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# Perception of land rights, village industrial development, and household entrepreneurial behavior—evidence from non-farm entrepreneurship in rural China

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**Introduction:** Household entrepreneurship has a positive significance in increasing farmers' income, but currently farmers' entrepreneurial willingness is insufficient and entrepreneurial behavior needs to be further activated. Existing studies have examined the mechanism of entrepreneurial behavior more in terms of individual factors. However, behavioral decisions are the result of internal and external factors. Therefore, we analysed the mechanisms influencing farmers' entrepreneurial behavior from two aspects: farmers' internal psychological perception of the stability of land rights and the driving role of village-level industrial development.

**Methods:** Our analysis is based on data from a sample of 2356 farmers in Jiangsu Province, China, and uses mathematical modeling and binary logic modeling methods.

**Results:** The results show that the regression coefficient for the perception of land rights on farmers' entrepreneurial behavior is 0.573; the regression coefficient for village industrial development on farmers' entrepreneurial behavior is 1.480; and the regression coefficient for the interaction term between perception of land rights and village industrial development on farmers' entrepreneurial behavior is 0.361. This indicates that both the perception of land rights and village industrial development have a promoting effect on farmers' entrepreneurial behavior, and village industrial development moderates the impact of perception of land rights on farmers' entrepreneurial behavior.

**Discussion:** Based on the results of the study, the following implications have been drawn: first, it is necessary to strengthen land rights, regulate and guide the transfer of land, and strengthen the concept of stability of land rights; second, it is necessary to develop local speciality industries, and to help farmers' employment and entrepreneurship in a variety of forms and through a variety of channels.

## KEYWORDS

perception of land rights, industries development, entrepreneurial behavior, mathematical model, regression analysis

# 1 Introduction

Entrepreneurship helps to generate new forms of industrial development, create new demand and provide new jobs (Kahn, 2018). However, entrepreneurship is currently more concentrated in towns and cities, Entrepreneurial activity within the rural sector has been cold for a long time (Heaphy and Wiig, 2020). For example, entrepreneurial activities in the United States are mainly concentrated in high-tech parks such as Silicon Valley, and entrepreneurial activities in China are mainly concentrated in economically developed coastal urban areas (Wortman, 1990). The concept of rural entrepreneurship was first introduced as the process of creating new organizations to provide new products or services, develop new markets, or utilize new technologies in the wider rural environment. Arguably, as a starting point for rural entrepreneurship research, researchers called to focus on urban entrepreneurship should also consider entrepreneurial activity in the rural sphere.

Currently, urban market space is limited, space for development has become tighter, and entrepreneurial vitality in towns and cities is gradually weakening (Zhao et al., 2023; Zheng and Du, 2020). In fact, there is still a lot of room for entrepreneurial activity and investment in the rural sector compared to urban areas. It can be seen that the scale of rural infrastructure continues to increase in order to create a better investment environment in the countryside. Under the strategies of new rural construction and rural revitalization, China's countryside has the conditions for a basic investment environment, which can revitalize rural resources, transform them into attractive capital investments. At the same time, the jobs offered by urban entrepreneurship often require strong vocational skills and qualifications, creating a mismatch between the employment of farmers and the demand for labor in urban markets. Therefore, in the context of farmers going to the city to obtain wealth opportunities to shrink, farmers tend to return to their hometowns to start their own businesses, making the countryside become a new round of investment hotspots.

In view of the wide geographical area of rural areas and the scattered distribution of the population, large-scale entrepreneurial behavior, such as groups and chain stores, is not very suitable; on the contrary, small-scale rural household entrepreneurship, such as small and microenterprises, cooperatives, supermarkets and vendors, can take the initiative (Hagos et al., 2014). Although small in scale, they are more resilient and can face market risks flexibly. The small-cost entrepreneurship of these farmers has continued to develop and has become an indispensable part of the local economy, effectively promoting the sustainable development of the economy in rural areas.

At present, the effect of entrepreneurship among farmers is not good, and the entrepreneurial willingness of farmers is weak (Yang et al., 2023; Bouichou et al., 2021). In order to activate the entrepreneurial vitality in the rural area, the study of the factors influencing the entrepreneurial behavior of farmers has become a hot research topic in the academic world. There is a general consensus that there is a strong link between property rights protection and economic activity (Barzel and Allen, 2023). Land rights stability is even more oriented to the behavioral decisions of farming households (Zhou et al., 2021) and is an important internal factor influencing household entrepreneurial decisions.

Land is the most important livelihood capital for farm households, but there has long been a lack of effective protection of rural

Perception of Land Rights (Bu and Liao, 2022). In order to maintain the security of Land Rights, farm households often consider the status of Land Rights as a key factor in decision-making on household economic behavior (Ferree et al., 2023). Thus, the stability of land rights determines, to some extent, the direction of household economic activities. So, will the stability of land rights be able to promote farm household entrepreneurship? Is there heterogeneity in this effect? If the state of land rights stability can influence the entrepreneurial activities of farm households, then the possible paths of influence will continue to be explored.

However, behavioral decisions on farm household entrepreneurship are not determined by a single factor, but are the result of a combination of internal and external factors (Lauwere et al., 2022). Whether external environmental factors can create a good entrepreneurial atmosphere, platform, etc. for farmers also has a key role in the occurrence of entrepreneurial behavior of farmers. The prosperity of rural industries means that the economic structure of rural areas is diversified and flourishing. Farmers' entrepreneurship is the process of changing industrial structure, business mode, organizational structure, production technology and other production factors through investment behavior. Then whether rural industrial development can provide entrepreneurial model reference, financial support, expert guidance, etc. for this process, thus affecting farmers' entrepreneurial willingness and entrepreneurial behavior.

Therefore, this paper focuses on the following questions: First, does Perception of Land Rights have a positive or negative impact on farmers' entrepreneurial behavior? Second, does the development of rural industry have a driving effect on farmers' entrepreneurial behavior? Third, when both Perception of Land Rights and rural industry development occur simultaneously, what kind of joint effect will it have on farmers' entrepreneurial behavior? Fourth, if both Perception of Land Rights and rural industry development can have an impact on the entrepreneurial behavior of farmers, what are the specific mechanisms of these two impacts?

Compared with existing studies, the marginal contribution of this paper is mainly reflected in three aspects. Firstly, it studies the occurrence mechanism of farmers' entrepreneurial behavior from the internal driving factors of land rights stability; secondly, it explores the influence effect of external market environment on farmers' entrepreneurial behavior from the environmental factors of rural industrial development; thirdly, it combines the analysis of internal driving factors and external market environment to explore the influence effect of the linkage of internal and external factors on farmers' entrepreneurial behavior.

This paper uses field research data to assess the relationship between land rights stability, rural industry development and farmers' entrepreneurial behavior. The rest of the paper is organized as follows. Section 2 outlines the theoretical framework and hypotheses regarding the relationship between land rights stability, rural industrial development and farm household entrepreneurial behavior. Section 3 details the data sources, variable settings and estimation strategies used to test the hypotheses. Section 4 presents the estimation results. Section 5 discusses the possible paths of the impact of land rights stability and rural industrial development on the entrepreneurial behavior of farm households. Section 6 draws these conclusions based on the theoretical analyses and empirical results.

