

The impact of policy-based agricultural insurance on agricultural entrepreneurship

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Abstract

Amid the continuous development of rural revitalization and agricultural modernization, agricultural entrepreneurship is now a vital way to promote the high-quality agriculture's development of and improve the income of farmers. Nevertheless, the dynamism of agricultural entrepreneurship is limited by compounded uncertainties from natural and market risks. In this context, this study utilizes the panel data from provinces in China from 2014 to 2023 to systematically examine the impact of policy-based agricultural insurance (PBAI) on agricultural entrepreneurial activity. Additionally, it investigates the mediating effect of inclusive finance and the heterogeneous effects between regions and periods. The results show three major findings. First, PBAI has a substantial impact on agricultural entrepreneurship and this effect is robust across a series of robustness checks, including sample scope and winsorization treatments. Second, the mediating effect analysis indicates that PBAI has a significant positive impact on regional inclusive financial development, which in turn has a positive role in stimulating agricultural entrepreneurial activity, indicating that inclusive finance partially mediates the relation between entrepreneurship and agricultural insurance. Third, heterogeneity analysis shows the positive effect of PBAI on agricultural entrepreneurship is significantly robust in the western and central regions than in the eastern region and is more pronounced in non-pandemic periods than during the periods affected by the shock of the Covid-19 pandemic. These findings enlarge the knowledge of the economic impacts of PBAI from the standpoint of agricultural entrepreneurship and offer specific policy recommendations on how to enhance agricultural risk protection systems and support entrepreneurial activities in rural areas.

Keywords: Policy-Based Agricultural Insurance; Agricultural Entrepreneurship; Inclusive Finance; Mediating Effect

1. Introduction

In recent years, China has come to understand more clearly the strategic importance of agricultural entrepreneurship in promoting agricultural modernization and rural revitalization. The 2023 *Opinions of the CPC Central Committee and the State Council on Effectively Advancing the Key Work of Comprehensive Rural Revitalization* explicitly calls for "stimulating entrepreneurial vitality in rural areas, supporting entrepreneurship by individuals returning to or relocating to rural areas, and strengthening the talent pool for agriculture and rural development." Similarly, the *National Agricultural Modernization Plan (2021-2035)* highlights the importance of "supporting the development of agricultural technology enterprises and encouraging young scientific and technological personnel to take up agricultural entrepreneurship." These policy directives reflect that the promotion of agricultural entrepreneurship has become a key goal in the execution of the rural revitalization strategy. Agricultural entrepreneurship plays a pivotal role in rural development with huge practical implications. First, agricultural entrepreneurs are generally well aware of the market and have good technical skills and management capabilities. They are capable of introducing modern agriculture technologies, digital technologies, and industrial chains integration concepts which could lead to improved agricultural productivity and value addition, greener, smarter, and more intensive agricultural practices, and ultimately high-quality agricultural growth. Second, agricultural entrepreneurship has significant spillover effects. It lengthens agricultural

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value chains, spurs associated industries such as agricultural product processing, cold chain logistics and rural e-commerce, and absorbs excess rural labor. In particular, it offers employment and development opportunities for returning youth, university graduates and veterans, expanding the sources of farmer's income. Moreover, agricultural entrepreneurship has boosted the process of agricultural business entity transformation and upgrading. Entrepreneurial family farms, farmer cooperatives and agricultural enterprises gradually replaced the traditional smallholder model, improving the scale, organization and market orientation of agricultural management. Overall, national policies always emphasize the strategic role of agricultural entrepreneurship in rural revitalization and agricultural modernization, with an emphasis on technological innovation as a key driving force in high-quality agricultural development. Consequently, the promotion of agricultural entrepreneurship has become a key policy priority of implementing China's rural revitalization strategy.

Entrepreneurship is by its nature uncertain and agricultural entrepreneurship is especially vulnerable to the twin shocks of natural and market risks. In the initial stages of business establishment, agricultural businesses often do not have mature risk management systems in place, making them extremely vulnerable to failure if faced with unforeseen events. During the early stage of agricultural insurance development in China, commercial insurance dominated the agricultural insurance market, which was characterized by typical market failures such as high loss ratios, heavy premium burdens and weak risk-sharing mechanisms. As a result, there were insufficient incentives for insurance companies to take part, product coverage was limited and protection capacity was inadequate, and it was difficult to provide effective risk mitigation for agricultural entrepreneurs. To solve this institutional challenge and make agricultural insurance affordable, accessible and sustainable, China has progressively promoted a policy-based agricultural insurance (PBAI) system since 2007. The 2007 *Opinions of the CPC Central Committee and the State Council on Promoting the Construction of a New Socialist Countryside* explicitly proposed the establishment of a PBAI system, in which the central government would subsidize premiums for major crops. This initiative was further reinforced by the *Agricultural Insurance Regulations*, which came into force from 2012, which defined organizational responsibilities, fiscal subsidy mechanisms, and risk protection obligations, formally putting PBAI on a law-based development path.

Against this background, there is a critical question: has the introduction of PBAI been effective in stimulating agricultural entrepreneurship? Addressing this question has important practical implications for the formulation and improvement of policies to support China's rural revitalization strategy.

