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The analysis of multidimensional poverty reduction effects of dual financial participation: evidence from rural household in China

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This study examines the impact of formal and informal financial participation on the multidimensional poverty status of rural households in China. Using panel data from the China Family Panel Studies (CFPS) covering the period 2014–2020, we construct a multidimensional poverty index based on the Alkire–Foster method and conduct empirical analyses employing panel Logit and dynamic Probit models. The results indicate that dual financial participation significantly reduces the likelihood of multidimensional poverty, a finding that remains robust after accounting for poverty state dependence and addressing endogeneity concerns. Further analysis reveals that formal financial participation primarily alleviates poverty in the dimensions of assets, risk resilience, and education, whereas informal financial participation is more strongly associated with improvements in living standards. The poverty reduction effects also exhibit substantial heterogeneity across households with different income levels, household head characteristics, and family structures. In addition, macro-institutional factors play a moderating role: higher agricultural insurance penetration and greater maturity of social credit systems enhance the poverty reduction effects of formal finance, while excessive financial regulation may undermine the effectiveness of informal finance. Overall, the findings provide comprehensive empirical evidence on the complementary roles of formal and informal financial systems in supporting rural poverty alleviation efforts in China.

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Introduction

Extreme poverty remains a critical obstacle to sustainable development in developing countries (Saleem et al., 2021). According to PovcalNet data from the World Bank, as of 2018, over 80 percent of the world's extreme poor—defined as individuals living on less than $1.25 per day—resided in rural areas of developing countries (Castañeda et al., 2018). Consequently, alleviating rural extreme poverty has become a focal issue among policymakers and academics. China, the largest developing country, initiated a comprehensive rural targeted poverty alleviation campaign in 2013, integrating interventions in healthcare, employment generation, and inclusive financial services. By the end of 2020, China officially announced the successful elimination of absolute income poverty in rural areas[1]. However, although income-based poverty measures are straightforward and operationally convenient, they primarily capture economic deprivation, ignoring critical dimensions such as social exclusion, malnutrition, substandard living conditions, and limited access to essential resources and employment[2]. Evidence suggests that many households that exit income poverty remain vulnerable to relapse, primarily due to persistent structural constraints. (Zhou et al., 2022). Thus, adopting a broader perspective on poverty and identifying key factors facilitating its reduction are essential for achieving inclusive and sustainable development in rural areas.

In measuring poverty, the multidimensional approach inspired by Sen's capability framework has offered significant advancements beyond traditional income-based methods (Sen, 1985). This approach conceptualizes poverty as a deprivation of basic capabilities, encompassing living standards, education, health, and asset ownership, thus providing a more holistic evaluation of poverty (Alkire and Seth, 2015; Bukari et al., 2024). Strengthening rural households' capability to sustainably escape poverty is critical, and financial services play a vital role in this process. Financial instruments can provide essential funding, improve credit conditions, promote productive investments, and facilitate effective risk management, significantly enhancing self-sufficiency and resilience (Beck et al., 2007). Indeed, financial interventions such as microcredit, rural credit cooperatives, and local financial associations have demonstrated substantial poverty-reducing effects across many developing countries (El-Nasharty, 2022; Saha and Qin, 2023; Dewi et al., 2018). Additionally, advancements in digital finance have further expanded financial access and efficiency, thus reinforcing their potential role in poverty alleviation (Gautam et al., 2021; Ye et al., 2022).

Despite the abundant literature examining financial development and poverty reduction, limited attention has been given to the unique dual-structure of rural financial systems in China. In developing economies characterized by weak legal frameworks and low-income markets, formal financial institutions—such as commercial banks and policy-driven banks—often coexist with informal networks, including familial and community-based lending (Ayyagari et al., 2008; Germidis et al., 1991). The combination of China's expansive territory and sizeable population has led to a structurally dualistic rural financial system. Formal institutions typically provide basic, policy-oriented financial services with growing yet still limited influence, whereas informal finance, rooted in traditional interpersonal networks, continues to play a critical and pervasive role. Due to such structural differences, formal and informal financial participation may distinctly affect rural multidimensional poverty (Das, 2019; Li and Hu, 2024).

Using panel data from the China Family Panel Studies (CFPS) from 2014 to 2020, this paper evaluates the dynamics of multidimensional poverty among rural Chinese households and empirically examines the effects of dual financial participation. The primary objective is to contribute to improving the multidimensional well-being of rural households. Employing panel Logit regression, dynamic Probit models, and instrumental variable techniques, this study addresses three core questions: Does participation in formal and informal finance significantly reduce rural multidimensional poverty? How do these two forms of financial participation affect multidimensional poverty differently? What are the respective strengths and limitations of each in contributing to poverty reduction?

This study contributes to the literature in three key ways. First, existing research predominantly focuses on macro-level impacts of financial inclusion, with little attention to the dual financial structure in rural developing countries (Wang et al., 2024; Boulanouar et al., 2024; Nsiah et al., 2021). This paper integrates formal and informal financial participation into a unified micro-level analytical framework. The analysis is grounded in China's rural development experience and offers insights with broader relevance for other developing countries. Second, existing studies often overlook the dynamic state-dependence of multidimensional poverty, whereby prolonged deprivation intensifies household vulnerability and renders poverty exit increasingly difficult. (Yonas and Eyoual, 2020). By employing a dynamic Probit model, this research explicitly addresses the dynamic state-dependence issue, offering a robust assessment of sustained poverty alleviation effects of dual financial participation. Finally, given that institutional factors may shape the effectiveness of financial interventions, this study empirically examines how institutional contexts influence the poverty-reducing impact of dual financial participation. It further highlights the critical conditions under which financial policies are most effective.