## 2 Literature review and theoretical analysis

### 2.1 Literature review

#### 2.1.1 Research on the effects of land property rights

Land institutional arrangements for farmers are not only a change in the ecology of the social system but also an important factor in economic performance. (i) Agricultural land property rights and farmers' economic behavior. Clear and stable property rights on agricultural land can increase farmers' inputs to the land, motivate them to innovate in agricultural technology, and enhance land productivity (Fei et al., 2021). As Yang and Meseret (2024) point out, with the development of the land transfer market, land resources have been used more efficiently, and the level of agricultural production scale and intensification has increased. (ii) Agricultural land property rights also involve social dimension effects, especially on farmers' social status, social security and quality of life. Many studies have shown that security of property rights over agricultural land can help improve farmers' perception of social security and increase their confidence in the future (Gedefaw, 2023; Li et al., 2022). (iii) Some scholars are concerned about the impact of the unequal distribution of property rights over agricultural land on the social structure and status of peasants. Inequality in land rights may exacerbate the gap between rich and poor in rural areas, leading to social stratification and conflict (Wegerif and Guereña, 2020; Sullivan et al., 2023). For example, inequities in the land transfer process may result in disadvantaged groups (e.g., poor farmers, women farmers) losing land resources and increasing social inequality (Yokying and Lambrecht, 2020; Masuku et al., 2023).

In addition, current research has also focused on the correlation between farmers' perceptions of land rights and their behavioral patterns. For example, land rights perceptions influence farmers' behavioral decisions such as risk assessment and long-term planning (Qian et al., 2022; Abab et al., 2022). It can be seen that there have been studies proving the strong relationship between land property rights and farmers' behavioral patterns, but the current studies are less concerned with the relationship between perceptions of farmland property rights and farmers' entrepreneurial behavioral choices. Therefore, this paper will examine the possible link between the perception of land property rights and farmers' entrepreneurial behavior.

#### 2.1.2 Research on the effect of rural industrial development

Rural industrial development is the key to promoting sustainable rural economic development. In the literature related to the effect of rural industrial development, the main research results are:

First, the relationship between rural industrial development and farmers' income and employment. The development of rural industries, especially non-agricultural industries, can effectively absorb rural labor, provide employment opportunities and increase farmers' income (Bai et al., 2024). In addition, rural industry reduces rural poverty and enhances the economic status of farmers through the extension of industrial chain and diversification of business (Chen and Long, 2024; Qiu et al., 2024).

Second, the development of rural industry and urban–rural integration development. The development of rural industries helps to narrow the urban–rural gap and promote the optimal allocation of urban and rural resources. With the development of rural industries, more urban resources have been introduced into the countryside, such as technology, capital and talents. This resource flow not only drives the enhancement of rural economy, but also promotes the communication and integration between urban and rural areas (Liu et al., 2020; Yang et al., 2021).

Third, the development of rural industries and rural quality of life. The development of rural industries has not only increased farmers' income, but also improved the quality of life of rural residents (Hassan et al., 2022; Li et al., 2020). For example, new industries such as rural tourism not only enhance the economic level of the countryside, but also improve the rural environment and enhance the sense of access and happiness of farmers (Yusriadi et al., 2024).

Although rural industrial development has become a hot topic in academia, systematic and in-depth analysis of its multidimensional effects is still lacking. For example, most studies focus on the role of rural industries in promoting entrepreneurship among farmers, but rarely explore how rural industrial development specifically affects the entrepreneurial behavior of farmers from the perspective of mechanisms. Therefore, this paper combines rural industrial development and land property rights to jointly analyze the interaction and complex relationship between these factors.

#### 2.1.3 Main factors affecting household entrepreneurial behavior

Existing studies mainly focus on risk attitude, social capital, digital technology and other aspects to explore the influencing factors of farmers' entrepreneurial willingness and behavior. (i) From the perspective of risk attitude: it is found that risk aversion is significantly associated with entrepreneurial behavior, risk aversion inhibits the entrepreneurial incentive brought by experience accumulation (Ahmed et al., 2022). There are gender differences in risk aversion, with the depression of risk aversion on entrepreneurial behavior being less pronounced among men (Vamvaka et al., 2020). In an analysis of entrepreneurial activities in the Bali region of Indonesia, social capital was found to increase female entrepreneurial opportunities and become an important tool for female entrepreneurship (Setini et al., 2020). (ii) From the perspective of social capital: in the impact of social capital on sustainable livelihoods, women's entrepreneurship was found to mediate the relationship between social capital and the promotion of indigenous women's livelihoods (Mahato and Jha, 2024). (iii) From the perspective of digital technology: digital technology provides easy access to tools for entrepreneurial activities, new avenues for entrepreneurship, and new products, among others, which will be able to facilitate entrepreneurial behavior (Zahra et al., 2023; Bican and Brem, 2020).

It can be seen that the current study is more on the entrepreneurial behavior of farmers from a single dimension. Farmers' decision-making involves multiple objectives, such as economic efficiency, risk management, and family needs. This makes farmers' behavioral decision-making a multidimensional, multilevel and complex process involving multiple factors such as internal factors and external environment. Moreover, these factors are intertwined and have interaction with each other. However, the current research more often analyses the entrepreneurial behaviors of farmers from individual

influencing factors, and lacks multi-dimensional discussion. Therefore, this paper analyses the generation mechanism of farmers' entrepreneurial behavior from the dimensions of endogenous drive and external development.

## 2.2 Theoretical analysis

### 2.2.1 Mathematical model

It is assumed that a farmer's utility function  $U$  consists of two components: utility from current agricultural production,  $U_a$ , and utility from entrepreneurial activity  $U_e$ . Agricultural utility is determined by land resources ( $L$ ), agricultural labor inputs ( $A$ ), and technology level ( $t$ ). Entrepreneurial utility is determined by external environmental incentives ( $E$ ), capital inputs ( $C$ ), and farmers' psychological expectations and risk preferences ( $\mu$ ).

$$U = U_a + U_e$$

$$U_a = f(L, A, t)$$

$$U_e = g(E, C, \mu)$$

Perception of tenure  $P$  affects farmers' confidence in the use of land resources  $L$  and their stable expectations of future returns. It is hypothesized that tenure perception enhances the utility coefficient  $\alpha(P)$  of farmers' perception of land security.

$$\text{Thereby enhancing their total utility: } U_a = \alpha(P) \cdot f(L, A, T).$$

The external environment stimulus  $E$  indicates the intensity of support from policy and market industrial development. The external environment affects entrepreneurial behavior in two ways. One is to increase the expected return of entrepreneurship, which is expressed as the coefficient in the entrepreneurial utility function  $\beta(E)$ . The second is to reduce the entrepreneurial risk  $r$ , thus increasing the willingness of farmers to participate in entrepreneurship.

$$\text{Thus, } U_e = \beta(E) \cdot g(C, \mu) - R(E), \text{ where } \beta'(E) > 0 \text{ and } R'(E) < 0.$$

Farmers have limited total labor and capital to allocate between agricultural production and entrepreneurial activities. Time constraint:  $A + A_e = T$  ( $A_e$  denotes labor input for entrepreneurial activities,  $T$  denotes total labour time). Capital constraint:  $C + C_a = M$  ( $C$  denotes capital for agricultural production,  $C_a$  denotes capital for entrepreneurship, and  $M$  denotes total capital).

Farmers maximize utility:  $\max U = \alpha(P) \cdot f(L, T - A_e, t) + \beta(E) \cdot g(C_a, \mu) - R(E)$ .