2. Literature Review

2.1. Studies on the Economic Effects of Agricultural Insurance

2.1.1. Definition and Development of Agricultural Insurance

Agricultural insurance refers to a group of agricultural insurance covering agricultural industries, such as farming, forestry, animal husbandry, sideline production, and fisheries. When insured parties have property losses during agricultural production as a result of natural disasters, accidents, epidemics or other similar events, insurance companies are obliged to compensate for the losses according to the provisions of the contract. The earliest form of agricultural insurance can be traced to hail insurance in nineteenth century Germany^[1], and was institutionalized in the United States and Canada. In China, agricultural insurance started in the early 2000s^[2]. Following China's accession to the WTO and the implementation of the Eleventh Five-Year Plan, the state began large-scale pilot programs of premium subsidies in 2007 nationwide to mitigate the high-risk nature of agricultural production, protect farmer incomes and stabilize grain supply. As of the end of 2009, China's agricultural insurance premium income was second in the world and first in Asia^[3]. Since then, an agricultural insurance system, which is jointly subsidized by the central and local government and is mainly guided by policy objectives, has been gradually established, forming an independent framework, which is different from commercial agricultural insurance.

Agricultural insurance can be divided into commercial agricultural insurance and PBAI, which have a significant difference in terms of operating entities, objectives and insurance mechanism^[4]. Specifically, the insurance of commercial agriculture is dominated by private insurance companies, operates under a completely market-oriented model, and its primary goal is to maximize profits. In contrast, PBAI is usually carried out under the guidance of the government and underwritten by the designated insurance companies.^[5] According to Dai Yuling^[6], the main features of PBAI are government fiscal support, equitable participation of low-income farm households and wide social benefits. The insured are usually agricultural producers and farmers with coverage being made towards risks such as fluctuations in agricultural product prices and natural disasters. In fact, the government gives different preferential policies to the insured and adjusts the subsidy rates to actual needs to create macroeconomic benefits for the society^[7]. Currently,

PBAI contributes around 95% of agricultural insurance market in China, which makes it an important tool to protect farmer's interest and ensure stable agricultural development.

2.1.2. Effects of Agricultural Insurance

Agricultural insurance has substantially improved the welfare^[8] of farmers by compensating the incurred loss and also providing effective protection to agricultural production which safeguards farmers from any financial risks^[9]. Existing research on the impacts of agricultural insurance has primarily focused on agricultural output, agricultural income and the economic resilience of the agricultural sector.

With regard to agricultural production, income protection for farming operations through insurance subsidies has led to substantial investments in production by farmers, thereby improving per-unit production of grain crops. In addition, different premium subsidy standards for grain crops and cash crops can affect the decision of farmers regarding the allocation of land and result in an expansion of grain cultivation. These two mechanisms are responsible for the increased grain output together^[10].

In terms of agricultural income, Zhang Huiqin and Yang Yan^[11] suggest that agricultural insurance assists farm households to diversify operation risks, thereby facilitating the expansion of operation scale, the introduction of advanced technologies, the adjustment of planting structures and the choice of environmentally sustainable production methods. Collectively, these pathways produce circumstances for growth of income in agriculture. Li et al.^[12] further show that enhancing the coverage of crop insurance can facilitate the growth of farmers' income and grain output, mainly by strengthening investment incentives in agricultural inputs and facilitating strategic adjustments in cultivated land use in pilot counties. This positive effect is especially strong in counties with slower economic growth, higher levels of agricultural technology, and lower levels of wealth.

As far as agricultural economic resilience is concerned, the promotion of agricultural insurance can help to enhance the ability of agricultural systems to recover from extreme weather events, which will strengthen overall agricultural economic resilience^[13]. Utilizing provincial panel data from China from 2009 to 2023, Chen et al.^[14] show that agricultural insurance development substantially enhances agricultural economic resilience. Furthermore, according to Quan Tianshu et al.^[15] this effect is especially pronounced in areas with high natural agricultural risk and a high degree of dependence on foreign trade.

In addition, agricultural insurance has a role in green and good agricultural development. By raising the income of farmers it can stimulate environmentally sustainable production methods, especially in large-scale breeding operations, reducing environmental pressures, and supporting green development^{[16][17]}. Zhou Yueshu and Yin Zijian^[18] suggest that agricultural insurance facilitates green development in Chinese agriculture by enhancing agricultural green total factor productivity (GTFP) through more efficient and optimized allocation of production factors. Their analysis shows that for every 1% raise in agricultural insurance premium income, there is a 0.024% increase in GTFP. Similarly, Yang et al.^[19] show that investment in agricultural insurance has a substantial positive impact on GTFP, although the size of this effect varies by region. Using a comprehensive data set from 333 cities from 2006 to 2020, He et al.^[20] studied the effect of agricultural insurance on soil nitrogen balance and found that, for every RMB 1 million spent in agricultural insurance, 0.0195 kilotons of nitrogen surplus is avoided and 0.0089% of nitrogen use efficiency is increased.

2.2. Studies on the Influencing Factors of Entrepreneurial Behavior

2.2.1. Effects of Individual Entrepreneurial Factors on Agricultural Entrepreneurship

Entrepreneurial insight is a key factor in entrepreneurial success^[21]. Successful entrepreneurs are generally good information processors who can effectively identify and exploit opportunities^[22]. Entrepreneurial alertness is the result of the combination of a number of factors^[23], of which individual characteristics, such as personality, values and personal experience, are direct drivers of entrepreneurial behavior. Zhang Yuli et al.^[25] find that entrepreneurs with broader social networks, more diverse interaction partners and stronger connections to people of higher social status are more likely to identify innovative opportunities. Experienced entrepreneurs, on the other hand, tend to identify highly innovative opportunities based on dense network structures, with less reliance on broader network connections. Swartz et al.^[25] demonstrate how several identity factors, such as gender, culture and generational background, influence the use of digital platform strategies by female entrepreneurs in South Africa. Zhou Chenboa et al.^[26] further shows that both self-compassion and empathy have a positive effect on entrepreneurial opportunity identification through the mediating role of entrepreneurial alertness and that empathy has a stronger effect than self-compassion on entrepreneurial opportunity recognition.