The remainder of the paper is structured as follows: Section I presents the theoretical framework and research hypotheses. Section II outlines the empirical methodology, data sources, and variables. Section III reports the results, including multidimensional poverty measurements, baseline regressions, and robustness checks. Section IV provides further analysis, examining impacts on single dimensions of poverty, institutional moderation effects, and heterogeneity analyses. Section V concludes the paper and discusses policy implications.

Theoretical analysis

Dual financial participation and rural multidimensional poverty. Formal financial services, including bank loans, savings, investments, and insurance products, are primarily provided by regulated financial institutions (Nwosu and Ilori, 2024). Bank credit constitutes a central component of formal financial participation for rural households in China. It serves as the primary mechanism for promoting financial inclusion and implementing targeted financial poverty alleviation policies (Su et al., 2021). Engagement with formal financial services enables rural households to accumulate savings securely, access long-term productive credit, and obtain risk protection. The financial functions play a crucial role in enhancing household health, improving educational attainment, and stabilizing livelihoods (Demirguc-Kunt et al., 2018). At the macro level, greater formal financial inclusion not only stimulates regional economic growth and expands employment opportunities, but also strengthens the fiscal capacity for public investment in healthcare, education, and social protection. Together, these effects contribute meaningfully to the reduction of multidimensional poverty (Shah and Ali, 2023). Nonetheless, some studies suggest that formal financial development can exacerbate inequalities through financial exclusion and elite capture, thereby intensifying relative poverty (De Haan et al., 2022; Zhang and Yin, 2016). However, empirical evidence broadly

supports the poverty reduction effectiveness of formal finance in developing countries (Elumah et al., 2024).

Informal finance, primarily represented by loans from friends, relatives, and community-based financial organizations, also plays a critical role in poverty alleviation, especially in rural areas where formal financial services are limited. Informal finance is characterized by low entry barriers, minimal procedural requirements, operational flexibility, and a heavy reliance on social networks (Baland et al., 2017). By promptly addressing short-term funding needs, managing economic emergencies, and compensating for formal financial service gaps, informal finance significantly reduces multidimensional poverty in rural areas (Khandker and Koolwal, 2010). For instance, informal financial services in Nigeria have effectively alleviated poverty through improved access to credit and savings, entrepreneurship promotion, reduced economic volatility, and strengthened community social capital (Emmanuel et al., 2024). Similarly, Li and Hu (2024) document that informal finance facilitates land circulation and non-agricultural employment in rural China, effectively reducing multidimensional relative poverty.

Some research emphasizes the collaborative poverty-alleviation effects of formal and informal finance. Under certain conditions, formal finance, characterized by structured and long-term credit support, can complement informal finance, which is better suited to meeting short-term and emergency financial needs. This synergy enhances households' risk management capabilities and autonomous development, thereby alleviating multidimensional poverty (Mansour et al., 2024). In China, formal finance serves as the foundation of the financial poverty alleviation strategy by providing efficient and inclusive financial services (Liu et al., 2018). However, formal financial resources predominantly focus on urban areas, limiting their reach in rural regions (Jiang et al., 2025). Informal finance compensates for this gap by offering accessible, rapid, and low-cost financial solutions (Tsai and Wang, 2017). Expansion of formal finance improves financial access and optimizes income distribution in rural areas (Sun et al., 2018), while informal finance reduces transaction costs and mitigates informational asymmetries, supporting rural economic growth and poverty alleviation (Jia et al., 2015).

Based on these discussions, the Hypothesis 1 (H1) is proposed: Participation in both formal and informal financial services significantly alleviates rural households' multidimensional poverty.

Dual financial participation and specific dimensions of rural multidimensional poverty. Multidimensional poverty encompasses a variety of dimensions, and the contrasting service mechanisms and risk management models of formal and informal finance may influence these aspects in distinct ways. Formal financial institutions, backed by institutionalized service networks and prudent regulatory frameworks, can provide a portfolio of inclusive financial products covering savings, credit, and insurance (Ayyagari et al., 2010). Such products often feature high levels of contractual completeness and legal protection. They also offer risk mitigation and intertemporal allocation functions that align with households' financial planning needs. The market penetration of formal finance improves household living conditions and strengthens asset accumulation. It also alleviates liquidity constraints on human capital investment, through instruments such as education loans, thereby broadening access to educational opportunities (Yang and Fu, 2019). In Bangladesh, standardized microfinance programs with structured repayment mechanisms have been shown to generate multiple benefits at the household level. These include increased business income, improved health outcomes and school enrollment for children, and significantly enhanced women's bargaining power in household decision-making (Khandker, 2005). By contrast, informal finance capitalizes on relational contracts and flexible governance structures, which confer a comparative advantage in terms of service accessibility. Its credit assessment mechanisms are often embedded in social capital, thereby reducing transaction costs, while flexible loan terms effectively match temporary funding needs (Jiang, 2009). Other studies also indicate that, in rural areas where formal finance is absent, community-based mutual finance can significantly enhance the ability to smooth medical expenditures and can raise households' educational investment rates (Karlan et al., 2017).

In the Chinese context, Han et al. (2019) find that broader participation in formal finance substantially improves rural residents' living standards, fosters household asset accumulation, and increases access to education and healthcare. As formal finance extends further into rural regions, vulnerable groups benefit from heightened financial inclusion, which drives regional economic growth and helps optimize income distribution. At the same time, informal finance provides a crucial supplement by reducing the transaction and usage costs of financial services and alleviating credit constraints rooted in information asymmetries (Sakyi-Nyarko, 2018). Its community-based mutual support model can swiftly satisfy small-scale financing needs and offers protective capacity against unexpected economic shocks. Lee and Persson (2024) further note that relational contracts in informal finance effectively curb moral hazard and adverse selection, thereby strengthening the targeting and sustainability of poverty alleviation efforts. Consequently, both formal and informal finance play essential roles in shaping rural households' multidimensional poverty outcomes, though they operate through different mechanisms and coverage channels. These institutional differences can lead to heterogeneous impacts across various dimensions of poverty.