Deriving from  $A_e$  yields the marginal utility condition:

$$\frac{\partial U}{\partial A_e} = \alpha(P) \cdot \frac{\partial f}{\partial (T - A_e)} \cdot \frac{\partial (T - A_e)}{\partial A_e}$$

Increased  $A_e$  reduces labor time in agriculture. Resulting in a negative  $\frac{\partial (T - A_e)}{\partial A_e}$ .

Agricultural utility has a positive marginal return to labor. Leading to a positive  $\frac{\partial f}{\partial (T - A_e)}$ .

$$\text{Obtaining the formula: } \frac{\partial U}{\partial A_e} = \alpha(P) \frac{\partial f}{\partial (T - A_e)}.$$

The perception of land rights  $P$  enhances  $\alpha(P)$  and increases the marginal utility of agriculture. To balance utility, farmers increase the allocation of  $A_e$ , which drives entrepreneurship.

Derivation of  $C_a$  yields the marginal utility condition:

$$\frac{\partial U}{\partial C_a} = \beta(E) \cdot \frac{\partial g}{\partial C_a} - \frac{\partial R}{\partial C_a}$$

The external environment  $E$  increases  $\beta(E)$  and decreases  $R$ , thereby increasing  $C_a$  to promote entrepreneurial activity.

Through the above derivation, the following conclusions can be drawn: first, the improvement in the perceived security of land rights can release more labor for entrepreneurship by increasing farmers' confidence in and utility of land resources. Second, external environmental stimuli can directly promote farmers' participation in entrepreneurship by increasing the expected returns and reducing the risks of entrepreneurship.

### 2.2.2 Research hypothesis

- 1 Theoretical analysis of the impact of land rights stability on the entrepreneurial behavior of farming households' families.

Among the intra-self-factors affecting the entrepreneurial behavior of rural households, previous studies have mostly focused on the financial literacy and risk awareness of rural households. For example, the deepening of rural household financial literacy is one of the prerequisites for the improvement of the quality of entrepreneurship in farming households, the lack of financial support and other insufficient credit services for farmers leads to a lack of start-up capital (Purnawan et al., 2021), and the Internet improves the awareness of risky investment, reduces entrepreneurial risk, and increases the probability of entrepreneurial success (Mei et al., 2022). However, institutions are key influences in individual action decisions. Individual actions are in the constraints of various institutional frameworks. Actors search for the most favorable course of action for themselves through the incentives and constraints of institutions. Farm households make their living from land. China had basically completed the registration and licensing of rural collective land, and the effects of the system are beginning to emerge (Hong and Sun, 2020).

In a study of the effects of property rights regimes on agricultural land, Dixon (1950) argued that land is the motivating mechanism for human migration and that population shifts are a function of land. However, different property rights attached to land resources produce different incentive effects. For example, the clarification of agricultural land rights strengthens the security of property rights and incentivises the non-farm transfer of labor. It can be seen that clarifying the collective land subject status of farmers plays an important role in the choice of livelihood mode of farmers, brought about by changes in the entrepreneurial factors of farmers themselves. Living on land is the traditional livelihood strategy of farm households. Confirmation of the right to farmland promotes the transfer of farmland and transforms the choice of livelihood strategy of farmers.

TABLE 1 Variable definitions and descriptive statistics.

Variables	Definition	Mean	SD
<b>Explained variable</b>			
Entrepreneurial Household	Are you self-employed or running a private business: (Yes = 1; No = 0)	0.128	0.334
<b>Explanatory variable</b>			
Perception of land rights	Is there a confirmation of rights and certification: Yes = 1; No = 0	0.941	0.236
Village industrial development	Is there a rural industry in your village: Yes = 1; No = 0	0.237	0.425
<b>Control variable</b>			
Gender	Male = 1; Female = 0	0.701	0.458
Age	Age	61.044	11.326
Literacy	Years in school	6.906	3.949
Health status	Self-identified health status: Incapacitated = 1; Poor = 2; Moderate = 3; Good = 4; Excellent = 5	3.911	1.076
Vocational training	Received at least 1 week of education or training in a non-agricultural occupation: Yes = 1; No = 0	0.117	0.322
Online loan facilities	Do you know about the online loan business launched by Alipay, We Chat and other online platforms: No knowledge = 0; Knowledge = 1; interest = 2; apply = 3; get credit = 4; spend = 5; default = 6	0.093	0.432
Economic status	What is the economic status of your family in the local area: very low = 1; relatively low = 2; average = 3; relatively high = 4; very high = 5	2.935	0.744
Party member	Are any of your family members of the Communist Party of China (CPC)? Yes = 1; No = 0	0.298	0.457
Ethnicity	Does your family belong to the Han ethnic group? No = 1; Yes = 0	0.033	0.179
Credit village	Is the village a credit village as assessed by the Agricultural Credit Union: Yes = 1; No = 0	0.582	0.493
Entrepreneurial services	Number of participation in entrepreneurship training activities	3.042	1.648

Furthermore, having the right amount of financial capital is the basic condition of entrepreneurial behavior, sufficient household wealth stimulates the idea of entrepreneurial behavior, and the promotion of land leasing after land rights can expand household wealth and provide basic financial support for household entrepreneurship (Leight, 2016). Therefore, agricultural land rights from the change in the livelihood capital on the impact of entrepreneurial behavior of farming households has a strong endogenous driving effect.

Hypothesis H11: Stabilization of property rights on agricultural land has an endogenous drive to generate entrepreneurial behavior in farm households.

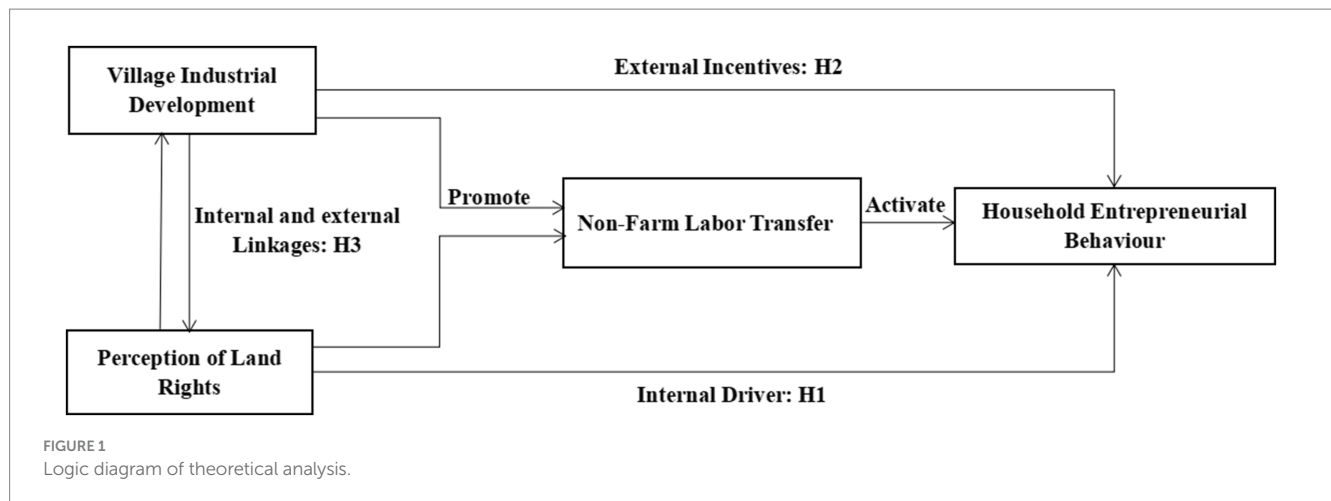
## 2 Theoretical analysis of the impact of rural industries on the entrepreneurial behavior of farm households.