In the context of agricultural entrepreneurship, individual factors are still the most direct determinant of entrepreneurial behavior. Wang Jieqiong and Sun Zehou^{Error! Reference source not found.} identify human capital needed for new agricultural entrepreneurs as including a range of knowledge, experience and capabilities that are relevant to entrepreneurial activity. From a family angle, Yang Chan et al.^[28] find that entrepreneurial activities are more likely to be undertaken by families with higher social status than by those with limited human capital. Ataei et al.^[29] study agronomy students and show that entrepreneurial leadership is found to positively affect the perception of entrepreneurial opportunities, entrepreneurial orientation, and innovation culture. They go on to show that the intellectual capital, innovation culture and entrepreneurial orientation significantly increase opportunity recognition. Drawing on 438 cases of new farmer entrepreneurship in China, Shi et al.^[30] find that entrepreneurial learning and capability strengthen multiple pathways, including the resource-capability path, the exploratory learning-opportunity-capability path, and the exploitative learning-opportunity-capability path, collectively improving the entrepreneurial performance of new farming households.

2.2.2. Effects of the External Policy Environment on Agricultural Entrepreneurship

In addition to developing individual capabilities, entrepreneurs must be able to be sensitive to changes in the external policy environment, to identify emerging opportunities and to respond effectively. Consequently, the success of entrepreneurial activities is also affected by external contextual factors such as policy frameworks, technological developments, and general social conditions, all of which shape the course of agricultural entrepreneurship.

With regard to policy, relevant incentive measures can open up significant development opportunities for young people returning to rural areas, by releasing entrepreneurial dividends, expanding scope for development and improving growth potential^[31]. Liu Yiwei et al.^[32] investigate the effects of the long-term care insurance pilot policy on household entrepreneurial willingness and returns in pilot areas. They conclude that the policy has a significant impact on stimulating necessity driven entrepreneurship by reducing time pressures related to caregiving, increasing household risk tolerance, and facilitating asset accumulation, thus improving time flexibility, psychological security and economic stability for entrepreneurial activities.

With regard to technology, the most recent wave of technological development plays a critical role in promoting technological and scientific innovation, industrial transformation and optimizing the entrepreneurial ecosystem, to stimulate regional entrepreneurial vitality^[33]. The development of digital technologies has a positive effect on the identity aspirations of digital entrepreneurs and their capability to explore and exploit entrepreneurship opportunities^[34], which also attracts more involvement in agricultural entrepreneurship. Li Tao et al.^[35] find that the adoption of digital technologies optimizes the industrial structures and contributes to the success of migrant workers to return to rural areas to start businesses. Due to digital economy's relatively advanced development in eastern China, the success rate of entrepreneurship is higher in this region, while the lack of infrastructure in western and central regions leads to low success rates. Cheng et al.^[36] further argue that digital skills reinforce agricultural entrepreneurship by improving access to key resources such as production credit, modern technologies and social capital.

Regarding social environment, heterogeneous factors such as regional geographic conditions, cultural context and prevailing social norms affect farmer entrepreneurial behavior^[37]. In a humanistic environment with a focus on commerce farmers are influenced by the local social atmosphere and more likely to actively pursue entrepreneurial opportunities. In addition, programs like entrepreneurial training, legal consultation, and support services offered by local governments and entrepreneurial institutions provide new agricultural entrepreneurs with the knowledge and skills needed for successful ventures. Zhou Nannan et al.^[38] further emphasize the role of social trust in agricultural entrepreneurship. Social trust makes it easier to form social networks, builds up risk tolerance, and helps to accumulate social capital, which in turn boosts the willingness of residents to recognize opportunities, take on entrepreneurial risks and mobilize resources for business development. This effect is especially strong for residents with agricultural household registration, women and people without higher education who are relatively disadvantaged in terms of market participation.

2.3. Literature Commentary

Existing research on this topic generally takes two lines. First, in terms of the economic impacts of agricultural insurance, previous research has systematically investigated the role of agricultural insurance in reducing agricultural risks, stabilizing farmer incomes, boosting agricultural production and raising the agricultural economic resilience. The consensus is that PBAI is effective in reducing uncertainty in agricultural production via fiscal subsidies and institutional safety net mechanisms, and is also conducive to green and high quality agricultural development. Second, research on entrepreneurial behavior has mainly concentrated on individual characteristics as well as the external environment, emphasizing the importance of human capital, social capital, policy support, technological advancement, and the general

social environment in the decision-making process of entrepreneurship and the performance of entrepreneurs. These insights are well established in the fields of urban and non-agricultural entrepreneurship. Despite these contributions, there are still multiple gaps. Research on agricultural insurance and entrepreneurial behavior is largely conducted in silos, with little research directly addressing the effect of PBAI on agricultural entrepreneurship. Furthermore, agricultural entrepreneurship, a type of entrepreneurship with high risk and high policy dependence, has no systematic empirical evidence, and little attention has been paid to the internal mechanism by which PBAI affects agricultural entrepreneurship through the financial channel. Building on these gaps, the present study seeks to incorporate PBAI and agricultural entrepreneurial behavior in a unified analytical framework, and further explore the underlying mechanisms that drive the relationship.