Consequently, we propose Hypothesis 2 (H2): Participation in formal and informal financial services differentially impacts the alleviation of specific dimensions of rural household poverty.

Institutional moderation of dual financial participation in multidimensional poverty reduction. Formal finance is characterized by large-scale resource allocation and institutionalized risk management, while informal finance primarily relies on social networks and flexible service adaptation. In rural financial systems, these two forms of finance complement each other, creating a dual structure that contributes to poverty alleviation. However, the cost and efficiency of accessing financial services are influenced by more than just their intrinsic characteristics. They also depend on broader institutional factors, including the coverage of agricultural insurance, the maturity of the social credit system, and the stringency of financial regulation.

Agricultural insurance is a widely implemented economic policy instrument in rural China. Its penetration rate serves as a proxy for the development of financial infrastructure and households' risk tolerance at the regional level (Khan et al., 2024; Huong, 2024; Ankrah et al., 2021). Regions with higher agricultural insurance penetration tend to have more developed formal financial networks and mature financial markets, making it easier for rural residents to access formal credit. In addition, agricultural insurance functions as a risk diversification mechanism, reducing the uncertainty of agricultural production and improving farmers' ability to absorb financial shocks. This enhanced risk-bearing capacity strengthens their ability to repay loans, thereby increasing their creditworthiness. Furthermore, the establishment of an agricultural insurance system facilitates credit history accumulation. Borrowers who consistently pay insurance

premiums and maintain claim records develop financial track records, which help mitigate information asymmetries faced by financial institutions. As a result, lenders can better assess borrower risk, improving credit allocation efficiency (Janzen and Carter, 2019). Given these institutional effects, agricultural insurance penetration should be considered when evaluating the impact of dual financial participation on multidimensional poverty among rural households.

As a critical component of financial infrastructure, the maturity of the social credit system can significantly affect rural residents' access to formal financial services (Beck et al., 2007). The development level of the credit system directly influences financial institutions' credit allocation decisions. In regions with more advanced credit systems, rural residents' credit history, repayment ability, and other soft information are systematically recorded and integrated into lending decisions. This improves financial institutions' ability to assess borrower risk (Jappelli and Pagano, 2002). Consequently, lenders can reduce their reliance on traditional collateral-based lending and instead apply credit-scoring models to implement differentiated risk pricing. This process expands the availability of formal credit to a broader range of rural households. Conversely, in regions where the credit system is underdeveloped, financial institutions face greater asymmetric information problems. This weakens the inclusiveness of formal finance, limiting its role in alleviating multidimensional poverty.

Compared to formal finance, informal finance is characterized by lower entry barriers, more flexible loan terms, and strong reliance on social networks. It often serves as a complementary source of credit, particularly for rural households excluded from the formal financial system. However, the effectiveness of informal finance in poverty alleviation is shaped by institutional constraints, especially the intensity of financial regulation. Stronger financial regulations increase compliance costs and restrict operational models, placing constraints on the expansion of informal finance (Mughal et al., 2020). As regulatory standards tighten, informal lenders face stricter disclosure requirements, capital adequacy thresholds, and interest rate regulations. These measures raise operating costs and may force some informal lenders out of the market, reducing rural households' access to small-scale, short-term credit. This crowding-out effect of financial regulation limits the availability of informal lending channels, weakening their role in alleviating multidimensional poverty (Chai et al., 2019). While stricter regulations may enhance the stability of the financial system, they also increase barriers to credit access, particularly for rural borrowers reliant on informal finance. As a result, financial regulation must strike a balance between ensuring financial stability and preserving financial accessibility for underserved populations.

Based on the above analysis, we propose Research Hypothesis 3: Agricultural insurance penetration, social credit system maturity, and financial regulatory intensity moderate the relationship between dual financial participation and multidimensional poverty reduction.

Research design

Methods of multidimensional poverty measurement. The paper employs the Alkire-Foster (A-F) method to identify and measure multidimensional poverty, with a specific focus on rural China and its temporal evolution (Alkire and Foster, 2011). The A-F methodology necessitates the establishment of dual thresholds for a comprehensive assessment of multidimensional poverty. The first threshold pertains to unidimensional poverty assessment, determining whether a sample falls into poverty within a specific indicator or dimension. The second threshold ascertains multidimensional poverty status, assessing whether the sample meets the criteria for being classified as multidimensional poor. This dual-threshold approach captures the multifaceted nature of poverty, encompassing a broader spectrum of social, educational, and health-related dimensions.

Specifically, d indicators are tracked for n households over t periods, using the values of the jth indicator taken by sample j at time point t. To identify the poverty status in different dimensions, the vector $z = (z_1, z_2, z_3 \ldots, z_d)$ is set, with z_i denoting the deprivation threshold for the ith indicator. At this point, the poverty identification function $g_{ij}^t(z)$ for individual indicators is constructed. The weighted multidimensional poverty threshold, denoted as k, conceptualizes the critical value of the deprivation score for each indicator. The weighted multidimensional poverty status of the sample can be measured according to the A-F method (MP_0^t):

$$MP_0^t = HM_0^t \times AM_0^t = \frac{q}{N} \times \sum_{i=1}^{N} C_i(k)/qD \quad (1)$$

In Eq. (1), HM_0^t is the incidence of multidimensional poverty in the sample in period t, which is the share of the multidimensional poor in the total population; and AM_0^t is the average deprivation in the sample in period t, which is the share of the multidimensional poor individuals that are deprived on average. There are:

$$MP_0^t = \sum_{i=1}^{N} C_i(k)/ND \quad (2)$$

Equation (2) is the multidimensional poverty index measured by the first and second type of thresholds, which measures the multidimensional poverty status of the sample in a specific period, capturing its intertemporal variation.

