



OPEN ACCESS

EDITED BY
Sendhil R.,
Pondicherry University, India

REVIEWED BY
Wonder Agbenyo,
Sichuan Agricultural University, China
Sara Javed,
Beijing University of International Business and
Economics, China

*CORRESPONDENCE
Lingming Chen
✉ lingming1016@mail.hnust.edu.cn

RECEIVED 14 June 2023
ACCEPTED 31 October 2023
PUBLISHED 16 November 2023

CITATION
Yang J, Chen L and Zhang Y (2023) Rural
industrial convergence, urbanization
development, and farmers' income growth
– evidence from the Chinese experience.
Front. Sustain. Food Syst. 7:1237844.
doi: 10.3389/fsufs.2023.1237844

COPYRIGHT
© 2023 Yang, Chen and Zhang. This is an
open-access article distributed under the terms
of the [Creative Commons Attribution License
\(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction
in other forums is permitted, provided the
original author(s) and the copyright owner(s)
are credited and that the original publication in
this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted which
does not comply with these terms.

Rural industrial convergence, urbanization development, and farmers' income growth – evidence from the Chinese experience

Juan Yang^{1,2}, Lingming Chen^{3*} and Yadong Zhang¹

¹School of Business, Hunan University of Science and Technology, Xiangtan, Hunan Province, China, ²School of Business, Loudi Vocational and Technical College, Loudi, Hunan Province, China, ³School of Economics and Management, Xinyu University, Xinyu, Jiangxi Province, China

Farmers' income growth is a significant social problem, which has a bearing on the building of a moderately prosperous society in an all-round way. The convergence of rural industries based on agricultural development has become a meaningful way to solve the problem. The convergence of rural industries cannot be separated from the construction of urbanisation because the aggregation of population resources and the optimisation of industrial structures need the support of urbanisation. Based on the panel data of 29 provinces in China from 2004 to 2020, this paper makes an empirical study on the interaction between rural industrial agglomeration, urbanisation level, and farmers' income using the theories of "intermediate role" and "threshold effect." The results show that rural industrial agglomeration significantly affects farmers' economic development, among which the eastern, western, and central regions have the most substantial positive effect. The level of urbanisation development is the mediating variable of the impact of rural industrial convergence on farmers' income growth, which indirectly promotes farmers' income growth, and the mediating effect is significant. Lastly, the level of urbanisation development is the threshold variable for the impact of rural industrial convergence on farmers' income growth, and the coefficient of rural industrial convergence on farmers' income growth is highest when the level of urbanisation is between 0.7960 and 0.8500. Therefore, in order to achieve sustainable growth in farmers' operating income, wage income and financial transfer income, the country should give full play to the advantages of rural industrial integration, build a modernised industrial system for agriculture, expand the functions of agriculture in the secondary and tertiary sectors, and make good use of the policies that benefit the people in rural industrial development. At the same time, with the opportunity of county urbanisation, a rural industrial development system with the county as the centre of development has been established, guiding the rational flow and effective integration of urban and rural industrial resource elements and realising the integrated development of urbanisation and rural industry. Given the differences in industrial development in the eastern, central and western regions, the State should also promote rural industrial integration policies by stage, region and strategy to raise the level of farmers' income.

KEYWORDS

rural industrial convergence, urbanization, farmers' income growth, mediating effect, threshold effect

1. Introduction

Farmers' income growth is related to building a well-off society in an all-around way, and it is an unavoidable problem that promotes the sustainable growth of farmers' income in the process of socialist modernisation. How to effectively increase farmers' income is of great concern to the academic community. Farmers' income growth is affected by many factors. One is the natural environment, such as rice farmers' income, which is affected by weather, temperature, precipitation and other climatic influences (Ojo and Baiyegunhi, 2021). In Iran, climate change can also lead to changes in groundwater mineralisation that pose a risk to farmers' incomes (Akbari et al., 2020), and Philippine smallholder agro-forestry composite farmers are adopting adaptive strategies in response to climate change in a bid to improve farm incomes (Landicho et al., 2016). Second, government policy. Agriculture is a declining industry when agricultural products rely on the world market, and the U.S. government's transfer payment mechanism can enhance the competitiveness of agricultural products (Miljkovic et al., 2008). China has used PES programmes to create some non-farm jobs and relies on non-agricultural employment to increase the incomes of small and medium-sized farmers (Sheng and Wang, 2022) while increasing forestry subsidies to raise farmers' incomes (Lu et al., 2020). Third, the level of economic development. Regional economic development impacts farmers' incomes, and transport infrastructure is crucial in economic development, especially in China, where the supply of rural roads has an inverted U-shaped effect on inter-provincial farmers' income disparities (Weng et al., 2021). The impact of infrastructure on rural-urban income inequality is also present in other Asian countries (Mishra and Agarwal, 2019). Fourth, the development of urbanization equally affects farmers' income growth (Mishra and Agarwal, 2019). Nigeria's agricultural labour market is centred on towns and cities, making it easy for job-seekers to find work (Tiffen, 2018). China's large surplus of rural labour has also increased the farmer's income through urbanization, but it has resulted in the agricultural modernisation level lagging behind urbanisation (Yuan et al., 2018). Fifth, production technology improvement. Science and technology innovations have had a more significant impact on farmers' income growth, with Indian regions bridging the rice yield gap through soda soil management techniques (Sheoran et al., 2021), Nigerian smallholder maize producers further improving farmers' income through knowledge innovations such as improving traditional farming techniques (Ayanwale et al., 2023), and China applying internet technology to farmers' income growth, which increases farmers' income through entrepreneurial effects and the availability of non-farm jobs (Zhou et al., 2020). Sixth, agricultural economic co-operation organisations. Farmers' production and management companies in India (Anirban et al., 2018), farmers' economic cooperation organisations and levels of agricultural specialisation in China (Yang and Liu, 2012), and agribusiness supermarket pacts in Kenya (Ogotu et al., 2020) have all played an essential role in improving farmers' incomes. The above studies have provided solutions for farmers' income growth and laid a sound research foundation. However, researchers seldom combine two or more of these influences to examine their impact on farmers' income growth. As science and technology continue to progress, productivity levels rise, and urbanisation accelerates, the development trend expands the agricultural industry chain, increases farmers' non-agricultural income and improves the structure of farmers'

income. Nowadays, especially in the context of constructing China's agricultural powerhouse, it is necessary to speed up the pace of agricultural modernization, do an excellent job of extending the agricultural industry chain and take the road of rural industrial convergence. At the same time, China has stepped into the stage of county urbanisation, and it is worth trying to put the convergence of rural industries, urbanisation development, and farmers' income growth into a research framework by taking advantage of the momentum of *in situ* urbanisation development. Indeed, some theoretical literature has confirmed that rural industrial convergence is an effective way to increase farmers' income (Zhang et al., 2020), and it promotes the efficiency of factor allocation through the cross-border penetration and cross-convergence of capital, labour, and technology (Luo and Wei, 2022); rural industrial convergence can achieve farmers' income increase through accelerating urbanisation as a mediating variable (Li and Ran, 2019). The faster the urbanisation process, the higher the farmers' income (Huang, 2016). The convergence of rural industries can contribute to urbanisation and the rapid growth of farmers' incomes by acting as a catalyst.

Based on the theoretical analysis of the above literature, what is the relationship between the convergence of rural industries, urbanisation, and farmers' income growth from an empirical perspective? Is there a direct and indirect transmission mechanism between each other? Is there a linear relationship between the impact of rural industrial convergence on farmers' income growth? With doubts, based on the panel data of 29 provinces and cities in China from 2004 to 2020, this study uses principal component analysis to measure rural industrial convergence, empirically analyses the transmission mechanism of rural industrial convergence affecting farmers' income increase, and uses the level of urbanisation development as a threshold variable to examine the non-linear relationship between rural industrial convergence and farmers' income growth, to provide theoretical and practical guidance for the scientific implementation of the convergence of rural industries, urbanisation development and the positive interaction with farmers' income growth in China.

The rest of the paper is organised as follows: Part II briefly reviews and critiques the relevant literature; Part III presents the theoretical mechanisms and research hypotheses; Part IV reports mainly on the model, variables, and data descriptions; Part V analyses and discusses the empirical results; and Part VI presents the research conclusions and policy implications.