The overall external environment of society, such as national entrepreneurship policies, has a huge impact on rural industries. e.g., a favorable social credit environment enhances households' attitudes toward the market, which in turn increases the willingness to start up a business (Herkenhoff et al., 2021); financial inclusion raises the level of inclusive finance for rural households and lowers the threshold of the entrepreneurial capital source threshold promotes increased chances of entrepreneurship (Ajide, 2020); and the social environment of further development of urban-rural

integration accelerates the two-way flow of factors of production between urban and rural areas (Ma et al., 2020). In addition, the countryside is the main place of production and life for rural households, and is the natural witness of rural development, so the development of rural industry is one of the most direct social external environments faced by rural households. In the process of rural economic and social development, rural industrial development serves as an important material guarantee and a powerful initiative to enhance the endogenous motivation of farm households.

Rural industries are characterized by the diversification of business entities and industrial forms. This can provide farmers with a variety of entrepreneurial cases and enrich the choice of entrepreneurial paths for farmers (Müller and Korsgaard, 2018). The comprehensive development of rural industries has gradually improved rural infrastructure, providing basic resources for farmers to start their own businesses and further reducing the cost of entrepreneurship (Yurui et al., 2021). The high-quality development of rural industries has brought the demonstration effect of land transfer to farmers, changing the traditional small farmers' single way of earning a living based on agriculture (Tian, 2015).

Hypothesis H21: Rural industrial development has external incentives to stimulate entrepreneurial behavior in farm households.



- 3 Land tenure stability, rural industries influence internal and external linkages in farm household entrepreneurship.

Stabilization of land rights can facilitate the movement of farm households away from farming and toward non-farm employment in their economic activities. There are two types of off-farm employment status for farm households, one being employed by others and the other being self-employed. Farmers' choice of non-farm employment status will be influenced by external factors (Table 1).

The development of rural industries can create more employment opportunities, so that farmers have more choices to earn income; diversified sources of income can reduce the economic pressure on farmers and provide financial support for entrepreneurship. Industrial prosperity is usually accompanied by improvements in infrastructure, such as the construction of roads, electricity and communications, as well as upgraded services such as education, healthcare and finance. These improvements not only directly improve the quality of life of farmers, but also provide a better infrastructure environment for farmers' entrepreneurial activities. The development of new industries often requires new skills and knowledge, which are passed on to farmers through training and education programmes. Armed with new skills and knowledge, farmers are better equipped to carry out their own entrepreneurial projects. As rural industries flourish, the market demand for agricultural products increases and sales channels become more diverse and convenient. Farmers can more easily realize their entrepreneurial activities with the help of established e-commerce and co-operatives. Therefore, without the development of rural industries to create a favorable environment and conditions for the entrepreneurial activities of farmers, the stable non-agricultural employment status of land rights will tend to go out to work rather than promote entrepreneurship. This also suggests that the development of rural industries will increase the contribution of tenure stability to the entrepreneurial behavior of rural households (Figure 1).

Hypothesis H31: Rural industries have a moderating role in the impact of tenure stability on the entrepreneurial behavior of rural households.

## 3 Data, variables, and estimation strategy

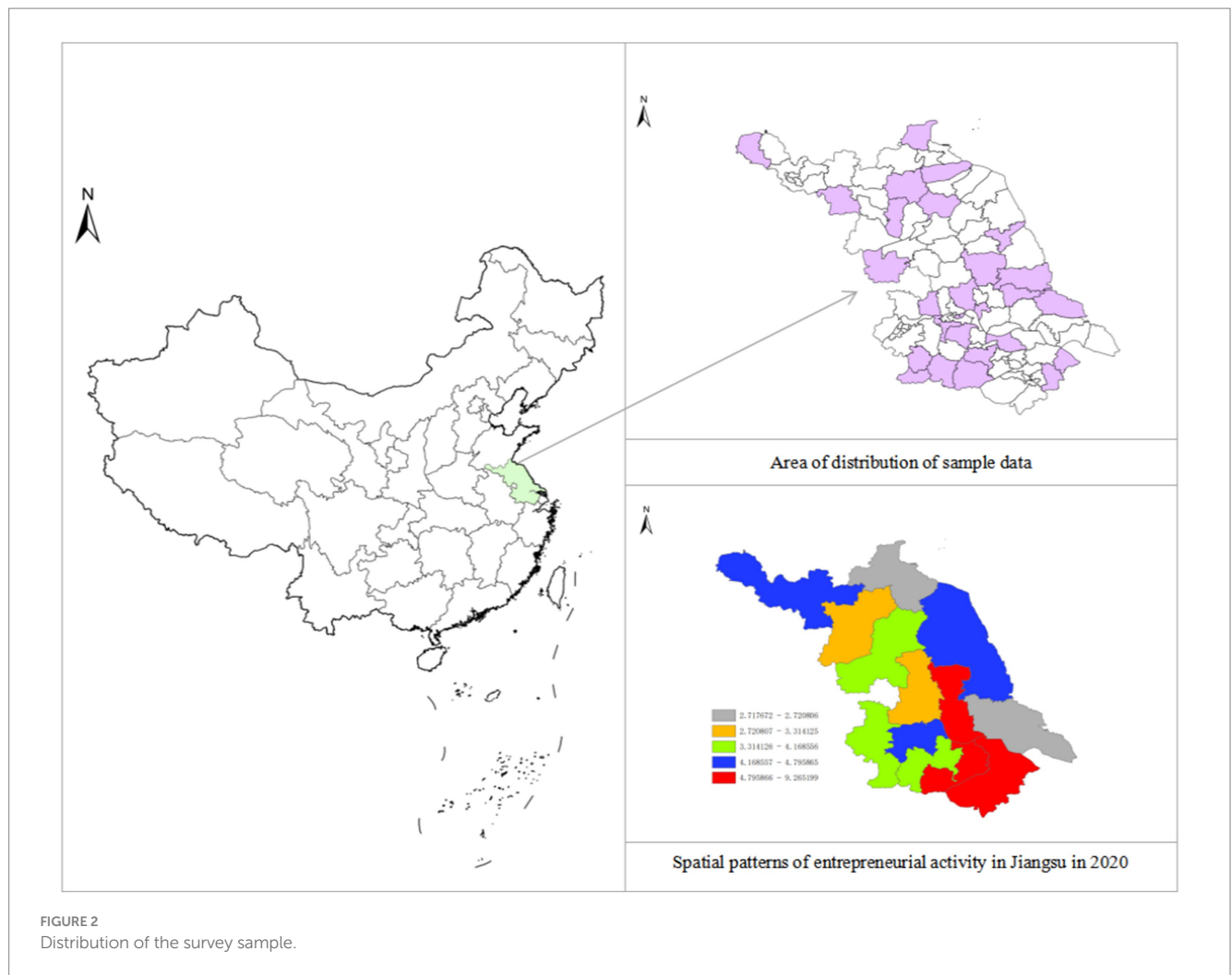
### 3.1 Data

The data used in this paper comes from the China Land Economy Survey (CLES) conducted in 2020 by a team organised by Nanjing Agricultural University, with data collection taking place in Jiangsu Province. Jiangsu Province was chosen as the study site because it is one of the most economically developed provinces in China. Therefore, due to its good economic foundation, the implementation of policies in Jiangsu is usually stronger, especially in the field of entrepreneurship, than in some other regions that are relatively economically backward. At the same time, the level of entrepreneurship within Jiangsu shows variability. According to Figure 2, the south of Jiangsu is higher than the north, and the east is higher than the west. This regional imbalance provides a natural sample for the research object of this paper.