3. Theoretical Analysis

3.1. Research Hypotheses on the Effect of PBAI on Agricultural Entrepreneurial Behavior

This study discusses the mechanisms of agricultural entrepreneurial behavior under the influence of PBAI from three perspectives based on supply side incentive theory and prospect theory.

First, PBAI is a source of incentives for agricultural entrepreneurial behavior by decreasing the costs of entrepreneurship and institutional burdens. According to the supply-side incentive theory, easing institutional constraints and cost pressures can be effective in stimulating the willingness of economic agents to produce and invest, which will improve overall supply capacity. Agricultural entrepreneurship being a high-risk and capital-intensive activity is subject to significant natural risks and market uncertainty especially at the early stages of its development when funding gaps, low risk resiliency, and high fixed costs prevail. Traditional commercial agricultural insurance, with its high premiums and narrow coverage, is often not effective in providing good insurance for small-scale farmers or start-up agricultural enterprises, which in turn limits entrepreneurial activity. The basic benefit of PBAI is the fiscal subsidies of the insurance premiums, which greatly reduce the cost of insurance to farmers and offer a relatively high level of insurance against risk at low cost. This mechanism increases the willingness and ability of agricultural producers to conduct entrepreneurship. Moreover, PBAI provides comprehensive coverage and basic insurance, which provides compensation of income in the event of force majeure events, such as natural disasters, epidemics, or extreme climatic conditions, thus reducing excessive sensitivity to the risk of failure. For farmers who are poor in resources but possess entrepreneurial goals, such insurance acts as an institutional safety net that incentivizes proactive risk-taking and experimentation with new agricultural business models. Accordingly, as an institutional incentive, PBAI plays a significant role in enhancing the sustainability and attractiveness of agricultural entrepreneurship by reducing the costs in the early stages and compensating the losses in the later stages.

Second, PBAI promotes agricultural entrepreneurial behavior by lowering the expected losses due to entrepreneurial failure. According to prospect theory, people making decisions under uncertainty do not only use expected utility, but they use subjective perceptions of gains and losses to evaluate outcomes, where losses are judged to be more important than equal gains, a phenomenon known as loss aversion. In the very uncertain environment of agricultural entrepreneurship, farmers are exposed to significant natural and market risks. This is particularly pronounced in the early stages, when the low accumulation of resources and low experience in risk management increase their perception of possible economic losses and psychological pressure, reinforcing conservative behavior and stifling entrepreneurial willingness. As an institutional risk-protection mechanism, agricultural insurance on a policy basis offers basic insurance coverage through government fiscal subsidies, which defuses the anticipated losses from entrepreneurial failure on the part of farmers. The system addresses fears about sudden losses in income due to uncontrollable factors, such as natural disasters and epidemics, through economic compensation for losses incurred. Also, its inclusive features such as wide coverage, low entry barriers and low premiums allow agricultural business entities to more readily access institutional protection. This creates a stable sense of security and builds the ability of entrepreneurs to take risk. Under such protection, the subjective fear of failure is greatly reduced, which helps to change from a loss avoidance to an opportunity seeking orientation, which in turn promotes agricultural entrepreneurial activity.

Accordingly, Hypothesis 1 is proposed.

Hypothesis 1: PBAI significantly promotes agricultural entrepreneurial behavior.

3.2. Research Hypotheses on the Effect of PBAI on Agricultural Entrepreneurial Behavior

This research uses the financial accelerator theory to investigate the mediating effect of inclusive finance on the relationship between PBAI and agricultural entrepreneurial behavior. According to financial accelerator theory, the lack of information and uncontrollable risk are among the main factors that constrain the allocation of financial resources to the agricultural sector. PBAI, through fiscal subsidies and institutional risk-sharing arrangements, provides basic risk insurance for agricultural enterprises, which significantly reduces the impact of natural disasters and price fluctuations on the balance sheet of agricultural enterprises. The mechanism of insurance indemnity stabilizes the cash flows and the expected returns for agricultural entities, thereby making them more creditworthy. Simultaneously, insurance coverage signals to the financial institutions that the risks associated are manageable and hence reduce the costs of due diligence and risk assessment and alleviate the problems of adverse selection and moral hazard. As a result, banks, insurance providers, and digital financial institutions are more likely to invest financial resources in the agricultural sector, leading to an increase in credit availability, expansion of financial services to underserved areas, and financial product innovation. This process encourages the development of inclusive finance, which improves both its depth of coverage and efficiency of service to agricultural enterprises.

Inclusive finance has a major role to play in promoting agricultural entrepreneurship, including by increasing financial accessibility and lowering financing thresholds and costs. First, it relieves the financing constraints of agricultural enterprises in the start-up phase, enabling access to initial and working capital and thus enhancing the feasibility of entrepreneurial initiatives. Second, digitalized and diversified financial services improve the efficiency of risk pricing and capital allocation, which make funding uncertainty throughout the entrepreneurial process less prevalent and increase the ability of entrepreneurs to bear risk. Third, sustained and stable financial support allows entrepreneurial entities to scale up operations, invest in new technologies and lengthen industrial value chains, thereby enhancing the sustainability and success of their ventures. Through these mechanisms, by reducing barriers, stabilising expectations and reinforcing support, inclusive finance offers much needed financial support for agricultural entrepreneurship and significantly spurs its vitality.