2. Literature review

2.1. Rural industrial convergence and farmers' income growth

The theory of rural industrial convergence can be traced back to the "six industries" theory advocated by Japanese scholar Imamura in the 1990s. He believes that to enhance the added value of agricultural products and increase farmers' income, it is necessary to rely on agriculture to do a good job in the integrated development of agricultural "production, processing and marketing" to resolve the dilemma of Japanese agricultural development (Li et al., 2020). The central idea of the "six industrialisation concept" highlights the essential role of agriculture and reflects the importance of rural

industrial convergence for regional economic benefits (Qi et al., 2021). Rural industrial convergence is essential for China to implement a rural revitalisation strategy and achieve shared prosperity (Fu et al., 2022). In January 2016, the General Office of the State Council officially issued the document “Guiding Opinions on Promoting the Convergence and Development of Rural Primary, Secondary, and Tertiary Industries” (Central People's Government of the People's Republic of China Network, 2016). At this point, the convergence of rural industries has become a critical development way to sustain farmers' income in China. Currently, the literature on rural industrial integration and farmers' income growth focuses on the following two aspects:

First, the impact of rural industrial integration on farmers' income growth. One hand, rural industrial convergence has a significant positive impact on farmers' income (Wang and Li, 2019). The convergence of rural industries helps alleviate farmers' poverty vulnerability (Li and Lu, 2019). It promotes farmers' income growth by extending the agricultural industry chain, giving full play to agricultural versatility, and promoting the integrated development of agricultural service industries (Tang and Hu, 2017). The income of the subjects participating in the convergence of rural industries has increased significantly (Guo et al., 2019; Li et al., 2020). In particular, the average gross and operating incomes of farm households involved in rural industrial convergence are significantly higher than those of households not involved in rural industrial convergence (Yang and Ding, 2019). The micro-survey data of farmers' households also confirmed that compared with the traditional agricultural development model, the income increase effect of farmers participating in rural industrial convergence is as high as 50% (Li et al., 2017).

On the other hand, there is heterogeneity in the impact of rural industrial convergence on farmers. The impact of rural industrial convergence on farmers is not the same, and the effect of low-income farmers' income increase is more prominent (Qi et al., 2021). In addition, due to the differences in location conditions, resource conditions, development foundations and other factors between rural areas (Li J. J., 2021), the impact of rural industrial integration on farmers' income between different regions is also heterogeneous (Wang and Li, 2019).

Second, rural industrial convergence helps to narrow the income gap between urban and rural areas and can lead farmers to shared prosperity. Agricultural industrialisation is the focus of rural industrial convergence. It is a crucial breakthrough to narrow the urban-rural income gap (Chen, 2005). The critical reason for the increasing urban-rural income gap in Hunan Province is that agricultural industrialisation is not high (Song, 2011). The impact of urban-rural income gap changes in the Yangtze River Economic Belt is also in developing rural industrial convergence (Li, 2022). Promoting agricultural industrialisation, improving land and labour productivity, and increasing farmers' operating income will help narrow the urban-rural income gap (Lai, 2012).

2.2. Rural industrial convergence and urbanization development

When it comes to industrial convergence, it is necessary to analyse urbanisation construction because industrial development and

urbanisation are interactive, and industrial employment structure can significantly affect the urbanisation rate (Long et al., 2015). In the early days, Lewis (1954) found that the industrial sector absorbed surplus labour from the agricultural sector and played an essential role in increasing the income of rural labour. Rural workers are usually affected by the expected income gap to decide whether to migrate from rural to urban areas (Todaro, 1969). Urbanisation is gathering population and resources into cities and towns, promoting social and cultural convergence and economic structure optimisation (Liu et al., 2023). With the continuous improvement of the economy and industrial structure, farmers' income has been increasing. The literature research on rural industrial convergence and urbanisation development mainly focuses on the following:

First, rural industrial convergence and urbanisation development have a promoting effect. Michaels et al. (2008) believe that with the advancement of urbanisation, the specialisation of the labour force improves production efficiency and promotes the improvement of technological innovation level and the aggregation of emerging industries, which leads to the adjustment of industrial structure. Duan (2017) found that the key to the success of urbanisation is to realise the upgrading of industrial structure through the improvement of production efficiency; the adjustment of industrial structure, especially the change of the proportion of employment structure, is the reason for the increase of urbanisation rate (Sun and Chai, 2012; Hong, 2013). Similarly, urbanisation can promote the transformation of industrial and employment structures (Li, 2011).

Second, there is a negative correlation between rural industrial convergence and urbanisation development. Farhana et al. (2014) found that due to the division of labour under urbanisation, developing countries promote urbanisation in an extensive development mode, which inhibits the adjustment and optimisation of industrial structures. When the level of new urbanization does not match the relative amount of industrial transfer, such as industrial transfer lags behind the development of new urbanization, and the development of new urbanization inhibits the transfer of industrial structure (Zhou et al., 2019). With regard to urbanization, different countries and regions have different impacts on their industrial structure in developing countries. There is no significant impact on its industrial structure in Africa (Gollin et al., 2015). In addition, urbanization will also have a negative impact on some industries. For example, urbanization will have a specific crowding-out effect on manufacturing (Huang and Qiu, 2017). At the same time, other factors (such as the level of financial support for agriculture) will also restrict the effect of urbanisation on the development of rural industrial convergence (Li X. L., 2021).

Based on the current literature review, it is found that most researchers focus on the analysis of the single factor influence of rural industrial convergence or urbanisation development level on farmers' income or directly discuss the developing relationship between rural industrial convergence and urbanisation. Few people include rural industrial convergence, urbanisation development level, and farmers' income growth in a research framework. Therefore, it is one of the marginal contributions of this paper to integrate the above three into an analytical framework and use the level of urbanisation development as an intermediary variable and threshold variable to carry out empirical research on the intermediary effect and threshold effect. The second marginal contribution is constructing the index system of rural industrial convergence and using the principal component

analysis method to objectively measure rural industrial convergence development.

3. Theoretical mechanism and research hypothesis

3.1. The direct influence mechanism of rural industrial convergence on farmers' income increase

The influence mechanism of rural industrial convergence on farmers' income is as follows: First, rural industrial convergence is conducive to developing agricultural industrialisation and improving comprehensive agricultural income. Jiang (2017) believes that agricultural industrialisation is the source and main content of the convergence and development of rural industries. Agricultural industrialisation focuses on the radiation and driving role of leading enterprises and realises the endogenous development of rural areas and the multi-functional development of agriculture (Zhao, 2015). In particular, the convergence of primary, secondary, and tertiary industries led by farmers' professional cooperatives can enhance the potential of agriculture itself, realise the increase of agricultural added value and sustainable development, and increase farmers' income (Li and Liu, 2019). Second, the convergence of rural industries is conducive to broadening the channels for farmers to increase their income and build a non-agricultural employment platform. (Rhodes, 1993) believes that industrial convergence makes the production and sales stages of agricultural products and other related products more integrated, forming an orderly chain from the supply of production materials to the processing and retail of products so that farmers can obtain the profits of industrialisation. China's rural industrial convergence development practice models mainly include leading agricultural enterprises, industrial and commercial capital, vertical convergence management, and 'Internet + agriculture' e-commerce platforms (Lv and Liu, 2017). These platforms save production transaction costs and create conditions for realising local non-agricultural employment and household utility maximisation (Cai et al., 2020). The income of farmers has increased steadily in the development trend of rural industrial convergence. Because of this, this paper proposes hypothesis 1.

Hypothesis 1: Rural industrial convergence promotes the increase of farmers' income.

3.2. The indirect mechanism of rural industrial convergence to promote farmers' income

The level of urbanisation development is an indirect mechanism for rural industrial convergence to promote farmers' income increase. It is proposed to optimise the industrial structure based on urbanisation (Tian and Abdurezak, 2010), and the convergence of rural industries can also promote the development of local urbanisation (Li and Zhao, 2017). In the long run, there is a positive interaction between urbanisation development and farmers' income growth (Song and Xiao, 2005). The impact of urbanisation

development on farmers' income growth: First, urbanisation development is conducive to improving the operating income of rural households. Population urbanisation is an essential manifestation of urbanisation development. With the migration of agricultural surplus labour, the requirements of agricultural production for agricultural production are also increased, thus increasing the operating income of farmers (Li, 2016). At the same time, by transferring farmers' land use rights, we can expand the scale of farmers, thus creating new development opportunities for farmers to increase their income. Second, the development of urbanisation is conducive to improving the wage income of rural residents. Urbanisation helps to increase farmers' wage income (Wang and Peng, 2013). Urbanisation development provides farmers with many employment opportunities, and the transfer of rural labour force employment increases wage income (Fang and Zhang, 2015). Thirdly, urbanisation development is conducive to improving farmers' financial transfer payment income. Urbanisation development is closely related to local economic growth. 'As urbanisation enters a stage of rapid development, a large number of rural surplus labour force pours into cities and towns, the level of industrialisation continues to increase, and economic growth accelerates simultaneously (Cai et al., 2023). When a region's economy develops to a certain extent, its funds for supporting agriculture will be adequately guaranteed. Simultaneously, there will be more capital inflows of transfer payments to rural areas. Based on this, this paper proposes Hypothesis 2.