Empirical strategy

Benchmark model: In order to rigorously analyze the influence of financial participation on the multidimensional poverty experienced by rural households, this paper establishes the following benchmark model:

$$MP_{it} = \alpha + \beta X_{it} + \gamma Z_{ikt} + \varepsilon_{it} \quad (3)$$

where MP_{it} denotes the multidimensional poverty status of a household over time. The variable X_{it} represents a set of explanatory variables, encompassing aspects of rural formal and informal financial participation. The coefficients associated with these variables measure the impact of financial development on reducing multidimensional poverty. Additionally, Z_{ikt} comprises a set of control variables, included to account for other factors that may influence the poverty status of the household. This paper employs the panel logit regression method for the benchmark regression analysis. This statistical approach is particularly adept at estimating marginal effects, which are crucial for understanding the dynamics between financial participation variables and their impact on the likelihood of rural households experiencing multidimensional poverty.

Dynamic probit model: Multidimensional poverty is characterized by a phenomenon known as state dependence, where the longer a household remains in poverty, the more challenging it becomes to escape this condition (Yonas and Eyoual, 2020). This dynamic implies that a household's current poverty status may be correlated with its past experiences of poverty. However, the standard panel Logit model is not well-suited to capture this potential correlation between current and past poverty states. To address this limitation, this study employs a dynamic Probit model, which explicitly incorporates the persistence of poverty

Table 1 Dimensions, indicators and thresholds of multidimensional poverty.

Dimension (weights)	Indicators (weights)	Description of indicators	Threshold value
Quality of life	Domestic water (1/18)	Uses non-tap, well, or mineral water	Yes = poor; otherwise non-poor
1/6)	Domestic fuel (1/18)	Uses firewood as fuel	
	Food Consumption (1/18)	Engel's coefficient >60%	
Household Assets	Productive assets (1/18)	Lacks agricultural machinery	
(1/6)	Consumer durables (1/18)	Lacks durable consumer goods	
	Houses (1/18)	No dwelling or area <12 m^2 per capita	
Medical Health	Medical insurance (1/12)	Health insurance participation <100%	
(1/6)	Health condition (1/12)	Pension insurance participation <100%	
Household Education	Educational Level (1/12)	Any member BMI < 18.5 kg/m^2	
(1/6)	Children's education (1/12)	Children (6–16) dropped out	
Economic and social participation	Employment status (1/12)	Adult employment rate <100%	
(1/6)	Internet access (1/12)	No household Internet access	
Risk resilience	Informal employment (1/12)	No formal labor contract	
(1/6)	Source of income (1/12)	≤2 sources of income	

and accounts for unobserved heterogeneity and serial correlation in the error terms.

In the dynamic Probit model, a value of 1 indicates that a household is in a state of multidimensional poverty during a given period, while a value of 0 signifies the absence of poverty. This model allows for the inclusion of past poverty experiences in the analysis of current poverty status. The standard Probit model is formulated as follows:

$$\Pr_{(P_{it}=0)} = \Phi(X_{it}, Z_{ikt}) \tag{4}$$

Here, $\Pr_{(P_{it}=0)}$ represents the probability that a household is not in a state of poverty durina a given period. The function $\Phi(\cdot)$ denotes the cumulative distribution function of the standard normal distribution. Other symbols retain their meanings as defined in Eq. (3).

While the standard Probit model provides insights into the probability of achieving multidimensional poverty reduction from a static perspective, it does not account for the dynamic aspects of poverty. The dynamic Probit model extends this framework by incorporating a lagged term for poverty status and an unobserved household heterogeneity effect. The model is structured as follows:

$$P_{it} = \gamma P_{it-1} + \alpha X_{it} + \beta_k \sum_{k=1}^{n} Z_{ikt} + u_{it} + c_i \tag{5}$$

In this equation, γP_{it-1} represents the lagged poverty status, capturing the "inertia" effect, where current poverty is influenced by past poverty. The term c_i accounts for unobserved household heterogeneity, reflecting long-term characteristics or omitted factors that influence poverty status. The error term u_{it} is assumed to follow a normal distribution and is uncorrelated with the explanatory variables. The initial state of poverty at $t = 0$ is modeled as:

$$P_{i0} = \alpha X'_{i0} + \beta_k \sum_{k=1}^{n} Z_{ik0} + u_{i0} + c_i \tag{6}$$

Here, P_{i0} represents the poverty status at the initial period, X'_{i0} and Z_{ik0} are the explanatory variables and covariates at $t = 0$, u_{i0} is the initial period's error term, and c_i is the unobserved heterogeneity effect. By treating the initial state as random, the model accounts for the dynamic nature of poverty transitions.

The dynamic Probit model is estimated using the Gauss-Hermite quadrature method (Butler and Moffitt, 1982). This method is particularly effective for handling the complexities of the model, including the integration of high-dimensional probability distributions. The Gauss-Hermite quadrature provides a robust and efficient approach for approximating the integrals in the likelihood function, enabling accurate parameter estimation.

Data. The data for this study were sourced from the CFPS conducted between 2014 and 2020. The CFPS database, established by the China Social Science Survey Centre at Peking University, commenced in 2010 and conducts biennial follow-up surveys. The survey's sample encompasses 25 provinces, municipalities, and autonomous regions across China, focusing on areas with higher population concentrations. The survey data are notably comprehensive, encompassing a wide range of information, including education, medical and health care, assets, finance, and the income and consumption patterns of all household members.