Accordingly, Hypothesis 2 is proposed.

Hypothesis 2: PBAI promotes agricultural entrepreneurial behavior by improving the level of inclusive finance.

4. Empirical Analysis

4.1. Research Design

4.1.1. Variable Construction

The empirical analysis in this study has four categories of variables, namely the dependent variable, the independent variable, the mediating variable, and a set of control variables.

The dependent variable in this study is agricultural entrepreneurship. While previous studies have generally measured the level of entrepreneurship at the regional level by the number of newly registered enterprises, few studies have specifically constructed an indicator for agricultural entrepreneurial behaviour. Building on Zhao Tao et al. (2020), this study finds newly registered agricultural enterprises in each province over time, using Chinese industrial and commercial enterprise registration data. An indicator of the vitality of agricultural entrepreneurship is then constructed by dividing the number of newly registered agricultural enterprises by the resident population, giving a measure of agricultural entrepreneurial activity at the provincial level.

The independent variable is PBAI. Following Ling Tao et al. (2024), the level of PBAI in each province is measured by agricultural insurance depth indicator, which is calculated as the ratio of agricultural insurance premium income to the gross output value of agriculture, forestry, animal husbandry, sideline production and fisheries.

The mediating variable is digital inclusive finance. Drawing on Zhang Zhongxiang and Hu Yahui (2024), this study uses the provincial-level comprehensive index of digital inclusive finance development to represent the level of digital financial inclusion in each province.

In order to ensure robustness and reliability, a series of control variables is incorporated in the empirical analysis. The complete list and definitions of these variables are shown in Table 1.

Table 1 Description of Control Variables

Variable	Definition
GDP growth rate	Total provincial GDP in the current year divided by total provincial GDP in the previous year
Fiscal deficit ratio	Provincial general public budget expenditure in the current year divided by provincial general public budget revenue
Urbanization level	Urban population of the province in the current year divided by the total population
Disposable income of residents	Per capita disposable income of residents in the province in the current year (10,000 RMB)
Mobile phone penetration rate	Number of mobile phones per 100 persons in the province in the current year

4.1.2. Empirical Models

Baseline Regression Model

In order to analyze the impact of PBAI on agricultural entrepreneurship, a linear panel model with both provincial and year fixed effects is specified, as shown in Equation (1).

$$Y_{it} = \alpha + \beta X_{it} + \chi Con_{it} + \eta_i + \theta + \varepsilon_{it} \quad (1)$$

In Equation (1), Y denotes the dependent variable, which measures the level of agricultural entrepreneurship, while X represents the independent variable, which measures the level of PBAI. The subscripts i and t represent province and year respectively. Con denotes a set of control variables; η represents provincial fixed effects; θ represents time fixed effects and ε is the random error term. The relation between Hypothesis 1 and Equation (1) is as follows: if the X's estimated coefficient is significantly positive, it means that PBAI has a substantial promoting impact on agricultural entrepreneurship Y, which provides empirical support for Hypothesis 1.

Mediating Effect Model

To investigate the mediating role of inclusive finance, a 3-step approach is used. Building on Equation (1), two other models, Equations (2) and (3), are specified for testing the mediation effect.

$$Z_{it} = \alpha_2 + \beta_2 X_{it} + \chi_2 Con_{it} + \mu'_i + \eta'_t + \varepsilon'_{it} \quad (2)$$

$$Y_{it} = \alpha_3 + \beta_3 X_{it} + \phi_3 Z_{it} + \chi_3 Con_{it} + \mu''_i + \eta''_t + \varepsilon''_{it} \quad (3)$$

In these equations, Z denotes the mediating variable, presenting the level of inclusive finance. Equation (2) assesses the impact of PBAI on the mediating variable, while Equation (3) evaluates the impact of the mediating variable on agricultural entrepreneurship. If the estimated coefficient β_2 is substantially positive and the coefficient ϕ_3 is also significantly positive, this provides evidence that PBAI promotes agricultural entrepreneurship in part by enhancing the level of inclusive finance.

4.1.3. Data Description

This study uses data at the provincial level in China from 2014 to 2023. The main sources of data are provincial statistical yearbooks. The data for the construction of the agricultural entrepreneurship indicator are derived from the Chinese industrial and commercial enterprise registration records that are made publicly available. Information on PBAI is taken from the *China Rural Statistical Yearbook* and the *China Insurance Statistical Yearbook*. Data on digital inclusive finance are taken from the dataset jointly released by the Institute of Digital Finance at Peking University and Ant Group.

4.2. Analysis of Empirical Results

4.2.1. Descriptive Statistical Analysis

As shown in the descriptive statistics in table 2, the basic characteristics of the core and control variables in the sample can be summarized as follows.