Hypothesis 2: Rural industrial convergence promotes farmers' income through urbanisation.

3.3. The influence mechanism of non-linear relationship between rural industrial convergence and farmers' income growth

The proportion of the urban population is significantly related to the industrial structure and distribution (Long et al., 2015) and plays an essential role in the city's economic development. Of course, there is a non-linear relationship between industrial integration and regional economic development. For example, the convergence of cultural and tourism industries can positively promote economic growth in ethnic areas, and its impact has non-linear characteristics. There is an optimal level of convergence of cultural and tourism industries that promotes economic growth (Zhao and Wang, 2022). In addition, urbanisation development also has a threshold effect on farmers' income growth. Since the mid-1980s, farmers' income has been developing in an unstable and discontinuous trend, and the growth has been prolonged (Li et al., 2017). In recent years, due to the fluctuation of economic development and the weak occupational stability of migrant workers, the difficulty of increasing farmers' income and the risk of partial reduction have increased significantly (Jiang and Lu, 2017). Therefore, this paper proposes hypothesis 3.

Hypothesis 3: There is a non-linear relationship between the impact of agricultural industry convergence on farmers' income.

4. Materials and methods

4.1. Model construction

On this basis, this paper examines the relationship between the degree of urbanisation on rural industrial agglomeration and the increase in farmers' income, examines the regulatory effect of the degree of urbanisation on rural industrial agglomeration and peasant household income, and takes urbanisation as an intermediary variable. This part mainly refers to the literature of [Baron and Kenny \(1986\)](#) and [Wen et al. \(2004\)](#), then introduces the stepwise test method to construct the intermediary effect model.

$$\text{Income}_{i,t} = \beta_0 + \beta_1 \text{Industry}_{i,t} + \beta_2 Z_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$\text{Urban}_{i,t} = \alpha_0 + \alpha_1 \text{Industry}_{i,t} + \alpha_2 Z_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$\text{Income}_{i,t} = \lambda_0 + \lambda_1 \text{Industry}_{i,t} + \lambda_2 \text{Urban}_{i,t} + \lambda_3 Z_{i,t} + \varepsilon_{i,t} \quad (3)$$

In equation (1), $\text{Income}_{i,t}$ refers to the disposable income of farmers in i province during the t period, $\text{Industry}_{i,t}$ refers to the development level of rural industrial integration in i province during the t period, $Z_{i,t}$ is a group of control variables, $\varepsilon_{i,t}$ is a random disturbance term. Based on the test of the influence coefficient of rural industrial convergence development level $\text{Industry}_{i,t}$ on farmers' income increase $\text{Income}_{i,t}$, β_1 in Eq. 1. The linear regression equation of rural industrial convergence development level $\text{Industry}_{i,t}$ to the intermediary variable urbanisation development level $\text{Urban}_{i,t}$ is constructed (such as Eq. 2). Finally, the linear regression equation of $\text{Industry}_{i,t}$ and intermediary variable $\text{Urban}_{i,t}$ to $\text{Income}_{i,t}$ (such as formula 3) was constructed, and the significance of regression coefficients such as α , λ , and λ_2 judged the existence of the intermediary effect. In addition, to further explore the non-linear effect of agricultural industry convergence on farmers' income due to urbanisation development, a threshold effect model of agricultural industry convergence on farmers' income under the background of urbanisation construction is constructed to verify Hypothesis 3. This paper draws on [Hansen \(1999\)](#), [Wang \(2015\)](#) and other threshold research experience, combined with the actual data, to set up a double threshold model; the particular assumptions are as follows:

$$\begin{aligned} \text{Income}_{i,t} = & \mu_i + \eta_1 \text{Industry}_{i,t} I(\text{Urban}_{i,t} \leq \gamma_1) + \\ & \eta_2 \text{Industry}_{i,t} I(\gamma_1 < \text{Urban}_{i,t} \leq \gamma_2) + \\ & \eta_3 \text{Industry}_{i,t} I(\text{Urban}_{i,t} > \gamma_2) + \theta Z_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (4)$$

i represents the region, t represents the year, $\text{Income}_{i,t}$ is the explained variable, μ_i is used to reflect the individual effect of the region, $\text{Urban}_{i,t}$ represents the threshold variable, γ as the specific threshold value, $I(\cdot)$ is the indicative function, and the true and false are determined according to the results of 0 and 1 in the brackets. $Z_{i,t}$ is a set of control variables, θ is the corresponding coefficient vector and $\varepsilon_{i,t}$ is the random disturbance term.

4.2. Variable description

4.2.1. Explained variable

Farmers' income, variable symbol marked as *Income*. The growth of rural residents' income is measured by the logarithm of the *per capita* disposable income of rural residents.

4.2.2. Core explanatory variable

This paper takes the rural industrial convergence evaluation index as the core explanatory variable, and the variable symbol is marked as *Industry*. Rural industrial convergence is a comprehensive indicator, including two secondary and six tertiary indicators (as shown in [Table 1](#)). This index is mainly processed by principal component analysis.

4.2.3. Threshold or intermediary variable

This paper selects the level of urbanisation development as an intermediary and threshold variable, measured by the ratio of the urban and variable symbol marks *Urban*.

4.2.4. Control variables

(1) Government support, the variable symbol mark *Government*, measured by budget expenditure. (2) Scientific and technological innovation, variable symbol mark *Innovations*, take the logarithm of patent authorisation. (3) the degree of opening to the outside world, variable symbol mark *Open*, measured by the total import and export. (4) The level of domestic tourism development, the variable symbol mark *Tourism*, with the total domestic tourism consumption to measure (see [Table 2](#)).

4.3. Data sources and data processing

4.3.1. Data source

Considering the accessibility of data, this paper uses the panel data of 29 provinces or municipalities from 2004 to 2020, excluding Tibet, Xinjiang, Taiwan, Macao, and Hong Kong in China. The data in this paper mainly come from the National Bureau of Statistics, China Statistical Yearbook, China Industry Statistical Yearbook, China Rural Development Yearbook, China Agriculture and Rural Development Database, and China Economic and Social Big Data Research Platform. Part is from annual reports on the national economic and social development of China and its provinces and municipalities and yearbooks for each province and municipality.

4.3.2. Data processing

First, the missing value of the indicator data is filled by the moving average method. Second, the index lacks value in dealing with two methods. On the one hand, the average value is obtained by adding the annual growth rate of the index. On the other hand, the data without relevant index refers to the literature of [Zhu and Xu \(2003\)](#) in the Economic Research magazine, such as the amount of investment completed in industrial pollution control is processed using the calculation index (0.55* Consumer Price Index + 0.45 * Fixed Asset Investment Price Index). Third, the income of statistical indicators is deflated with 2004 as the base year to eliminate the impact of inflation on the value.

TABLE 1 Rural industry convergence index system description.

First grade indexes	Level 2 indicators	Three levels indicators	Index calculation and description	Attribute
The comprehensive development level of rural industrial convergence	Convergence behaviour	Agricultural Industry	Agricultural production and processing level (%): The primary income of agricultural and sideline food products processing / Total output value of agriculture, forestry, fishery, and animal husbandry; Symbol D1	Positive
			Agricultural commodity rate (%): commercial agricultural output / total value of farm product; Symbol D2	Positive
		Agricultural Multi-purpose	The ratio of rural population to the added value of agriculture, forestry, animal husbandry, and fishery per 10,000 people (yuan/person): G.D.P. of primary industry / Rural population; Symbol D3	Positive
			Fertiliser application rate per unit area (tons/ha); Fertiliser application amount/crop planting area measurement; Symbol D4	Negative
			Percentage of non-agricultural employment (%): Rural individual employment + rural private enterprise employment / Rural employees; Symbol D5	Positive
		Industrial Support	Four highway mileage (km); Symbol D6	Positive
			Rural delivery route (km); Symbol D7	Positive
			Mobile telephone switch capacity (ten thousand); Symbol D8	Positive
		Fusion Result	Strong Farming	increased agricultural production: Total grain output <i>per capita</i> (kg/person); Symbol D9
	Modernisation of agricultural production: Agricultural machinery total power (kilowatts); Symbol D10			Positive
	Rich People		Rural retail sales (billion yuan); Symbol D11	Positive
			Rural residents 'consumption expenditure (yuan/person); Symbol D12	Positive
	Strong Village		Fixed asset investment and housing construction of rural households (billion yuan); Symbol D13	Positive
			Rural solar water heater (ten thousand square meters); Symbol D14	Positive

TABLE 2 Variable description.