The survey uses the pps sampling technique of probability proportional to size to sample counties and administrative villages. Twenty-six research counties (districts and cities) were randomly selected from the 13 prefecture-level cities in Jiangsu Province, two sample townships were randomly selected from each county (district and city) respectively, and one administrative village was randomly selected from each township. Rural households were interviewed through face-to-face questionnaire interviews. The research direction of this paper is rural household entrepreneurship, so after eliminating irrelevant sample data, we get 2,356 valid samples.

### 3.2 Variables

Explained variables. The explanatory variable in this paper is entrepreneurial household. The variable selection draws mainly on the definition of Pauslon and Townsend (2004). That is, whether or not they are engaged in industrial or commercial production and operation projects, including self-employment, renting, transport, online shops, and running a business. It is therefore defined according to whether one is self-employed or starts a private business. Non-farm entrepreneurship is set as a dichotomous dummy variable. If the



answer is “yes,” it is non-farm entrepreneurship and assigned a value of “1” and vice versa “0.”

In addition, we collect macro-level data to measure the intensity of regional entrepreneurial activity. Based on China’s industrial and commercial enterprise registration data, the number of new start-ups per 100 people is used to express entrepreneurial activity, using population as a standardized base. The regional level measures the breadth and depth of entrepreneurship in China, reflecting the overall intensity of entrepreneurial activity in a given region. According to Figure 3, the intensity of entrepreneurial activity in China has increased significantly from 2005 to 2020, but regional imbalance is also evident, with a long period of time concentrated in the eastern region.

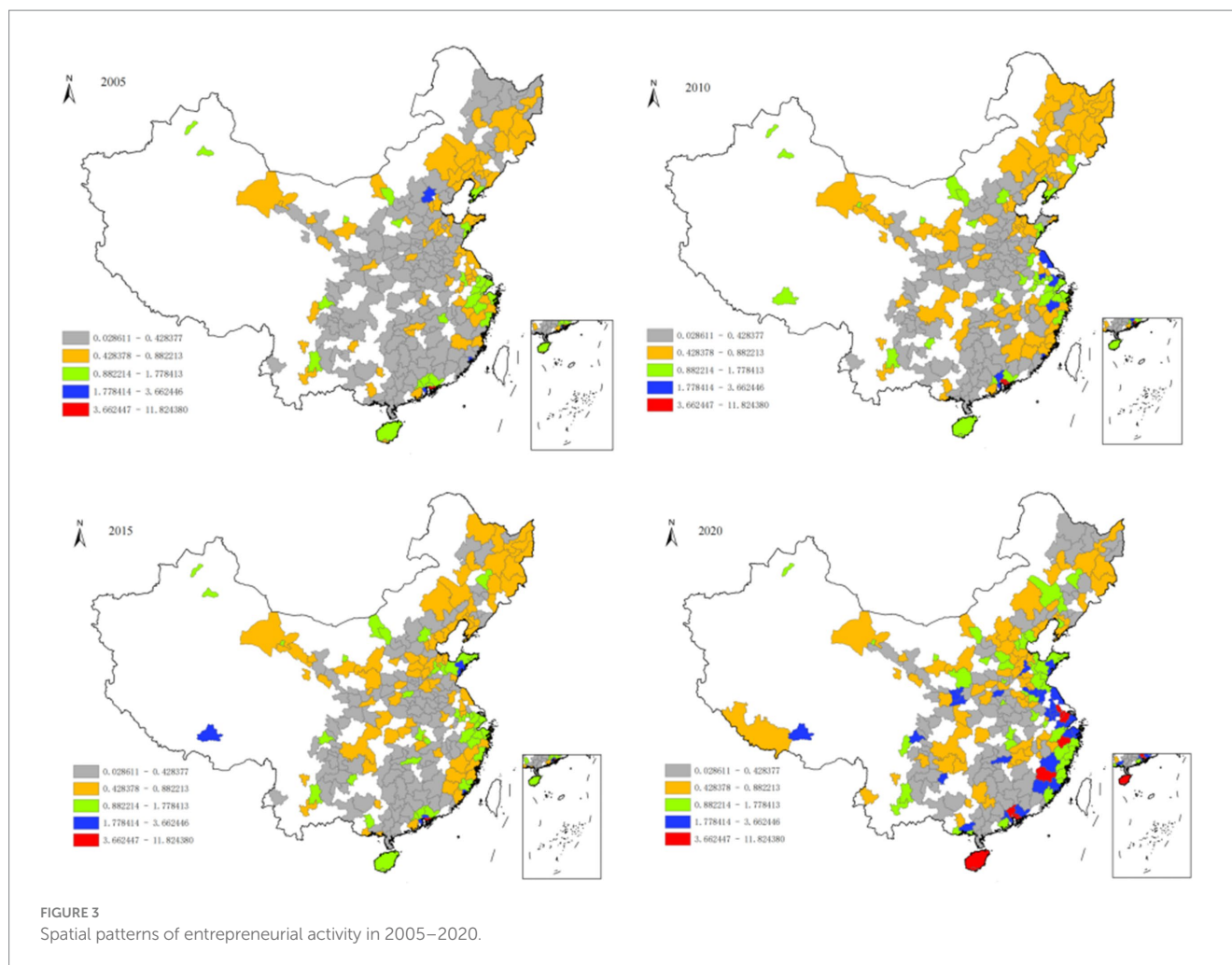
**Explanatory variables.** The explanatory variables in this paper are perception of land rights and village industrial development. (i) Perception of land rights. China proposed in 2013 to comprehensively carry out the registration of rural land rights, to improve the definition of the boundaries and tenure of farmers’ land contract management rights at the legal level, and to promote the clarification of property rights on agricultural land. Therefore, the question “whether the right to farmland has been confirmed and certified” is used to measure the right to farmland. (ii) Village industrial development. China issued the National Rural Industry Development Plan (2020–2025) in 2020.

Rural industries are identified as agricultural product processing industry, rural speciality industry, leisure agriculture and new rural service industry. According to China’s Rural Revitalisation Industry Integration Development Report (2022), under the development of rural industries, the rural leisure tourism industry absorbs 11 million people, and the number of people who start businesses and innovate in the countryside reaches 31.5 million. Rural industry is orientated toward chain and cluster development, so rural industry is measured by the question “whether there is rural industry in the village.”

**Control variables.** According to previous studies, this paper mainly selects three levels of individual characteristics, family characteristics and village characteristics of farmers. Among them, the individual characteristics are gender, age, literacy and health status, vocational training, and online loan facilities; the family characteristics are the economic status of the family, party member and ethnicity; the village characteristics are the credit villages and entrepreneurial services.

### 3.3 Estimation strategy

Binary logistic model. Since whether farmers carry out family entrepreneurship is a dichotomous variable, thus this paper adopts a



binary Logistic model for analysis, the model 1 is constructed as follows:

$$Y_i = \text{Ln} \left( \frac{P_i}{1 - P_i} \right) = \beta_0 + \beta_1 X_i + \beta_2 Z_i + \beta_3 S_i + \varepsilon \quad (1)$$

Equation 1 where  $Y_i$  represents the probability that farmer  $i$  conducts home-based entrepreneurship,  $X_i$  represents perception of land rights,  $Z_i$  represents the development of rural industries,  $S_i$  represents the relevant control variables,  $\beta_0$  represents the constant term,  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$  represent the regression coefficients of the corresponding variables, and  $\varepsilon$  represents the random error term.