As for the basic variables, the average value of agricultural entrepreneurship is 2.193 with a standard deviation of 3.333, a minimum of 0.0367, and a maximum of 25.09. These statistics show that there is a significant interprovincial variation in the vitality of agricultural entrepreneurship, with large regional differences. Agricultural entrepreneurial activity is very concentrated in some provinces, while most regions have rather low levels. The average value of PBAI is 1.813, with a standard deviation of 2.068, a minimum of 0.200, and a maximum of 13.19, indicating that there is a large gap in the development of agricultural insurance among provinces and the coverage of risk protection is uneven across regions, with the intensity of fiscal support also varying. The mean value of inclusive finance is 314.8 with a standard deviation of 67.25 and a range of 186.4 to 473.8, which shows the level of inclusive finance across provinces was above the median, although there were obvious regional differences. This variation lays a good foundation for investigating the mediating role of inclusive finance in the relationship between PBAI and agricultural entrepreneurship. For the control variables, the mean of GDP growth rate is 106.1, showing that the economic growth was relatively stable in the provinces during the sample period. The average fiscal deficit ratio is 0.716, which implies that there is widespread pressure on local fiscal balances. The average level of urbanization is 0.622, indicating significant interprovincial differences in urbanization. The disposable income of residents is 30,310 RMB on average, reflecting the overall improvement of household income, although there are significant regional differences. Finally, the mean mobile phone penetration rate is 111.4, which suggests a relatively high level of coverage across provinces of information infrastructure.

Table 2 Descriptive Statistics of Variables

Variable	Mean	Standard deviation	Minimum	Maximum
Agricultural entrepreneurship	2.193	3.333	0.0367	25.09
PBAI	1.813	2.068	0.200	13.19
Inclusive finance	314.8	67.25	186.4	473.8
GDP growth rate	106.1	2.507	94.60	112.9
Fiscal deficit ratio	0.716	0.0725	0.542	0.903
Urbanization level	0.622	0.116	0.288	0.895
Disposable income of residents	3.031	1.318	1.225	8.483
Mobile phone penetration rate	111.4	22.50	66.37	188.6

4.2.2. Analysis of Baseline Regression Results

Table 3 shows the baseline regression results for the impact of PBAI on agricultural entrepreneurship. Column (1) reports estimates controlling only for provincial and year fixed effects, and Column (2) further includes a set of control variables. The results show that, regardless of the inclusion of control variables, the coefficient of PBAI is positive and statistically significant at 1% level. Notably, the coefficient rises from 1.094 to 1.439, indicating that higher levels of agricultural insurance based on policies are related to higher vitality in agricultural entrepreneurship. These results provide strong evidence that PBAI is associated with agricultural entrepreneurial activity by reducing risk and stabilizing expectations, providing preliminary evidence in support of Hypothesis 1.

Regarding the control variables, the coefficient of the growth rate of GDP is significant (10% level) and positive, implying that economic growth contributes to a better entrepreneurial environment and supports agricultural entrepreneurship. The coefficient of the fiscal deficit ratio is substantially positive, implying that more fiscal capacity in a region may lead to stronger government support for agricultural and entrepreneurial activities, which in turn may lead to agricultural entrepreneurship. In contrast, the level of the coefficient of urbanization is significantly negative, indicating that urbanization may have a crowding out effect on agricultural entrepreneurship, by drawing labour and resources to non-agricultural sectors. Similarly, the coefficient of disposable income of residents is significantly negative, which may suggest that higher-income regions are more likely to be oriented towards entrepreneurship or non-agricultural

employment, so agricultural entrepreneurship is less relative. Finally, the coefficient of mobile phone penetration is also substantially negative at 10% level, which suggests that the improvement in information infrastructure does not directly promote agricultural entrepreneurship, and may have an effect through other channels.

Table 3 Empirical Results for the Effect of PBAI on Agricultural Entrepreneurship

Variable	(1)	(2)
	Agricultural entrepreneurship	Agricultural entrepreneurship
PBAI	1.094*** (7.668)	1.439*** (9.389)
GDP growth rate		0.159* (1.910)
Fiscal deficit ratio		7.754*** (2.631)
Urbanization level		-36.148*** (-2.881)
Disposable income of residents		-4.618*** (-6.833)
Mobile phone penetration rate		-0.035* (-1.932)
Constant	-0.677* (-1.810)	8.873 (0.646)
Sample size	310	310
R-squared	0.566	0.655
Province effects	Controlled	Controlled
Time effects	Controlled	Controlled
F-statistic	35.15	33.41

Note: t-values are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. The same applies below.

4.2.3. Robustness Analysis

Table 4 presents the results of several robustness tests that were performed in order to evaluate the robustness of the baseline regression results. Columns (1) and (2) exclude the samples of municipalities, Beijing, Shanghai, Tianjin and Chongqing, to avoid possible distortions due to their special characteristics in economic development, fiscal capacity and financial environment. The results indicate that the coefficient of PBAI is significantly positive at 1% level with the value of 2.084 and 2.098. This shows that even after removing the municipality-level samples, the promoting effect of PBAI on agricultural entrepreneurship still remains, and verifies that the results in the baseline are not affected by sample selection.

Columns (3) and (4) implement a 5% winsorization of the core independent and dependent variables in order to minimize the effect of extreme values on the estimates. The resulting coefficients of winsorized PBAI are 1.694 and 1.559 which are both statistically significant at 1% level. These results suggest that the positive impact of PBAI on agricultural entrepreneurship is robust and not driven by outliers.