Variable type	Variable symbol	Name of indicator	Index calculation
Explained variable	<i>Income</i>	Rural income	<i>Per capita</i> disposable income of rural residents
Core explanatory variable	<i>Industry</i>	The comprehensive development level of rural industrial convergence	P.C.A
Mediation /Threshold variable	<i>Urban</i>	Urbanisation development	Population urbanisation rate
Control variables	<i>Government</i>	Support from government	Budgetary fiscal expenditure
	<i>Innovation</i>	Science and technology innovation	Patent grants
	<i>Open</i>	Degree of openness to foreign trade	Total export–import volume
	<i>Tourism</i>	Domestic tourism consumption level	The total domestic tourism consumption

TABLE 3 Statistical description of variables.

Variable symbol	Name of indicator	Number of observations	Mean value	Standard deviation	Minimum value	Maximum value
<i>Income</i>	Rural income	493	42.5333	16.3528	17.9600	98.6828
<i>Industry</i>	The comprehensive development level of rural industrial convergence	493	1.1000	0.5671	0.0966	3.7843
<i>Urban</i>	Urbanisation development	493	0.5498	0.1436	0.2571	0.9215
<i>Government</i>	Support from government	493	3591.4410	2905.7450	123.0200	17430.7900
<i>Innovations</i>	Science and technology innovation	493	70122.2200	120460.1000	124	967204
<i>Open</i>	Degree of opening to the outside world	493	1.13e+08	1.95e+08	332,800	1.09e+09
<i>Tourism</i>	Domestic tourism development level	493	10588.6000	19067.2000	30.0662	153831.2000

Data source: The data in the table are calculated by STATA 15.0.

4.4. Statistical description of variables

There are 493 observed variables in this paper, and the descriptive statistics of variables are shown in Table 3. Among them, the mean value of the explained variable farmers’ income is 42.53329, the standard deviation is 16.35281, the minimum value is 17.96, and the maximum is 98.68276. These data show that the income gap between provinces is narrowing with the steady growth of farmers’ *per capita* disposable income. The mean value of the comprehensive development level of rural industrial integration is 1.1, the standard deviation is 0.5671242, the minimum value is 0.0965812, and the maximum value is 3.784256. This means that the comprehensive development level of China’s rural industrial integration has a large gap between provinces, with a difference of 39 times between the maximum and the minimum. The development of rural industrial integration still has a long way to go. In addition, the development of urbanization is relatively balanced. Still, the maximum and minimum values of variables such as government financial support, scientific and technological innovation, domestic tourism development level, and opening up are far from each other.

4.5. Co-linearity analysis

This paper verifies the multivariate collinearity among the explanatory variables by using the expansion factor. The judgment method is based on the V.I.F. of the explanatory variable. When the

V.I.F. exceeds 10, the multiple correlations are higher. The maximum value of V.I.F. is 6.16 from the detected value of the variation expansion factor in Table 4. It can be seen that there is no significant multivariate co-linearity among the explanatory variables. In addition, to prove that each variable is related to the other, this paper has carried out the correlation coefficient test, which also has a specific correlation.

5. Results

5.1. Analysis of benchmark estimation results

This paper estimates the panel data by ordinary least squares linear estimation (O.L.S.). Firstly, it empirically studies the relationship between industrial convergence and farmers’ income. On this basis, the control variables are added sequentially, and finally, the mode of (1)~(5) is obtained. As shown in Table 5, the regression analysis of the model (5) shows that for rural industrial integration, each additional 1 percentage point will bring 17.32 percentage points of growth to farmers. Therefore, rural residents’ *per capita* disposable income will increase with the improvement of rural industrial integration. This result confirms that the “rural industry integration” mentioned in Hypothesis 1 plays a positive role in promoting the economic development of farmers. Among the control variables, the degree of government support, openness, and the development of domestic tourism is most closely related to the economic income of farmers.

Among them, the opening-up index is positive, indicating that the degree of openness of enterprises is higher, and the degree of internationalisation of their products is higher; the development of enterprises has improved, and farmers have obtained more jobs; their treatment has been better guaranteed, and their quality of life has been further improved. In addition, the coefficient of domestic *per capita* tourism consumption is positive, which shows that under the influence of the improvement of domestic *per capita* tourism consumption and the policy of ‘tourism +’ industrial integration, farmers’ income will also rise gradually.

5.2. Analysis of mediating effect results

This paper draws on Baron and Kenny (1986) and Wen et al. (2004) three-step method to analyse the intermediary effect empirically and find an indirect transmission mechanism between rural industrial convergence and farmers’ income. Urbanisation is the intermediary variable between the two, and the result is significant.

TABLE 4 Expansion factor test results.

Variables	VIF	1/VIF
Industry	3.43	0.2919
Urban	1.51	0.6604
Government	6.16	0.1623
Innovation	5.26	0.1901
Open	3.40	0.2937
Tourism	1.30	0.7714
Mean VIF	3.51	

Data source: The data in the table are calculated by STATA 15.0.

The mediating effect test is divided into three steps: the first step, through the β_1 coefficient in equation 1 to represent the total effect of rural industrial convergence on farmers’ income, is clear that the β_1 coefficient is significantly positive. In the second stage, an empirical analysis was conducted to analyse the impact of rural industrial integration on urbanisation development according to Eq. 2. Model (6) shows that the variable Urban is significantly positive at 1%, indicating that rural industrial convergence is rising and urbanisation development is gradually accelerating. The third step is to test whether the results of rural industrial convergence (*Industry*) variables in Formula 3 are significant. Model (7) shows that the empirical results of rural industrial convergence (*Industry*) are significant, and the correlation coefficient decreases, which indicates that there is a partial mediating effect between urbanisation development (*Urban*) and rural industrial convergence (*Industry*). The Sobel test was carried out simultaneously for the validity of the above results. It was found that the Sobel test *p* value was 0.0004, the Z value was 3.485, and the *p* value of the test results was less than 0.001. In addition, the two significance tests of Goodman1 and Goodman2 also meet the requirements, which are significant at 1%. Alternatively, the proportion of mediating effect to total effect is 28.52%, and the empirical conclusion supports Hypothesis 2 (see Table 6).

5.3. Panel threshold effect analysis

Using the development degree of urbanisation as the threshold variable and the panel threshold regression method, this paper examines the internal relationship between rural industrial convergence and the increase in farmers’ income. It reveals the mechanism of rural industrial convergence on increasing peasant household income. To estimate all the parameters of the threshold model, the research should first test the number of thresholds and

TABLE 5 Benchmark O.L.S. regression results.

Variables	Income				
	(1)	(2)	(3)	(4)	(5)
Industry	16.69*** (15.73)	18.31*** (9.66)	19.95*** (11.15)	17.47*** (10.22)	17.32*** (10.19)
Government		-0.0003 (-1.03)	-0.0028*** (-6.24)	-0.0022*** (-5.14)	-0.0025*** (-5.64)
Innovation			0.0000*** (8.20)	0.0000 (1.35)	0.0000 (1.32)
Open				3.74e-08*** (8.13)	3.89e-08*** (8.45)
Tourism					0.0000** (2.68)
_cons	24.17*** (18.41)	23.76*** (17.32)	26.30*** (19.85)	26.30*** (21.14)	26.42*** (21.35)
N	493	493	493	493	493
R ²	0.34	0.34	0.42	0.49	0.49
Adj. R ²	0.33	0.33	0.41	0.48	0.49

t statistics in parentheses. * *p* < 0.1, ** *p* < 0.05, *** *p* < 0.01, One star shows 10% significance, two stars show 5% significance, and three stars show 1% significance.

TABLE 6 Mediating effect test results.