In line with the research objectives, this study specifically utilizes the rural household sample from the CFPS. It tracks and matches households surveyed in all four years to ensure data validity and stability. After excluding missing data and outliers, a final valid annual sample of 2947 households was compiled, culminating in a total empirical sample size of 11,788. This sample includes approximately 34.71% (4100 households) from the eastern region, 29.75% (3507 households) from the central region, and 35.47% (4181 households) from the western region.

Dimensional options for multidimensional poverty. This study builds on Hick (2014) and the Alkire-Foster methodology to develop a comprehensive multidimensional poverty index (MPI) tailored to rural households. Table 1 presents six dimensions: quality of life, household assets, medical health, household education, economic and social participation, and risk resilience. Together, these dimensions comprise 14 indicators. Each dimension is assigned an equal weight of 1/6, while the indicators within each dimension share the corresponding dimensional weight (e.g., each indicator in a dimension with three sub-indicators is weighted 1/18). We classify a household as "deprived" in an indicator if it meets or exceeds the threshold in Table 1. For example, using non-tap water denotes deprivation in "domestic water," and lacking durable consumer goods denotes deprivation in "consumer durables." We compute the overall multidimensional poverty score by summing the weights of all indicators in which a household is deprived. Consistent with the A-F method, a household is ultimately classified as multidimensionally poor if its total deprivation score exceeds a specified cutoff k.

Quality of life, household assets, medical health, and household education serve as fundamental dimensions because they capture core deprivations widely recognized in poverty research. We also emphasize economic and social participation and risk resilience

Table 2 Descriptive statistics for variables.

Variable Type	Variable Name	Description of variables	Mean	Std.dev	Sample size
Explained variable	MP	In multidimensional poverty. Yes = 1, No = 0	0.4999	0.5000	11788
	Quality of life	Poor in quality of life. Yes = 1, No = 0	0.5763	0.4942	11788
	Household asset	Poor in household assets. Yes = 1, No = 0	0.2750	0.4465	11788
	Healthcare	Poor in healthcare. Yes = 1, No = 0	0.6325	0.4821	11788
	MP_Edu	Poor in education. Yes = 1, No = 0	0.3613	0.4804	11788
	Economic/ social participation	Poor in economic/social participation. Yes = 1, No = 0	0.7682	0.4220	11788
	Risk resistance	Poor in risk resistance. Yes = 1, No = 0	0.9838	0.1263	11788
Explain variable	RFFP	Access to formal financial services. Yes = 1, No = 0	0.2288	0.4201	11788
	RIFP	Access to informal financial services. Yes = 1, No = 0	0.2923	0.4549	11788
Moderator variable	Agricultural insurance penetration	Provincial agricultural premiums/Provincial agricultural GDP	0.0085	0.0066	11788
	Maturity of the social credit system	Provincial creditability index (logarithmic)	4.9538	0.4650	11788
	Financial regulatory intensity	Provincial financial regulation noted/value added in the financial sector	0.0103	0.0085	11788
Control variable	Age	Age of head of household (years)	52.6984	12.8324	11788
	Age squared	Age of head squared/100	29.4178	13.5096	11788
	Gender	Gender of head, male = 1, female = 0	0.5649	0.4958	11788
	Marital	Marital status of head, married = 1, unmarried = 0	0.8761	0.3295	11788
	Health	Self-rated health of head, "1" lowest, "5" highest	2.8274	1.2761	11788
	Education	Education years of head	6.3137	4.1527	11788
	Family-size	Household size (persons)	2.5412	1.4072	11788
	Dependency ratio	% of children/elderly in household	0.3516	0.3090	11788
	Households' Income	Annual per capita net income (log)	8.7411	1.4683	11788

Age, gender, marital status, health and education level are head of household data for the sample households.

because they directly relate to financial access and use. Indicators such as employment status, internet access, informal employment, and income sources highlight households' vulnerability to external shocks and their ability to engage with wider economic networks. By applying the A-F framework to these six dimensions, we ensure that both traditional and finance-related deprivations are systematically accounted for. This approach allows us to more precisely observe whether and how dual financial participation—comprising both formal and informal channels—shapes households' intrinsic poverty-alleviation capacities across multiple dimensions.

Variables

Dependent Variables: We use multidimensional poverty status as the primary dependent variable. We classify a household as multidimensionally poor in a given year if it meets the established poverty criteria across multiple dimensions. In that case, the variable takes a value of 1. Conversely, households that do not meet these criteria are assigned a value of 0. The multidimensional poverty status is determined using a 30% cutoff. For the mechanism analysis, we also use unidimensional poverty status as a dependent variable. We classify a household as unidimensionally poor if it is deprived in any indicator within a single dimension; in this case, the variable equals 1. Otherwise, it equals 0.

Explanatory variables: This study evaluates the impact of rural financial participation – via formal and informal channels – on poverty reduction. We define formal financial participation as a binary variable equal to 1 if a household receives support from formal institutions (e.g., banks). The variable for formal financial participation is determined by whether a sample household receives financial support from formal financial institutions, such as banks. It equals 1 when support is received and 0 otherwise. We define informal financial participation as a binary variable equal to 1 if a household borrows from informal sources. These sources include friends, relatives, and private financial organizations. It equals 1 when such support is received and 0 otherwise.

Moderator variables: To examine how institutional factors moderate the effect of rural financial participation on multidimensional poverty reduction, we introduce three moderator variables. These are agricultural insurance penetration, social credit system maturity, and financial regulatory intensity. Agricultural insurance penetration is measured as the ratio of total agricultural insurance premiums to provincial agricultural GDP. We assess social credit system maturity using the provincial credit index developed by the Peking University Digital Finance Center. The index is based on per-capita credit inquiries and the share of Alipay users utilizing credit-based services. This measure indicates the level of regional credit system development. Financial regulatory intensity is proxied by the ratio of provincial financial regulatory expenditures to the value-added of the financial sector, reflecting the stringency of financial regulation and its potential constraints on financial participation.