Table 4 Empirical Results of Robustness Tests

Variable	(1)	(2)	(3)	(4)
	Excluding municipality-level samples		Winsorization of core variables	
	Agricultural entrepreneurship	Agricultural entrepreneurship	Agricultural entrepreneurship_winsorized	Agricultural entrepreneurship_winsorized
PBAI	2.084***	2.098***		
	(9.841)	(9.900)		
PBAI_winsorized			1.694***	1.559***
			(11.528)	(11.316)
GDP growth rate		0.157*		0.064
		(1.782)		(1.592)
Fiscal deficit ratio		5.380		5.070***
		(1.629)		(3.524)
Urbanization level		-54.176***		-30.838***
		(-3.404)		(-5.092)
Disposable income of residents		-2.405***		-1.452***
		(-2.615)		(-4.474)
Mobile phone penetration rate		0.012		-0.016*
		(0.424)		(-1.817)
Constant	-1.242***	9.320	-1.200***	9.847
	(-3.185)	(0.654)	(-5.647)	(1.474)
Sample size	270	270	310	310
R-squared	0.617	0.661	0.785	0.824
Province effects	Controlled	Controlled	Controlled	Controlled
Time effects	Controlled	Controlled	Controlled	Controlled
F-statistic	37.57	29.62	98.10	82.19

4.2.4. Mediating Effect Analysis

Table 5 presents the results of the mediating effect analysis, considering the role of inclusive finance in the relation between PBAI and agricultural entrepreneurship. Columns (1) and (2) take inclusive finance as the dependent variable and measure the effect of PBAI. The coefficients of PBAI are 0.991 and 1.811, respectively, both of which are statistically significant (1% level). These results show that the development of PBAI has a significant impact on improving the level of regional inclusive finance and therefore it can be suggested that through risk protection and credit enhancement mechanisms, PBAI helps to facilitate the flow of financial resources into the agricultural sector and improve access to inclusive financial services by agricultural entities. Columns (3) and (4) add inclusive finance to the regression model on agricultural entrepreneurship to assess the mediating role of inclusive finance. The coefficients of inclusive finance are 0.048 and 0.033, significant at 1% and 5% levels respectively, suggesting that inclusive finance has significant role of promoting agricultural entrepreneurial activity. After controlling for inclusive finance, the coefficient of PBAI is also significantly positive but is reduced compared to the baseline, showing that inclusive finance partially mediates the effect of PBAI on agricultural entrepreneurship. Overall, PBAI not only directly stimulates agricultural entrepreneurship, but also indirectly improves entrepreneurial vitality by improving inclusive finance, thereby easing financing constraints and risk pressures faced by agricultural entrepreneurial entities.

Table 5 Empirical Results of the Mediating Effect of Inclusive Finance

Variable	(1)	(2)	(3)	(4)
	Inclusive finance	Inclusive finance	Agricultural entrepreneurship	Agricultural entrepreneurship
Inclusive finance			0.048***	0.033**
			(2.911)	(2.127)
PBAI	0.991***	1.811***	0.842***	1.009***
	(2.920)	(3.944)	(8.060)	(9.537)
GDP growth rate		0.152		0.153*
		(0.610)		(1.853)
Fiscal deficit ratio		13.951		7.289**
		(1.581)		(2.470)
Urbanization level		139.982***		-40.815***
		(3.726)		(-3.181)
Disposable income of residents		27.599***		-5.538***
		(13.636)		(-6.297)
Mobile phone penetration rate		-0.005		-0.035*
		(-0.095)		(-1.928)
Constant	178.886***	21.143	7.986***	8.168
	(132.339)	(0.514)	(2.664)	(0.596)
Sample size	310	310	310	310
R-squared	0.991	0.995	0.580	0.658
Province effects	Controlled	Controlled	Controlled	Controlled
Time effects	Controlled	Controlled	Controlled	Controlled
F-statistic	3022	3636	33.62	31.69

4.2.5. Heterogeneity Analysis

To explore the heterogeneity in the impact of PBAI on agricultural entrepreneurship, this study creates dummy variables in both locational and time dimensions and includes interaction terms. For the locational heterogeneity analysis, a dummy variable for the eastern region is defined, which is equal to 1 if the province is part of the eastern region and 0 otherwise. This variable is interacted with the PBAI variable to create the term $PBAI \times \text{Eastern region}$. Under this specification, the coefficient of the main effect of PBAI reflects the impact of agricultural entrepreneurship in non-eastern regions (i.e., the central and western regions), and the coefficient of the interaction term represents the difference of the impact in the eastern region compared to the central and western regions. For the temporal heterogeneity analysis, the period from 2020 to 2023 is considered as the pandemic period and a dummy variable is built accordingly, with value 1 for the pandemic years and 0 for the rest. The interaction term $PBAI \times \text{Pandemic period}$ is then created. Here, the coefficient of main effect indicates the effect of PBAI during the non-pandemic period, while the coefficient of interaction term indicates the change in the effect of PBAI under the pandemic shock.

The locational heterogeneity results show that the coefficient of the main effect of PBAI is significantly positive, proving that PBAI greatly promotes agricultural entrepreneurship in the central and western regions. In contrast, the coefficient of the interaction term $PBAI \times \text{Eastern region}$ is significantly negative, indicating that the promoting effect of PBAI on agricultural entrepreneurship is significantly weaker in the eastern region than in the central and western regions. This finding suggests that the incentive effect of PBAI is more pronounced in less affluent areas with higher exposure to agricultural risks. In the eastern region, where marketization is more advanced, and the financial system is better

developed, the marginal dependence of agricultural entrepreneurial entities on policy-based risk protection is lower, and the promoting effect is relatively small.