Variables	Income	Urban	Income
	(5)	(6)	(7)
Industry	17.32*** (10.19)	0.0597*** (3.50)	12.38*** (12.85)
Government	-0.0025*** (-5.64)	0.0000 (0.09)	-0.0025*** (-10.22)
Innovation	0.0000 (1.32)	-0.0000** (-2.78)	0.0000*** (6.42)
Open	3.89e-08*** (8.45)	4.29e-10*** (9.29)	3.47e-09 (1.24)
Tourism	0.0000** (2.68)	0.0000 (1.63)	0.0000* (2.37)
Urban			82.69*** (32.69)
_cons	26.42*** (21.35)	0.448*** (36.14)	-10.65*** (-8.02)
N	493	493	493
R ²	0.49	0.34	0.84
Adj. R ²	0.49	0.33	0.84
Sobel test	0.0004*** (z = 3.485)		
Goodman test 1	0.0004*** (z = 3.483)		
Goodman test 2	0.0004*** (z = 3.486)		
Mediation effect coefficient	0.0004*** (z = 3.485)		
Direct effect coefficient	0.0000*** (z = 12.854)		
Total effect coefficient	0.0000*** (z = 10.190)		
The proportion of the mediating effect	0.2852		

t statistics in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01, One star shows 10% significance, two stars show 5% significance, and three stars show 1% significance.

credibility. Firstly, the number of threshold values of the model is searched and determined, and the F value and p value of a single threshold and two thresholds are obtained, as shown in Table 7. It can be seen from Table 7 that the single threshold is not significant, the double threshold effect is significant at the level of 10%, and the corresponding p values are 0.0940. Therefore, this paper selects the double threshold model for analysis.

To detect the authenticity of the threshold value, we construct a confidence interval to judge. This paper uses a double threshold estimate, and the result is inferred by a 95% confidence interval (as shown in Table 8). The paper also uses likelihood ratio function graphs, such as Figures 1, 2. Since there are two threshold values, it is a segmented display, which can help us understand the threshold value's estimation and the confidence interval's construction process. The estimated value of the threshold parameter refers to the value of γ when the likelihood ratio test statistic L.R. = 0, which is 0.7960 (Figure 1) and 0.8500 (Figure 2) in the double threshold model of this study.

From the threshold effect regression result in Table 9, it can be seen that the impact of rural industrial convergence on farmers' income changes in three intervals. Rural industrial convergence positively impacts farmers' income growth by acting on urbanisation,

which verifies hypothesis 3. According to the double threshold test value of urbanisation, rural industrial convergence's impact on farmers' income growth is significantly positive when urbanisation is less than or equal to 0.7960 ($Urban \leq 0.7960$). For every point of growth in rural industrial convergence, farmers' income will rise by 6.311 points; when the level of urbanisation is between 0.7960 and 0.8500 ($0.7960 < Urban \leq 0.8500$), the income of farmers will rise by 8.831 points for every increase in rural industrial convergence. Indeed, as the fundamental driving force to promote the development of urbanisation, the Industry creates opportunities for farmers' employment through industrial agglomeration, industrial chain extension, and industrial multi-functional expansion (Zhu and Zhang, 2022). The flow of farmers accelerates urbanisation construction, and at the same time, the disposable income of farmers increases. In addition, from Model (8), it can be seen that the influence coefficient of rural industrial convergence on farmers' income increases first and then decreases. When the urbanisation level is between 0.7960 and 0.8500, the coefficient of rural industrial convergence affecting farmers' income growth is the highest.

5.4. Regional heterogeneity analysis

Based on the national and regional development strategy and the geographical location of each province, drawing on Shen et al. (2021), three groups of regional division criteria for eastern, central, and western¹. This paper presents a comparative study of 29 provinces in eastern, central, and western China. As can be seen from models (9) to (11), the results of the impact of the integration of the "three industries" in rural areas on farmers' income growth are significant at the 1% level in both the eastern and western regions. At the same time, they are significant at the 10% level in the central region. Among the three regions, the eastern region has the best result for the impact of the integration of rural "three industries" on farmers' income, which is related to its good agricultural industry base; the western region ranks second, which mainly depends on the strong support from the Chinese government to the western region; the coefficient of the central region is relatively low, which indicates that there is still room for development in the impact of rural industrial convergence on farmers' growth. Besides, the coefficient ranking of urbanisation development affecting farmers' income growth is consistent with the coefficient ranking of the impact of rural industrial convergence. For the control variable, its impact on farmers' income is not consistent in different models (see Table 10).

5.5. Robustness test

In the empirical robustness study, we use a model about the fixed effect of the relationship between industrial convergence and farmers'

1 The eastern group includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan; the central group includes Shanxi, Jilin, Heilongjiang, Henan, Hubei, Hunan, Anhui, Jiangxi; the western group includes Inner Mongolia, Chongqing, Sichuan, Guangxi, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia.

TABLE 7 The result of the threshold effect test.

Threshold	RSS	MSE	Fstat	Prob	Crit10	Crit5	Crit1
Single	2626.6767	5.51821	35.77	0.1860	44.5128	52.8291	70.5220
Double	2451.4985	5.1502	34.01	0.0940	33.4835	38.2559	55.2367

TABLE 8 Double threshold estimation results.

Threshold types	Threshold	95% Confidence interval
The first threshold	0.7960	(0.7761,0.8046)
The second threshold	0.8500	(0.8471,0.8593)

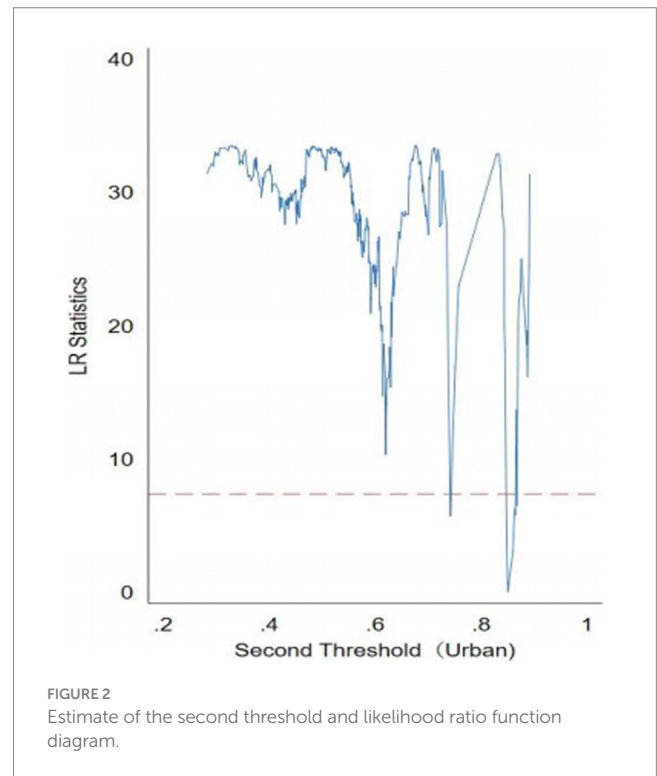
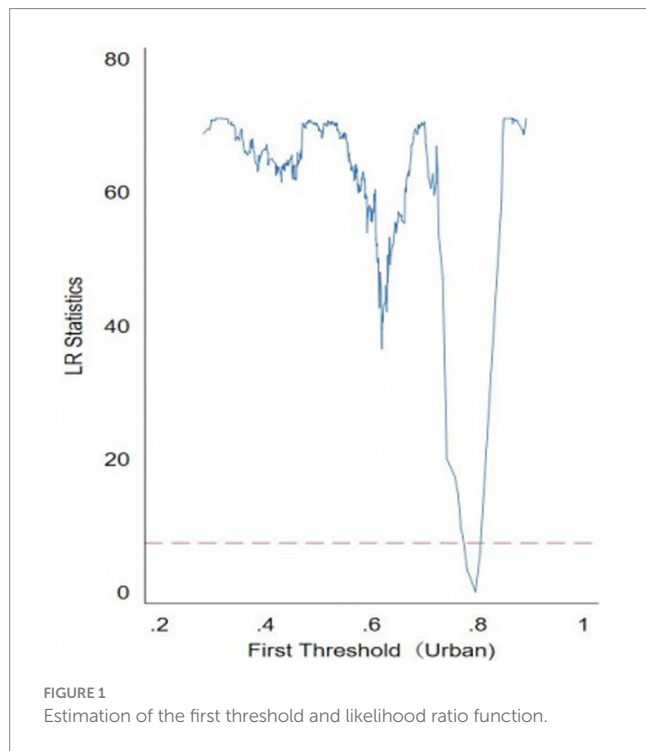


TABLE 9 Regression results of urbanization development threshold effect of rural Industrial convergence on farmers' income.