## 4 Results

### 4.1 Analysis of baseline regression results

Stepwise regression method is used to test the model, only two main core variables are added to the model (1) of Table 2, which includes only the two main core variables of the right to confirm agricultural land and rural industry, the model (2) adds the right to

confirm agricultural land, rural industry and related control variables, and the model (3) adds the interaction term of the right to confirm agricultural land, rural industry, rural industry and the right to confirm agricultural land, and related control variables. The results of the benchmark regression are shown in Table 2.

The impact of agricultural land rights on rural household entrepreneurial behavior. In models (1), (2), and (3), the confirmed right to farmland passes the positive test at 1, 5, and 10% significance levels, respectively. The regression coefficients are 0.498, 0.518, and 0.573, respectively. This shows that each unit increase in perception of land right promotes at least 0.498 units increase in entrepreneurial activities of farmers. This indicates that the number of entrepreneurial behaviors of rural households shows an increase after the confirmation of agricultural land rights. This is mainly due to the fact that after the confirmation of the right to agricultural land, the boundaries of the respective agricultural land of farmers are clarified, the disputes and conflicts over agricultural land between farmers are reduced, and it is convenient for enterprises or cooperatives to carry out large-scale leasing of land, from which farmers then receive land rent, which increases the family income, and also frees up some of the manpower engaged in agricultural production, and the overall cost of family entrepreneurship has been reduced, which contributes to the increase in their entrepreneurial willingness. In view of this, hypothesis H11 is valid.



TABLE 2 Basic regression results.

Variables	Entrepreneurial Household		
	(1)	(2)	(3)
Perception of land rights	0.498***(0.079)	0.518**(0.137)	0.573*(0.163)
Village industrial development	1.931***(0.198)	1.504**(0.241)	1.480**(0.238)
Perception of land rights × village industrial development			0.361*(0.206)
Gender		2.686*** (0.500)	2.684*** (0.500)
Age		0.950*** (0.007)	0.951*** (0.007)
Literacy		1.039 (0.025)	1.038 (0.025)
Health status		1.351*** (0.119)	1.354*** (0.120)
Vocational training		1.026 (0.211)	1.011 (0.208)
Online loan facilities		1.200 (0.152)	1.190 (0.152)
Economic status		1.790***(0.189)	1.794***(0.190)
Party member		0.821 (0.139)	0.842 (0.139)
Ethnicity		1.095 (0.439)	1.103 (0.442)
Credit village		0.928 (0.141)	0.921 (0.139)
Entrepreneurial services		1.063 (0.050)	1.068 (0.050)
N	2,356	2015	2015

Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

Impact of rural industry on rural household entrepreneurial behavior. In model (1) of Table 2, rural industry passes the positive significance test at the 1% level; in model (2), it passes the positive significance test at the 5% level; in model (3), it passes the positive significance test at the 5% level. The regression coefficients are 1.931, 1.504, and 1.480, respectively. This implies that 1 unit of rural industrial development leads to at least 1.480 units of improvement in farm household entrepreneurship. This indicates that the better the development of rural industries, the more it promotes rural household entrepreneurial behavior. This is mainly because the development of rural industry will bring more employment opportunities at the same time, thus attracting more locals to stay in the local area and more outsiders to work in the local area, leading to the development of the rural regional economy, and farmers earn more money, which prompts farmers to invest in their own entrepreneurial behavior based on the family unit. In addition, the development of rural industry is also one of the core requirements of industrial revitalization in the rural revitalization strategy, which is in line with the national development trend, which also strengthens the confidence and confidence of farmers to participate in entrepreneurship. In view of this, hypothesis H21 holds.

The moderating role of rural industry in the impact of agricultural land rights on the entrepreneurial behavior of rural households. According to Table 2 model (3) the interaction term between rural industry and farmland rights passes the 10% positive significance test, which indicates that rural industry has a positive facilitating role in the impact of farmland rights on the decision-making of rural household entrepreneurial behavior. The regression coefficient is 0.361, which suggests that the moderating effect will be enhanced by 0.361 units for 1 unit of development in the rural industry. This may be explained by the fact that in farmland rights enhance the sense of security of land ownership belonging to farmers, promote the transfer of farmland, and change the mode of livelihood capital of farmers who

live on land; and the development of rural industry can provide new experience of livelihood capital for the farmers who exit from the land-based livelihood, which can increase the interest of farmers in home-based entrepreneurship. In view of this, hypothesis H31 is valid.

Regarding the control variables, we find that gender, age, health and economic status pass the positive test at 1% level. It is evident that males are more likely to develop a desire to start a business than females. This phenomenon was also found in a study by [Guzman and Kacperczyk \(2019\)](#). Older age may be more likely to have sufficient startup capital and more likely to start a business. [Azoulay et al. \(2020\)](#) systematically studied startups in the United States and found that successful entrepreneurs are middle-aged rather than young. Their study noted that 1 in 1,000 of the fastest growing new businesses had an average age of 45.0 years of establishment. Farmers with better health conditions will have a higher willingness to start a business. A study of COVID-19 during the outbreak found that the level of health affects the level of social entrepreneurial activity ([Donthu and Gustafsson, 2020](#)). The better the economic conditions of the family, the higher the probability of the occurrence of entrepreneurial behavior in the family. [Edelman et al. \(2016\)](#) survey of university students from 19 countries found that the economic conditions of the family play an important role in youth entrepreneurship.

## 4.2 Robustness tests

### 4.2.1 Redrawing the core explanatory variables

In order to improve the robustness of the model, the explanatory variables are further replaced, and the ratio of the area of cultivated land in the village that has been authorized to the total area of cultivated land in the village is selected as the proxy variable for the authorization of agricultural land; and the question “whether there is a modern agricultural industry in the village” is taken as the proxy variable for the

TABLE 3 Robustness test 1: replacement of explanatory variables.

Variables	Entrepreneurial household	Entrepreneurial household	Entrepreneurial household
	(1)	(2)	(3)
Perception of land rights	1.251***(0.107)	0.563***(0.087)	1.375***(0.120)
Village industrial development	1.694***(0.260)	0.542**(0.148)	0.499***(0.077)
Control variable	Yes	Yes	Yes
N	1990	1835	1845

Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

TABLE 4 Robustness test 2: RE-estimation based on propensity score matching method.

Variables	Matching method	ATT	T
Village industrial development	Nearest neighbor matching	0.058**	2.330
	Radius matching	0.058**	2.330
	Kernel Matching	0.063***	3.370

Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

rural industry, and the binary logistic model is used to conduct the robustness test. The binary logistic model is used to test the robustness of the model. In Table 3, model (1) replaces the proxy variable of agricultural land rights alone, model (2) replaces the proxy variable of rural industry alone, and model (3) replaces the proxies of agricultural land rights and rural industry at the same time. As can be seen from the table, the effects of confirmed right to farmland and rural industry on farm household entrepreneurship in models (1), (2), and (3) pass the significance test, which is consistent with the results of the benchmark regression above, and further proves the robustness of the preceding logic.