Control variables. We include control variables at both the individual and household levels to ensure comprehensive analysis. At the individual level, we include the household head's age, gender, marital status, health status, and education level. At the household level, the variables encompass household size, the dependency ratio (including both young and old dependents), and the household's net income per capita. These control variables are integral in isolating the specific effects of rural financial participation on poverty reduction.

The description and descriptive statistics of the relevant variables are shown in Table 2.

Results

Multidimensional poverty measurement results. This study examines the temporal evolution of multidimensional poverty

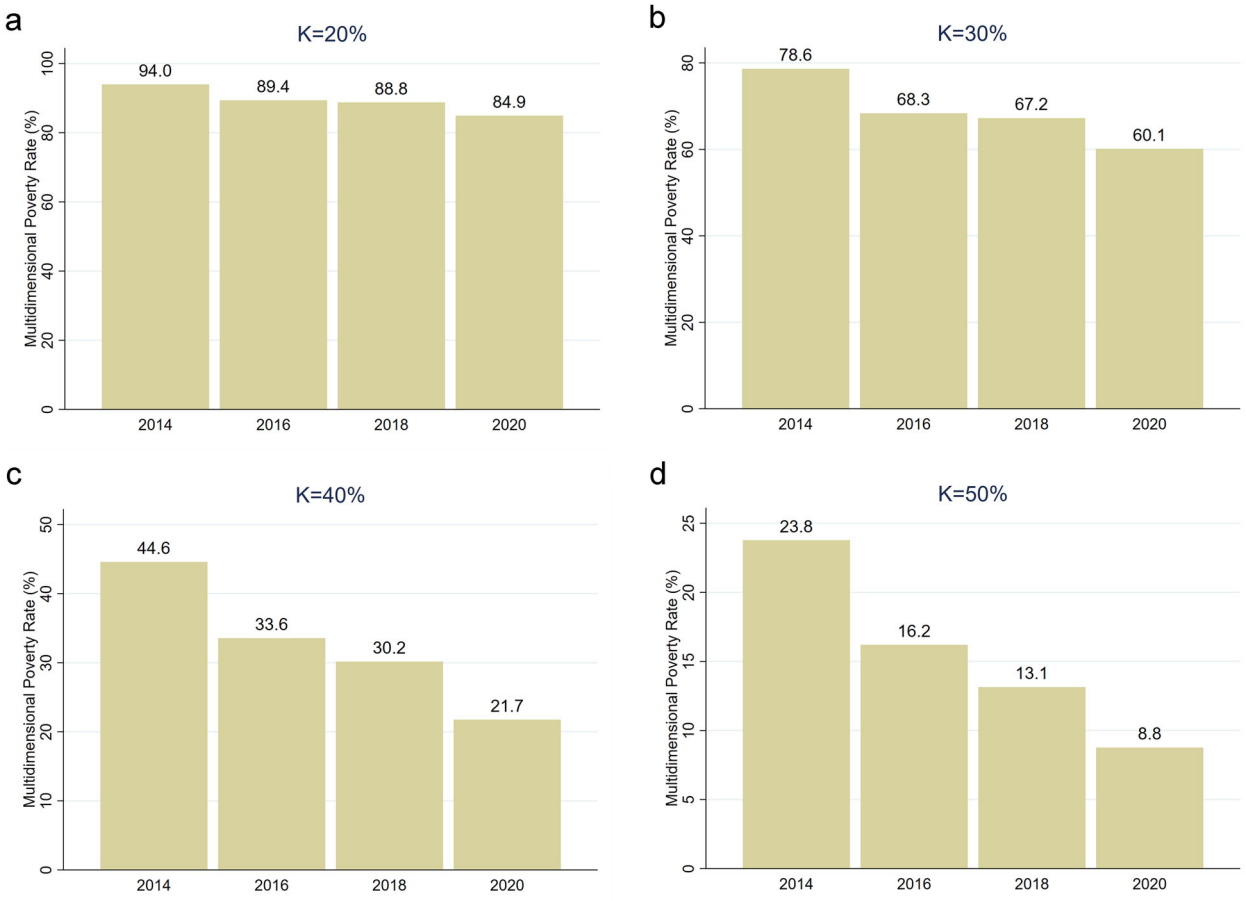

Fig. 1 Incidence of multidimensional poverty at different thresholds (*K*). Based on CFPS data from 2014 to 2020, the figure illustrates changes in the incidence of multidimensional poverty under varying cutoff thresholds (*K*). **a** $K = 20\%$, **b** = 30%, **c** = 40%, and **d** = 50%. Increasing values of *K* indicate progressively stricter standards for defining multidimensional poverty.

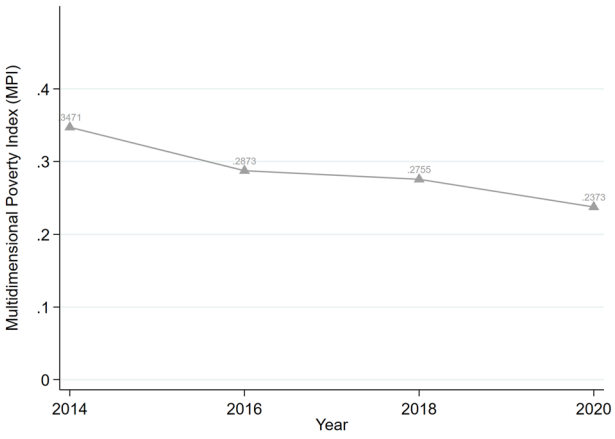

Fig. 2 Multidimensional poverty index ($K = 30\%$).

among rural Chinese households. Figure 1a–d shows the annual progression of multidimensional poverty incidence at different threshold values (*K*). Across all thresholds, multidimensional poverty incidence declines over time. For instance, Fig. 1a shows the decline in poverty incidence when $K = 20\%$, while Fig. 1b–d depict similar trends for $K = 30\%$, $K = 40\%$, and $K = 50\%$, respectively. Although other threshold values were also analyzed, only four representative cases are shown in the figure. In summary, these figures collectively suggest a general improvement trend in the multidimensional poverty situation among rural households in China over the study period.