Variables	Income	
	(8)	
Industry	Urban ≤ 0.7960	6.311*** (0.748)
	0.7960 < Urban ≤ 0.8500	13.76*** (1.009)
	Urban > 0.8500	8.831*** (0.815)
Constant	30.16*** (0.473)	
Control variables	Controlled	
Observations	493	
Number of ids	29	
R-squared	0.855	

Standard errors are in parentheses. **p* < 0.1, ***p* < 0.05, ****p* < 0.01, One star shows 10% significance, two stars show 5% significance, and three stars show 1% significance.

income (as shown in Table 11), as follows: First, it adjusts the sample size and deletes the municipalities to carry out the robustness test. Since Shanghai, Beijing, Chongqing, and Tianjin are municipalities directly under the central government, there are differences between urban volume and provinces. Thus, this paper directly excludes these four municipalities for regression. Model (12) shows that the impact of rural industrial convergence on farmers' income is still significant. Second, The study is robust by lagging the explanatory variables one period; the lag of one explanatory variable, L.industry in the model (13), passes the significance test at the 1% level, and the coefficient is positive, close to the benchmark result. Third, robustness is measured by replacing control variables. In model (14), the degree of economic development (*Economy*), the degree of human capital (*Capital*), and foreign investment (*FDI*) are added. Through linear regression analysis of the explanatory variables, the regression coefficients are robust and remain significantly positive at the 1% level. In terms of the control variables, the level of G.D.P. *per capita* (*Economy*) has a

significant effect on farmers' income with a positive coefficient; the number of college students per 100 people (*Capital*) also has a significant effect on farmers' income with a negative coefficient; The effect of foreign investment, i.e., total investment in foreign enterprises, on farmers' income is significantly positive. The results of this study are robust through the above three methods.

TABLE 10 Regional heterogeneity regression results.

Variables	Income		
	East	West	Central
	(9)	(10)	(11)
Industry	16.80*** (8.21)	10.80*** (8.99)	1.564* (2.05)
Urban	96.96*** (19.07)	41.37*** (16.89)	16.19*** (4.30)
Government	-0.0052*** (-7.28)	-0.0010** (-2.89)	0.0001 (0.29)
Innovation	0.0001*** (6.37)	-0.0000** (-2.78)	0.0000 (1.06)
Open	3.16e-09 (0.63)	9.77e-08*** (8.23)	2.33e-08 (0.84)
Tourism	0.0000 (1.03)	0.0000 (0.38)	0.0000 (0.68)
FE	Yes	Yes	Yes
N	187	170	136
R ²	0.80	0.94	0.90
Adj. R ²	0.77	0.93	0.88

t statistics in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01, One star shows 10% significance, two stars show 5% significance, and three stars show 1% significance.

6. Conclusions and policy implications

6.1. Conclusion

This study conducted empirical research on developing rural industrial integration in 29 provinces (municipals) in China from 2004 to 2020. Least squares, mediation models, and panel threshold models were used to investigate the intrinsic relationship between the development of rural industrial integration and urbanisation and farmers' income growth. The research conclusions are: (1) Rural industrial convergence is essential to increase farmers' income. In addition, the empirical results are still robust by deleting the samples of municipalities, lagging one-period explanatory variables, and replacing control variables. (2) The degree of urbanisation as an intermediary variable of rural industrial convergence development affecting farmers' income increase indirectly promotes the growth of farmers' income, and the intermediary effect is significant. (3) The level of rural industrial convergence development has a non-linear impact on farmers' income. The degree of urbanisation development is the threshold variable and passes the double threshold test. The impact of rural industrial convergence development on farmers' income increases first and then decreases. When the level of urbanisation is between 0.7960 and 0.8500, rural industrial convergence development has the highest impact on farmers' income. (4) Rural industrial integration on the increase of farmers' income has regional differences. The contribution of rural industrial integration to farmers' income growth was significantly positive at the 1% level in both the eastern and western regions, with the highest coefficient of influence in the eastern region and the second highest in the western

TABLE 11 Robustness test results.

Variables	Income		
	Delete municipalities	Lag one phase explanatory variable	Replace control variables
	(12)	(13)	(14)
Industry	10.70*** (10.32)		3.580*** (4.86)
Urban	63.91*** (13.35)	89.03*** (27.66)	23.97*** (4.61)
Government	-0.0024*** (-6.72)	-0.0020*** (-5.47)	
Innovation	0.0000*** (9.60)	0.0000*** (6.07)	
Open	-5.66e-09 (-1.72)	-8.45e-10 (-0.25)	
Tourism	0.0000*** (3.60)	0.0000** (2.70)	
L.industry		11.40*** (10.39)	
Economy			0.109*** (15.10)
Incapital			-2.955** (-2.82)
lnfdi			1.381*** (4.15)
FE	Yes	Yes	Yes
N	425	464	493
R ²	0.77	0.84	0.90
Adj. R ²	0.75	0.84	0.89

t statistics in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01, One star shows 10% significance, two stars show 5% significance, and three stars show 1% significance.

region. Provinces in the central region were significantly positive at the 10% level.

6.2. Policy implications

Based on the above research conclusions, it can get the following policy implications:

First, it's necessary to give full play to the advantages of rural industrial convergence to improve the income structure of farmers and provide sustainable development momentum for farmers' income growth. One is that it should highlight the essential functions of agriculture, develop modern agriculture, and increase farmers' operating income. Each region should develop a modern industrial system of agricultural products according to local conditions in combination with regional resource endowment differences, not

only to ensure the adequate supply of agricultural products but also to avoid the homogenisation of agricultural industry development, form a reasonable layout of the agricultural industry and agricultural characteristic brand, and realise the steady increase of farmers' operating income. The other is it should strengthen the function expansion of the secondary and tertiary industries of agriculture and broaden the wage income of farmers. Fine agricultural industry division of labour, extending the industrial chain through the rich agricultural production, processing, sales, circulation, and another modern agricultural support system, using rural cooperatives or leading agricultural enterprises and other organisations to radiate the leading role of non-agricultural jobs for farmers. Another is to improve the national financial support for agriculture and agricultural policies and increase farmers' financial transfer payment income.

Second, it should use the advantages of "city-industry convergence" and take the opportunity of county urbanisation construction to provide new development impetus for farmers' income increase. According to the National Bureau of Statistics of China's urbanization rate of 0.6522 in 2022, the impact of China's urbanization development level on farmers' income growth has not yet reached the optimal level. At present, China's urbanization development strategy has shifted from the provincial level to the county level. Therefore, it is essential to strengthen the integrated development of county urbanisation and rural industry, guide the rational flow and effective convergence of urban and rural industrial resource elements, and establish a rural industrial development system with the county as the development centre. One of them is it should create a relaxed industrial development environment in the process of county urbanisation construction, break through the bottleneck of rural industrial convergence development, and create a good development environment for farmers' income increase. The second one is it should resolve the dilemma of lagging transformation of rural industrial production and processing, resource and environmental constraints, financial and insurance support, and market channel development with new ideas, new methods, and new measures. Then, it needs to take the opportunity of *in-situ* urbanisation development in the county to provide farmers with more non-agricultural jobs and expand farmers' income channels.

Third, it is essential to give full play to the advantages of industrial development in the eastern, central, and western regions and formulate diversified and differentiated policies for increasing farmers' income. At first, It should learn from advanced model experience. The eastern region has a good industrial foundation and preferential regional development policies. The impact coefficient of rural industrial convergence on farmers' income growth is the highest. So, summarising the typical experience of the impact of rural industrial convergence on farmers' income growth in the eastern region provides a reference for the central and western regions. The second is to stimulate the development potential of the central region. Most of the agricultural provinces in the central region are innovative in the mechanism of rural industrial convergence in the central region, giving full play to the advantages of resource endowments in the central agricultural provinces, taking the road of convergence of the three industries in the agricultural provinces, and maximising the disposable income of rural residents. Lastly, it should use the advantages of the Western development policy to store the growth momentum of farmers' income in the Western region.