### 4.2.2 Replacement model

In order to avoid possible self-selection problems and further test the robustness of the estimation results, this paper uses propensity score matching (PSM) to re-estimate the impact of rural industry development on farm household entrepreneurship in the context of agricultural land rights. Those with rural industries are the experimental group and those without rural industries are the control group, and nearest-neighbor matching, radius matching, and kernel matching are used to estimate the impacts on farmers' household entrepreneurial decisions under different rural industry patterns. Table 4 reports the estimation results of nearest neighbor matching, radius matching, and kernel matching, which have significant promotion effects under all three matching methods, further validating the robustness of the results in this paper.

### 4.3 Endogeneity discussion

The above model may have a possible endogeneity problem due to the existence of bi-directional causality of the missing variables, measurement errors, and core variables. The work of confirming and registering and certifying the rights of agricultural land has been gradually launched nationwide since 2009, and the work of confirming the rights of rural contracted land nationwide has basically been completed by 2018; therefore, the behavioral choices of confirming the rights of agricultural

TABLE 5 Discussion of endogeneity.

Variables	Two-stage least squares	
	Phase I	Phase II
Village industrial development		0.203**(0.082)
Satisfaction with rural civilization	0.087***(0.009)	
Control variable	Yes	Yes
First-stage f-statistic (p-value)	89.540(0.000)	
Anderson Canon.L.M (P-value)		86.450(0.000)
Cragg-Donald Wald Fstatistic		89.540
Dwh Test p-value		0.014
N	2,147	2,147

Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

TABLE 6 Heterogeneity analysis classification.

Variables	Variable division	Define
Generational	New generational	Year $\leq 40$
	Old generational	Year $> 40$
Educational Level	Low educational level	Number of years of schooling $\leq 6$
	Secondary educational level	$6 <$ Number of years of schooling $\leq 12$
	High educational level	Number of years of schooling $> 12$
Skill Context	No training	Received at least 1 week of education or training in a non-agricultural occupation
	Training	Have not received at least 1 week of education or training in a non-agricultural occupation

land are more of an institutional arrangement, which can be regarded as an exogenous policy variable (Cheng et al., 2016).

This paper uses "farmers' satisfaction with the village's rural civilization" as the question item of the rural industry instrumental variable, and calculates the mean value of the evaluation of the village's

TABLE 7 Results of heterogeneity analysis.

Variables	Generational		Educational level			Skill context	
	New	Old	Low	Secondary	High	No Training	Training
Perception of land rights	0.088** (0.106)	0.597* (0.171)	1.602 (1.226)	0.518** (0.139)	0.419 (0.500)	0.506** (0.146)	0.746 (0.488)
Village industrial development	1.184 (0.595)	1.575*** (0.266)	0.749 (0.300)	1.504** (0.241)	2.549 (1.448)	1.360 (0.261)	2.050** (0.745)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	105	1,910	857	2,015	86	1,798	217

Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

rural civilization by the other n-1 surveyed users in the village, as an instrumental variable. The civilization of rural customs includes the construction of ideological beliefs, spiritual civilization, rural culture construction, etc., which reflects the economic, cultural, industrial and other resource endowments of villages, and is more conducive to attracting investment to the villages, and activating the idle resources of villages (Tang and Zhu, 2020). Therefore, promoting the construction of rural civilization has an obvious promotion effect on the development of village industry. At the same time, the evaluation of village folkways civilization by other farmers' families cannot influence the behavioral decisions of farmers' own family entrepreneurship. The mean value of other n-1 surveyed users' evaluation of village rural civilization in this village satisfies the requirements of instrumental variable correlation and exogeneity.

According to Table 5, the DWH test results of IV-2SLS estimation indicate the rejection of the original hypothesis that village industry is an exogenous variable, which indicates that there is a problem of endogeneity in the model; the  $F$ -value in the first stage of the instrumental variable method is 27.350, which is  $>10\%$  level critical value of 16.38, and empirically this statistic is  $>10$ , which indicates that there is no problem of weak instrumental variables; in the second stage of instrumental variable method Anderson Canon.LM test is significant rejecting the original hypothesis and the Cragg-Donald Wald  $F$  statistic is greater than the Stock-Yogo test critical value of 16.38 at the 10% level indicating that there is no problem of under-identification of the model. After mitigating the endogeneity problem using the instrumental variables approach, the development of rural industries still contributes significantly to the entrepreneurial decision-making of farm households' families, and the hypothesis is again validated (Tables 6, 7).

#### 4.4 Heterogeneity analysis

**Generational context.** The new generation of farmers passed the 5% significance test on the right to farmland, but failed the significance test on rural industry, which can be seen that the right to farmland has a driving effect on the new generation of farmers to carry out entrepreneurial behavior, while the rural industry cannot enhance the entrepreneurial willingness of the new generation of farmers. This is due to the new generation of farmers less involved in agricultural production, the sense of belonging to the farmland is not high, they prefer to transfer the farmland to obtain the original resources for entrepreneurship; at the same time, due to the growth process of the new generation of farmers is just in the tide of socio-economic

development, they are deeply involved in the process of urbanization, but the entire external development of the rural industry of unfamiliarity with the environment, a sense of identity, cannot attract them to return to their hometowns to start their own businesses. The old generation of farmers due to age factors, they live in the countryside for a long time, the sense of belonging to the countryside is higher, compared with the new generation of farmers are more willing to stay in the countryside for entrepreneurship; rural industry is one of the sources of income of the old generation of farmers, the good state of development of the rural industry is more able to guide them to participate in the entrepreneurship.

**Cultural context.** It can be seen that between "high, medium and low" education level, agricultural land rights and rural industry, only medium education level passes the 5% significance test, showing an "inverted U-shape," which indicates that farmers with medium education level are more willing to start their own business. In terms of the right to farmland, although the right to farmland has a certain promotion effect on entrepreneurship, farmers with a lower level of education choose conservative employment due to their limited knowledge and unknown entrepreneurial prospects; farmers with a higher level of education are more willing to look for a well-paid and stable job due to their broad knowledge and rationality in starting their own business; and farmers with a medium level of education, although they also have a certain level of knowledge, are more willing to find a well-paid and stable job when entering the social workforce. Knowledge level, but younger when they enter the social work, they are more impulsive and have higher entrepreneurial willingness.

**Skill context.** The influence of the right to farmland, rural industry with or without non-farm vocational skills training on the entrepreneurial willingness of farmers presents an opposing situation. With the same agricultural land rights, no non-farm vocational skills training in 5% through the significance test, which indicates that farmers without non-farm vocational skills training than non-farm vocational skills training is more willing to start their own business, which is due to the non-farm vocational skills training in their own skills, they will tend to work through their own to get paid; no non-farm vocational skills training in the farm households have more choices of Farmers without non-farm vocational skills training have more choices and can start their own business. Under the same situation of rural industry, with non-agricultural vocational skills training passes the significance test at 5%, which indicates that farmers with non-agricultural vocational skills training are more willing to start their own business than those without non-agricultural vocational skills training, this is due to the fact that the development of rural industry must be accompanied by the development of

TABLE 8 Perception of land rights - non-farm transfer of labor - entrepreneurial household.

Variables	Entrepreneurial household	Non-farm labor transfer	Entrepreneurial household
Perception of land rights	0.536**(0.141)	0.596**(0.150)	0.581*(0.172)
Non-farm labor transfer			4.409***(0.513)
Control variable	Yes	Yes	Yes
N	2,037	1,822	1,802

TABLE 9 Village industrial development - labor non-farm transfer - entrepreneurial household.