We then calculated the multidimensional poverty index (MPI) based on average deprivation levels among rural households. Figure 2 shows the MPI trends over time. The MPI declines steadily over time, indicating overall improvement in rural multidimensional poverty. To explore the impact of financial participation, we initially divided the sample into formal participants versus non-participants and informal participants versus non-participants. Figure 3a, b presents the changes in poverty incidence for each group. Figure 3a compares poverty incidence between households with and without formal financial participation. The results suggest that households with formal financial participation were associated with a relatively greater decline in multidimensional poverty incidence over the years. Similarly, Fig. 3b shows that informal financial participation is also associated with a reduction in multidimensional poverty, although the magnitude appears less pronounced compared to formal financial services.

Figure 4a–d illustrates the contribution rates of various indicators to rural households' multidimensional poverty in four specific years. These figures provide a detailed view of how each dimension impacts overall multidimensional poverty. The data reveal significant variations in contribution rates over the years. For instance, the contribution rate of the 'quality of life' dimension has consistently been low and continues to decline, which may partly reflect the effects of extensive poverty alleviation policies implemented in China. Conversely, the

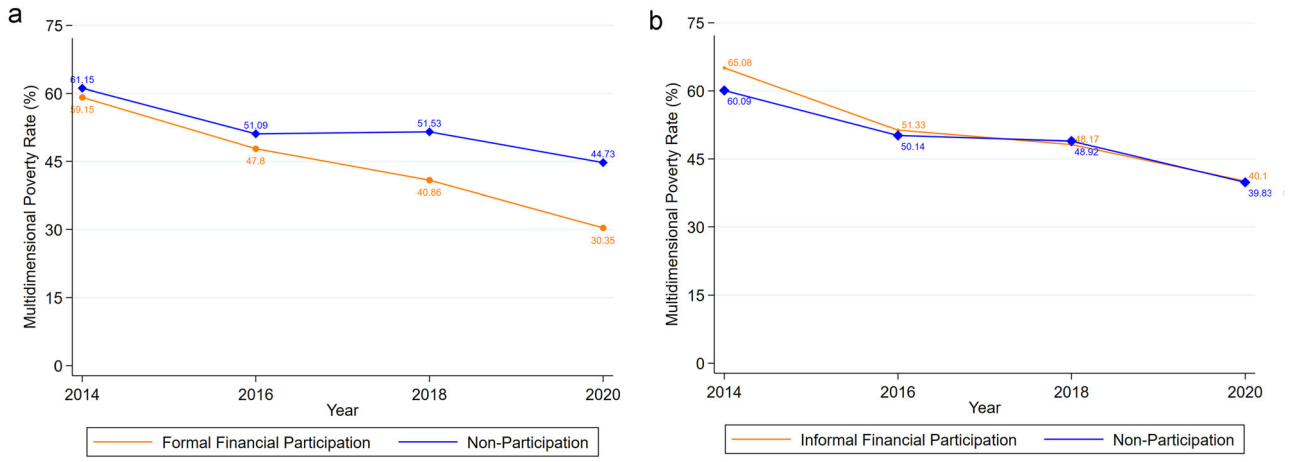

Fig. 3 Financial participation and multidimensional rural poverty ($K = 30\%$). Based on CFPS data from 2014 to 2020, the figure shows changes in multidimensional poverty incidence by financial participation status. **a** compares households with and without formal financial participation, while **b** presents the corresponding trend for informal participation.