Fourth, It is essential to rely on information technology to promote the convergence of rural industries and broaden the channels of increasing farmers' income in any way. The rapid development of science and technology promotes the improvement of agricultural production efficiency and broadens the channels for the growth of farmers' agricultural and non-agricultural income. Based on this, on the one hand, It should complete the construction of agricultural modernization as soon as possible with the help of information technology and increase farmers' income through scale, organization and intensification; on the other hand, it should extend the agricultural chain using the communication function of information technology (such as live broadcast, small video, etc.), meanwhile making use of 'rural tourism +' policy to expand the function of agricultural, and steadily increase farmers' income.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

YZ and JY: conceptualisation. JY: methodology and writing—review and editing. JY and LC: software, formal analysis, resources, data curation, and writing—original draft preparation. YZ and LC: supervision. All authors contributed to the article and approved the submitted version.

Funding

This study is funded by the Excellent Youth Project of Scientific Research of the Hunan Provincial Education Department, grant number 22B1057.

Acknowledgments

I would like to express our gratitude to all those who helped us while writing this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Alkbari, M., Alamdarlo, H. N., and Mosavi, S. H. (2020). The effects of climate change and groundwater salinity on farmers' income risk. *Ecol. Indic.* 110:105893. doi: 10.1016/j.ecolind.2019.105893
- Anirban, M., Premalata, S., Mrinmoy, R., and Burman, R. R. (2018). Enhancing farmers income through farmers' producers companies in India: status and roadmap. *Indian J. Agric. Sci.* 88, 1151–1161. doi: 10.56093/ijas.v88i8.82441
- Ayanwale, A. B., Ojo, T. O., and Adekunle, A. A. (2023). Estimating the distributional impact of innovation platforms on income of smallholder maize farmers in Nigeria. *Heliyon* 9:e16026. doi: 10.1016/j.heliyon.2023.e16026
- Baron, R. M., and Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J. Pers. Soc. Psychol.* 51, 1173–1182. doi: 10.1037//0022-3514.51.6.1173
- Cai, X. X., Cheng, Q. W., and Xu, A. A. (2023). Economic growth, urbanization and agricultural land transfer. *Soc. Sci. Front.* 3, 95–104.
- Cai, J., Liu, F., and Xia, X. L. (2020). Rural industrial convergence, non-farm employment and farmers' income increase: micro empirical evidence based on Liupan Mountain. *Resour. Environ. Arid Regions.* 34, 73–79. doi: 10.13448/j.cnki.jalre.2020.38
- Central People's Government of the People's Republic of China Network (2016). Available at: https://www.Gov.cn/gongbao/content/2016/content_5033865.htm (Accessed December 22, 2022).
- Chen, Y. C. (2005). Some issues on the urban-rural income gap in China. *De Economist* 4, 66–71.
- Duan, B. D. (2017). Interaction of urbanization and industrial structure change: characteristic facts and development logic. *J. Theory* 4, 59–66. doi: 10.14110/j.cnki.cn-37-1059/d.2017.04.009
- Fang, N., and Zhang, K. H. (2015). An empirical study on the relationship between urbanization and farmers' wage income based on the ECM model. *Stat. Decis. Mak.* 10, 137–139. doi: 10.13546/j.cnki.tjyc.2015.10.039
- Farhana, K. M., Rahman, S. A., and Rahman, M. (2014). Factors of migration in urban Bangladesh: an empirical study of poor migrants in Rahshahi City. *Soc. Sci. Electron. Publ.* 9, 105–117. doi: 10.2139/SSRN.2517201
- Fu, L. L., Huang, Z. H., and Peng, W. H. (2022). The mechanism and promotion path of "mutual benefit and symbiosis" of rural industrial fusion management subjects. *J. Nanjing Agric. Univ.* 22, 69–77. doi: 10.19714/j.cnki.1671-7465.2022.0091
- Gollin, D., Jedwab, R., and Vollrath, D. (2015). Urbanization with and without industrialization. *J. Econ. Growth* 21, 35–70. doi: 10.1007/s10887-015-9121-4
- Guo, J., Zhang, X. R., and Kong, X. Z. (2019). Convergence of rural one, two and three industries and farmers' income increase - based on the case of convergence of rural one, two and three industries in Henan Province. *Agric. Econ. Issues* 3, 135–144. doi: 10.13246/j.cnki.iae.20181114.001
- Hansen, B. E. (1999). Threshold effects in non-dynamic panels: estimation, testing, and inference. *J. Econom.* 93, 345–368. doi: 10.1016/S0304-4076(99)00025-1
- Hong, Y. Y. (2013). An empirical study on the relationship between population urbanization and economic growth and industrial structure. *Bus. Times* 8, 16–17.
- Huang, Z. M. (2016). An empirical study on the relationship between agricultural modernization, urbanization and farmers' income growth. *Stat. Decis. Mak.* 20, 106–109. doi: 10.13546/j.cnki.tjyc.2016.20.028
- Huang, C., and Qiu, D. R. (2017). Research on the interactive relationship between urbanization and manufacturing structure upgrading based on the crowding-in and crowding-out effect. *Econ. Theory Econ Manag* 5, 102–112.
- Jiang, C. Y. (2017). The role of agricultural industrialization leading enterprises in promoting rural industrial convergence. *Agric. Econ. Manag.* 2, 5–10.
- Jiang, C. Y., and Lu, Q. W. (2017). The current situation, difficulties and countermeasures of farmers' income increase. *Macrocon. Manag.* 10, 69–73. doi: 10.19709/j.cnki.11-3199/f.2017.10.016
- Lai, W. Y. (2012). Statistical analysis of the dynamic change of income gap between urban and rural residents in China. *Fujian Forum* 6, 34–37.
- Landicho, L., Paelmo, R., Cabahug, R., de Luna, C., Visco, R., and Tolentino, L. (2016). Climate change adaptation strategies of smallholder agroforestry farmers in the Philippines. *J. Environ. Sci. Manag.* 19, 37–45. doi: 10.47125/jesam/2016_1/05
- Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *Manch. Sch.* 22, 139–191. doi: 10.1111/j.1467-9957.1954.tb00021.x
- Li, L. S. (2011). On the impact of urbanization on industrial structure and employment structure. *Bus. Times* 18, 15–16.
- Li, L. (2016). Research on direct marketing model of agricultural products in the context of new urbanization. *Agric. Econ.* 2, 117–119.
- Li, J. J. (2021). *Research on the mechanism and path of rural industrial integration and human capital promoting farmers' income increase from the perspective of heterogeneity*. [Master, Jilin agricultural university] Available at: <https://kns.cnki.net/kcms/detail/detail.aspx?FileName=1021881119.nh&DbName=CMFD2022>.
- Li, X. L. (2021). Research on the impact of urbanization on the development of rural industrial convergence--analysis of the threshold effect based on financial support to agriculture. *Agric. Econ. Manag.* 2, 32–42.
- Li, J. (2022). *Study the effect of rural industrial convergence on the urban-rural income gap in the Yangtze River economic zone and its mechanism*. [Doctor, Chongqing Technology and Business University] Chongqing: Chongqing Technology and Business University.
- Li, Y. X., Dai, Z. Y., and Ding, S. J. (2017). Research on the income-increasing effect of the convergence of rural primary, secondary and tertiary industries for farm households--a PSM analysis based on a survey of 345 farm households. *J. Huazhong Agric. Univ.* 4, 146–147. doi: 10.13300/j.cnki.hnwxkb.2017.04.006
- Li, M. X., and Liu, C. F. (2019). Research on the convergence of one, two, and three industries in rural areas with interest linkage mechanisms to increase farmers' income: an example of industrial convergence driven by farmers' professional cooperatives. *Hunan Soc. Sci.* 3, 106–113.
- Li, X. L., and Lu, Y. Q. (2019). Poverty reduction effects and nonlinear characteristics of integrated rural industrial development--an empirical analysis based on a panel quantile model. *Stat. Inform. Forum.* 34, 67–74.
- Li, J. Y., Qin, C., and Xiang, M. (2020). Integration of rural one, two and three industries: a study on farmers' participation and its income increasing effect. *J. Jiangxi Univ. Finan. Econ.* 131, 106–116. doi: 10.13676/j.cnki.cn36-1224/f.2020.05.011
- Li, X. L., and Ran, G. H. (2019). How integrated development of rural industries affects the urban-rural income gap--based on the dual perspective of rural economic growth and urbanization. *Agric. Technol. Econ.* 8, 17–28. doi: 10.13246/j.cnki.jae.2019.08.002
- Li, X. J., and Zhao, M. L. (2017). Exploration of rural industrial convergence to promote local urbanization development. *Agric. Econ.* 11, 83–85.
- Liu, W., Lv, T., and Chen, Y. (2023). Research on the impact of new urbanization on promoting shared prosperity: an empirical analysis based on micro household data. *Urban Issues* 3, 92–103. doi: 10.13239/j.kxy.cswt.230310
- Long, F. J., Wang, X. Q., and Wang, J. (2015). Analysis of the interactive relationship between industrial development and urbanization. *Urban issues* 7, 19–25. doi: 10.13239/j.bjsshkxy.cswt.150703
- Lu, S. S., Sun, H. S., Zhou, Y., Qin, F., and Guan, X. (2020). Examining the impact of forestry policy on poor and non-poor farmers' income and production input in collective forest areas in China. *J. Clean. Prod.* 276:123784. doi: 10.1016/j.jclepro.2020.123784
- Luo, M. Z., and Wei, B. F. (2022). Analysis of environmental effects of rural industrial convergence. *Rural Econ.* 12, 57–66.
- Lv, Y. W., and Liu, Y. (2017). Integrated development of rural primary, secondary and tertiary industries: practical models, comparison of advantages and disadvantages and policy recommendations. *Rural Econ.* 12, 16–21.
- Michaels, G., Rauch, F., and Redding, S. J. (2008). Urbanization and structural transformation. *Q. J. Econ.* 127, 535–586. doi: 10.1093/qje/qjs003
- Miljkovic, D., Jin, H. J., and Paul, R. (2008). The role of productivity growth and farmers' income protection policies in the decline of relative farm prices in the United States. *J. Policy Model* 30, 873–885. doi: 10.1016/j.jpolmod.2007.01.006
- Mishra, A., and Agarwal, A. (2019). Do infrastructure development and urbanisation lead to rural-urban income inequality? Evidence from some Asian countries. *Int. J. Sustain. Econ.* 11:167. doi: 10.1504/IJSE.2019.099054
- Ogutu, S. O., Ochieng, D. O., and Qaim, M. (2020). Supermarket contracts and smallholder farmers: implications for income and multidimensional poverty. *Food Policy* 95:101940. doi: 10.1016/j.foodpol.2020.101940
- Ojo, T. O., and Baiyegunhi, L. J. S. (2021). Climate change perception and its impact on net farm income of smallholder rice farmers in south-west, Nigeria. *J. Clean. Prod.* 310:127373. doi: 10.1016/j.jclepro.2021.127373
- Qi, W. H., Li, J. J., and Cao, J. M. (2021). Research on the mechanism and path of rural industrial convergence to improve farmers' income: a new perspective based on rural heterogeneity. *Agric. Technol. Econ.* 8, 105–118. doi: 10.13246/j.cnki.jae.2021.08.008
- Rhodes, V. J. (1993). Industrialization of agriculture: discussion. *Am. J. Agric. Econ.* 99, 1137–1139. doi: 10.1093/ajae/aa020
- Shen, S., Chen, Y., and Lin, P. Q. (2021). The impact of technological progress and industrial structure distortion on energy intensity in China. *Econ. Res.* 2, 157–173.
- Sheng, J. C., and Wang, H. (2022). Participation, income growth and poverty alleviation in payments for ecosystem services: the case of China's Wolong nature reserve. *Ecol. Econ.* 196:107433. doi: 10.1016/j.ecolecon.2022.107433
- Sheoran, P., Kumar, A., Sharma, R., Barman, A., Parjapat, K., Singh, R. K., et al. (2021). Managing sodic soils for better productivity and farmers' income by integrating salt-tolerant rice varieties and matching agronomic practices. *Field Crop Res.* 270:108192. doi: 10.1016/j.fcr.2021.108192