Variables	Entrepreneurial household	Non-farm labor transfer	Entrepreneurial household
Village industrial development	1.682***(0.249)	1.357**(0.209)	1.519**(0.265)
Non-farm labor transfer			4.449***(0.500)
Control variable	Yes	Yes	Yes
N	2,160	1860	1907

Standard errors in parentheses. \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

agricultural extension industry or other non-agricultural industries, which can provide abundant employment and entrepreneurship opportunities for the local farmers, while farmers with non-agricultural vocational skills training have a greater chance to start their own business than those without non-agricultural vocational skills training. Farmers with non-farming vocational skills training have more choices in expanding their household income sources than those without non-farming vocational skills training. The former have a higher probability of choosing non-farming vocational skills corresponding to the industry for employment and entrepreneurship in order to increase their income, while the latter tend to engage in agricultural production or other unskilled work due to the lack of non-farming vocational skills training.

## 4.5 Mechanism analysis

Testing the mechanism of “agricultural land rights, non-agricultural transfer of labor, and entrepreneurial behavior of agricultural households.” Farm household entrepreneurship is selected as the dependent variable, the right to farmland is the core independent variable, and the non-farm transfer of labor is the mechanism variable. The first step examines the direct impact of farmland rights on the entrepreneurial decisions of farm households, the second step examines the impact of farmland rights on the mediating variable of non-agricultural labor force transfer, and the third step examines the impact of non-agricultural transfer of labor force on the entrepreneurial decisions of farm households. According to Table 8, it can be seen that the explanatory variables in the first, second and third steps above have passed the significance test, indicating that the confirmation of agricultural land rights can promote the non-farm transfer of labor and thus transform the livelihood capital decisions of farm households, and promote the decision-making of family entrepreneurship.

Testing the mechanism of “rural industry - non-agricultural transfer of labor - entrepreneurial behavior of agricultural households.” Farm household entrepreneurship is selected as the dependent

variable, rural industry as the core independent variable, and non-farm transfer of labor as the mechanism variable. The first step examines the direct impact of rural industry on the entrepreneurial decisions of farm households, the second step examines the impact of rural industry on the mediating variable of non-farm labor transfer, and the third step examines the impact of non-farm transfer of labor on the entrepreneurial decisions of farm households. According to Table 9, the explanatory variables in the first, second and third steps above all pass the significance test, indicating that rural industries can promote the non-farm transfer of labor and thus enhance the non-farm employment skills of farm households and provide basic skills for family entrepreneurship.

## 5 Discussion

This paper constructs a theoretical model of farmers' participation in entrepreneurial behavior. From the research on the factors influencing farmers' lack of willingness to engage in entrepreneurship, it was found that the factors contributing to this phenomenon are integrative.

Numerous studies highlight the critical influence of external environmental factors on farmers' entrepreneurial decisions; however, most focus primarily on their direct effects. This study emphasizes the importance of psychological expectations, demonstrating that external stimuli do not directly determine behavior but rather influence entrepreneurial behavior through the interaction of farmers' affective and cognitive expectations. For instance, consistent with the findings of Pulka et al. (2021), this study finds that external environmental support significantly enhances farmers' positive expectations. While extending his findings, we further reveal the specific paths through which the external environment and intrinsic perceptions are integrated to facilitate entrepreneurial behavior.

Unlike the purely economic perspective of previous studies, this study uncovers the broader social implications of land property rights reform through the lens of psychological expectations: a stable property rights system not only enhances the entrepreneurial

atmosphere in rural communities but also fosters efficient resource allocation and collaborative growth. Consistent with existing research, clear land property rights strengthen farmers' sense of security and their control over land resources, thereby reducing the perceived risk of entrepreneurial failure. The results of this study corroborate this finding, suggesting that the stability of land property rights significantly enhances farmers' entrepreneurial intentions by bolstering their return expectations and security perceptions.

The existing literature primarily analyzes the influence of policies or market dynamics on farmers' entrepreneurial behavior from a unified perspective, paying limited attention to the heterogeneity within the group of farmers. The findings of this study reveal that factors like age, education level, and occupational skills significantly modulate the influence of internal psychological perceptions and external stimuli on farmers' entrepreneurial expectations. In alignment with [Cheng et al. \(2021\)](#), we further suggest that farmers with more favorable individual circumstances are more likely to capture market opportunities, while those with insufficient resources rely more heavily on policy support. This finding contributes to the existing body of research by elucidating the differential entrepreneurial behavior of farm households.

## 6 Conclusion and implications

Based on the data from the 2020 China Land Economy Survey, this paper empirically analyses the effects of farmland rights and rural industries on the decision-making of rural households' entrepreneurial behavior. The results of the benchmark regression show that: the confirmation of agricultural land rights and rural industry have a facilitating effect on the entrepreneurial behavior of rural households; the rural industry has a moderating role in the impact of the confirmation of agricultural land rights on the entrepreneurial behavior of rural households. The analysis of farmland mechanism shows that; farmland rights, rural industry promote farm household family entrepreneurship through non-farm labor transfer. Heterogeneity analysis shows that: the right to farmland has a greater role in promoting the entrepreneurial behavior of the new generation of farmers; the distribution of the education level of farmers in the right to farmland and rural industry on the entrepreneurial behavior of rural households decision-making shows an "inverted U-shape"; in the absence of non-agricultural vocational skills training in the right to farmland on the entrepreneurial behavior of rural households to play a more promotional role, and the right to farmland in the absence of non-agricultural vocational skills training. In the absence of non-farm vocational skills training, the impact of farmland rights on the entrepreneurial behavior of farm households is more promotional, while in the presence of non-farm vocational skills training, rural industries have a more promotional effect on the entrepreneurial behavior of farm households.

The above empirical results provide us with academic and managerial implications, respectively. (i) Academic Implications: This study reveals the interaction between the perceived security of land rights and village industries, which provides a new perspective on the study of entrepreneurial behavior of farm households. While academics tend to view the stability of land rights as the main factor driving farm household entrepreneurship,

this study found that the development of village industries plays an important moderating role in this process. Therefore, future research could delve deeper into how security of land rights and local industrial development work together. Such research can provide a more systematic and comprehensive theoretical framework for the fields of agricultural economics and regional economics. (ii) Managerial Implications: The first is to strengthen the follow-up work of land rights, increase the interpretation of policies and team building, regulate and guide the transfer of land, and promote the transfer of non-agricultural labor. Secondly, we need to base on the local resource advantage conditions, provide farmers with capital, talents, technology and other support projects; vigorously develop local characteristic industries, cultivate and grow rural industries, help farmers to multi-form, multi-channel employment and entrepreneurship. Thirdly, we should strengthen the entrepreneurial skills training for farmers, give full play to the entrepreneurial driving effect, and increase farmers' income channels.

Although this study enriches the literature on common wealth and other related topics by revealing the internal logic between agricultural land rights, rural industries and entrepreneurial behavior of farm households, we are fully aware of the shortcomings of this study. First, due to data limitations, the sample coverage area needs to be further expanded. Second, due to the complexity of the influencing factors of the entrepreneurial behavior of agricultural households, the control variables in this paper may not be able to perfectly cover all the influencing factors, which need to be further improved and explored in the future research. Finally, under the continuous updating of econometric research methods, new research methods may more reduce the estimation errors and increase the credibility of the conclusions; however, the data structure makes it impossible to fully use the new measurement methods, and future research can be combined with the most recent research methods to justify.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the patients/ participants or patients/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

YW: Writing – original draft, Writing – review & editing. SW: Writing – review & editing, Formal analysis.

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## 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.

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## Generative AI statement

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