effects analysis:Methodology and model development[J]. Advances in Psychological Science,2014,22(05):731-745.
[23] CHEN Xueyun,CHEN Changming. The three-product integration path of rural revitalization strategy:logical necessity and empirical determination[J]. Agricultural Economic Issues, 2018,(11):91-100. DOI:10.13246/j.cnki.iae.2018.11.009.
[24] Wang Gangyi,Bai Lingxue. Research on the impact of rural three industries integration on farmers' income in China - based on the perspective of mediation effect[J]. Agricultural Economics and Management,2023,(04):48-64.
[25] Cong Xiaonan. The form, nature and some misuses of coupling degree model in geography[J]. Economic Geography,2019,39(04):18-25.DOI:10.15957/j.cnki.jjdl.2019.04.003.
[26] Zhang Xuchen,Zhao Min. Traceability and misunderstanding of "coupling research" in urban planning[J]. Urban Planning,2022,46(06):37-47+102.
[27] Liu Meiyan. Digital village construction, innovation and entrepreneurship activity and urban-rural high-quality integrated development[J]. Statistics and Decision Making, 2024, 40(19):38-43. DOI:10.13546/j.cnki.tjyjc.2024.19.006.
[28] Zhao Kangjie,Fu Xinyu. Research on urban-rural common wealth effect of digital inclusive finance empowering innovation and entrepreneurship[J]. Henan Social Science,2024,32(10):55-66.
[29] ZHANG Hui,LI Jing,ZHANG Yanyuan,et al. Digital village construction, urban-rural integration development and county economic growth[J]. Finance and Trade Research, 2024,35(09):28-42+93.

ISSN 2616-5902 Vol. 7, Issue 4: 21-33, DOI: 10.25236/AJBM.2025.070403

DOI:10.19337/j.cnki.34-1093/f.2024.09.003.
[30] Peng G, Zhou YJ, Qian J, et al. China's foreign aid for the development of digital economy? The experience of emerging market countries[J]. Journal of Economics,2023,10(3):1G30?