- Song, X. Y. (2011). The path of agricultural industrialization to narrow the urban-rural income gap in Hunan. *Econ. Geogr.* 31, 1003–1007. doi: 10.15957/j.cnki.jjdl.2011.06.020
- Song, Y. L., and Xiao, W. D. (2005). Dynamic econometric analysis of the relationship between urbanization development and farmers' income growth in China. *Quan. Econ. Tech. Econ. Res.* 9, 31–40.
- Sun, X. H., and Chai, L. L. (2012). An empirical test of the interaction between industrial structure and urbanization. *J. Dalian Univ. Technol.* 33, 22–27. doi: 10.19525/j.issn1008-407x.2012.02.005
- Tang, C., and Hu, Y. T. (2017). Exploration of village governance capable people to promote the convergence of rural industries--a survey based on Xia Liuzhai village in Anhui Province. *J. Hunan Agric. Univ.* 18, 7–14. doi: 10.13331/j.cnki.jhau(ss).2017.01.002
- Tian, K. M., and Abdurezak, T. (2010). Study on the relationship between rural urbanization and industrial structure in Xinjiang. *Xinjiang Soc. Sci.* 5, 38–43.
- Tiffen, M. (2018). "Transitions in sub-Saharan Africa: agriculture, urbanization and income growth" in *The Earthscan Reader in Rural-Urban Linkages*. Routledge. 90–123.
- Todaro, M. P. (1969). Model of labor migration and unemployment in less developed countries. *Am. Econ. Rev.* 59, 138–148. doi: 10.2307/1811100
- Wang, Q. Y. (2015). Fixed-effect panel threshold model using Stata. *Stata J.* 15, 121–134. doi: 10.1177/1536867x1501500108
- Wang, L. N., and Li, Y. S. (2019). The impact of integrated development of rural primary, secondary and tertiary industries on farmers' income and its regional heterogeneity analysis. *Reformation* 12, 104–114.
- Wang, P. F., and Peng, H. F. (2013). Analysis of transmission paths and regional differences of urbanization development affecting farmers' income - a panel model based on co-convergence. *Agric. Technol. Econ.* 10, 73–79. doi: 10.13246/j.cnki.jae.2013.10.008
- Wen, Z. L., Zhang, L., and Hou, J. T. (2004). Mediation effect test procedure and its application. *J. Psychol.* 5, 614–620.
- Weng, Y. Z., Zeng, Y. T., and Lin, W. S. (2021). Do rural highways narrow Chinese farmers' income gap among provinces? *J. Integr. Agric.* 20, 905–914. doi: 10.1016/S2095-3119(20)63374-3
- Yang, J., and Ding, S. J. (2019). Analysis of farm household income structure differences and its policy implications from the perspective of rural industrial convergence - evidence from a micro survey in Hubei. *Western Forum* 29, 97–108.
- Yang, D., and Liu, Z. M. (2012). Does farmer economic organization and agricultural specialization improve rural income? Evidence from China. *Econ. Model.* 29:990. doi: 10.1016/j.econmod.2012.02.007
- Yuan, J. J., Lu, Y. L., Ferrier, R. C., Liu, Z., Su, H., Meng, J., et al. (2018). Urbanization, rural development and environmental health in China. *Environ. Dev.* 28, 101–110. doi: 10.1016/j.envdev.2018.10.002
- Zhang, L., Wen, T., and Liu, Y. B. (2020). Integrated development of rural industries and farmers' income growth: theoretical mechanism and empirical determination. *J. Southwestern Univ.* 46, 42–56. doi: 10.13718/j.cnki.xdsk.2020.05.005
- Zhao, H. (2015). On the integrated development of one, two, and three industries in rural areas. *Rural Manag.* 7, 26–29.
- Zhao, M., and Wang, R. Z. (2022). Research on the impact of cultural and tourism industry convergence on economic growth in ethnic regions--an econometric analysis based on data from 2000-2019. *Qinghai Ethnic Stud.* 33, 211–219. doi: 10.15899/j.cnki.1005-5681.2022.02.029
- Zhou, X. L., Cui, Y. W., and Zhang, S. P. (2020). Internet use and rural residents' income growth. *China Agric. Econ. Rev.* 12:315. doi: 10.1108/CAER-06-2019-0094
- Zhou, M., Ding, C. J., and Gao, W. (2019). Study on the effect of new urbanization on industrial structure adjustment. *Ecol. Econ.* 35, 101–108.
- Zhu, P. F., and Xu, W. M. (2003). The impact of government's science and technology incentive policy on large and medium-sized industrial enterprises' R&D input and patent output: an empirical study in Shanghai. *Econ. Res.* 45, 53+94.
- Zhu, Z. Q., and Zhang, M. X. Z. (2022). Based on inter-provincial panel data, the impact of integrated development of rural industries on new urbanization. *Res. World* 1, 21–28. doi: 10.13778/j.cnki.11-3705/c.2022.01.003