The temporal heterogeneity results indicate that PBAI has a significant promoting effect on agricultural entrepreneurship in the non-pandemic period. In contrast, the coefficient of interaction term PBAI $\times$ Pandemic period is significantly negative, which suggests that the promoting effect of PBAI was substantially weakened during the pandemic period from 2020 to 2023. This finding suggests that, although PBAI provides risk protection for agricultural business entities, major exogenous shocks, such as the pandemic, can reduce its incentive effect. Factors such as contraction in demand, restrictions in production and circulation, and worsening in entrepreneurial expectations likely make risk protection policies less effective in stimulating entrepreneurial decision-making under such conditions.

Table 6 Empirical Results of Heterogeneity Analysis

Variable	(1)	(2)	(3)	(4)
	Locational heterogeneity		Temporal heterogeneity	
	Agricultural entrepreneurship	Agricultural entrepreneurship	Agricultural entrepreneurship	Agricultural entrepreneurship
PBAI	1.783*** (8.757)	1.710*** (8.810)	1.780*** (6.845)	2.057*** (8.262)
PBAI $\times$ Eastern region	-1.045*** (-4.590)	-0.667** (-2.246)		
PBAI $\times$ Pandemic period			-0.512*** (-3.132)	-0.478*** (-3.118)
GDP growth rate		0.167** (2.029)		0.164** (2.007)
Fiscal deficit ratio		6.903** (2.341)		8.538*** (2.934)
Urbanization level		-45.981*** (-3.484)		-39.197*** (-3.166)
Disposable income of residents		-3.815*** (-5.021)		-4.451*** (-6.672)
Mobile phone penetration rate		-0.032* (-1.768)		-0.024 (-1.294)
Constant	-0.895** (-2.461)	12.153 (0.887)	-1.273*** (-3.074)	7.425 (0.549)
Sample size	310	310	310	310
R-squared	0.598	0.661	0.582	0.667
Province effects	Controlled	Controlled	Controlled	Controlled
Time effects	Controlled	Controlled	Controlled	Controlled
F-statistic	36.26	32.12	33.90	32.97

5. Conclusions

Using provincial panel data from China over the period 2014-2023, this study systematically examines the impacts of PBAI on agricultural entrepreneurial behavior, the underlying mechanisms for the impacts, and their heterogeneity across regions and time. The key findings are as follows.

First, PBAI has a huge promoting effect on agricultural entrepreneurship. Baseline regression results show that, after controlling for province and year fixed effects and a series of macro-level control variables, the development of PBAI greatly increases the vitality of agricultural entrepreneurship. This finding suggests that decreasing uncertainty in agricultural operations through fiscal subsidies and risk-sharing mechanisms are effective in stimulating the entrepreneurial willingness and actual entrepreneurial behavior of agricultural entities. The conclusion holds up in several sensitivity analyses. Second, inclusive finance mediates, to some extent, the link between PBAI and agricultural entrepreneurship. The mediating effect analysis shows that the PBAI has a significant effect on improving the regional level of inclusive finance, which in turn further promotes the vitality of agricultural entrepreneurship. After including the inclusive finance variable, the direct effect of PBAI decreases somewhat but is still significant, suggesting that PBAI has a direct and indirect effect on agricultural entrepreneurship. The indirect effect works through the financial accelerator mechanism and improves financial accessibility and reduces financing constraints for agricultural entrepreneurial entities. Third, the impact of PBAI on agricultural entrepreneurship shows some interesting heterogeneity. From the point of view of location, the promoting effect is greater in the central and western regions than in the eastern region. From a temporal perspective, the positive effect is significantly weaker during the pandemic period from 2020 to 2023 as compared with the non-pandemic period. These results indicate that PBAI effectiveness depends on the level of development in the region and the external shock situation, with the incentive effect of agricultural insurance being greater in situations where the risk exposure is higher and financial resources are relatively limited.

Recommendations

First, the PBAI system should be continuously improved in order to enhance the basic risk protection function for agricultural entrepreneurship. Building on the finding that PBAI is an important enabler of agricultural entrepreneurial activity, policy design should further leverage its institutional advantages in risk-sharing and expectation stabilization. By enhancing the precision of fiscal subsidies, optimizing insurance clauses and coverage scope, the natural and market risks faced by agricultural entrepreneurial entities, especially at the start-up phase, can be mitigated, thus increasing the willingness and capacity to undertake sustained agricultural entrepreneurship.

Second, closer integration between PBAI and inclusive finance should be encouraged to create a comprehensive financial service system to support agricultural entrepreneurship. Given that inclusive finance mediates, in part, the effect of PBAI on agricultural entrepreneurship, it is imperative to build stronger policy linkages between insurance, credit and digital finance. Agricultural insurance participation and claims settlement records should be included as important references in the credit evaluations of financial institutions. This approach can help overcome financing constraints for agricultural entrepreneurial entities and increase the beneficial impact of PBAI through the efficient allocation of financial resources for the agricultural sector.

Third, differentiated support strategies should be put into practice in line with regional characteristics and external shock scenarios. In light of the heterogeneity analysis, the promoting effect of PBAI is more pronounced in the central and western regions and in non-pandemic periods. Therefore, higher policy intensity and targeted support should be given to the central and western regions and in the eastern region, emphasis should be placed on coordination with market-based financial instruments. Moreover, during major exogenous shocks, such as the Covid-19 pandemic, the stabilizing and protective functions of PBAI should be strengthened through phased subsidies and supplementary support measures for the resilience and vitality of agricultural entrepreneurship.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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