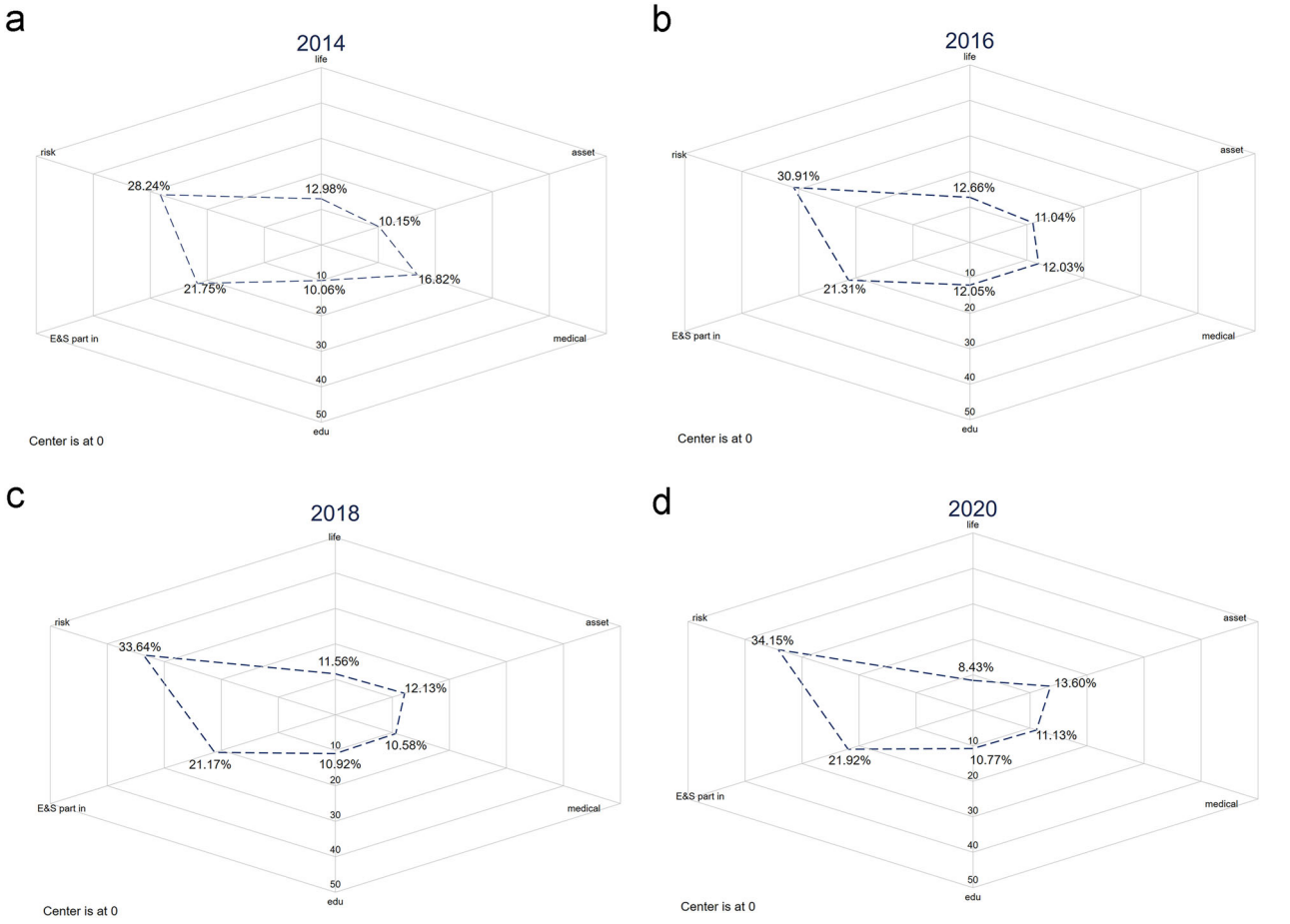

Fig. 4 Multidimensional poverty contribution rate ($K = 30\%$). The figure presents the contribution rates of different dimensions to rural households' multidimensional poverty in 2014, 2016, 2018, and 2020, with **a**–**d** corresponding to each respective year. The contribution rate reflects the relative weight of each dimension in the overall multidimensional poverty index, as illustrated by the rose chart.

contribution rate of the risk resilience dimension has been steadily increasing. This trend may stem from two factors. First, increased household debt from financial services can weaken risk resilience. Second, shifts in the economic environment may heighten vulnerability to sudden shocks. Moreover, in 2020 the contribution rate of economic and social participation rebounded from 21.17% to 21.92%. This rebound suggests that participation capabilities may have weakened in 2020. This phenomenon is

Table 3 Benchmark regression results.

Variable	MP	
	Benchmark regression	Dynamic probit regression (MLE)
	(1)	(3)
Panel A: Rural formal financial participation		
RFFP	−0.5217*** (0.0821)	−0.2153** (0.0908)
MP (lagged term)		0.3791*** (0.0589)
RFFP (Marginal effect)	−0.0905*** (0.0141)	
Control variables	YES	YES
Initial conditions exogenous	YES	NO
Initial poverty status	NO	YES
Sample size	11788	8841
Wald statistic	1290.88	1403.25
P-value	0	0
Panel B: Rural informal financial participation		
RIFP	−0.3070*** (0.0753)	−0.2601*** (0.0967)
MP (lagged term)		0.3723*** (0.0588)
RIFP (Marginal effect)	−0.0533*** (0.0130)	
Control variables	YES	YES
Initial conditions exogenous	YES	NO
Initial poverty status	NO	YES
Sample size	11788	8841
Wald statistic	1282.25	1389.57
P-value	0	0

Values in parentheses are robust standard errors; *** and ** represent significance levels at 1% and 5%, respectively. Columns (1) and (2) assume that unobservable factors are unrelated to the initial conditions of household poverty or not, using panel logit regressions; column (3) assumes that the initial conditions are endogenous, but excludes the autoregressive error term, using maximum likelihood estimator (MLE).

likely linked to the initial impacts of the COVID-19 pandemic. In the early pandemic, China's economic and social activities faced severe restrictions. Residents were compelled to adopt coping strategies. For rural households, especially those with weaker endogenous capabilities, this likely led to increased risks of unemployment and exacerbated inequality in opportunities. Consequently, these households' resilience to future crises diminished.

Benchmark regression results. Tables 3 reports how dual financial participation affects multidimensional poverty among rural households. We note three key observations before detailing the results. First, both formal and informal financial participation exhibit significantly negative coefficients across the benchmark and dynamic regressions, suggesting a robust negative association with multidimensional poverty. Second, adding the lagged poverty term to the dynamic probit model reveals poverty persistence: previously poor households remain more likely to be poor. Third, controlling for initial poverty status slightly reduces the estimated impacts of both participation types. This suggests that poverty legacies influence households' access to and use of financial services.

Columns (1) and (2) report the benchmark regression results, while column (3) shows the outcomes of the dynamic probit model. Both sets of regressions are statistically robust, given that the Wald test p-values are close to zero, suggesting strong statistical associations between dual financial participation and lower multidimensional poverty incidence. Turning to the specific results, Panel A highlights the estimated impacts of rural formal financial participation on multidimensional poverty. In the benchmark model (columns (1) and (2)), the estimated coefficient and marginal effect of formal financial participation are −0.5217 and −0.0905, respectively. These estimates confirm a strong negative association between formal participation and rural households' multidimensional poverty. In the dynamic probit regression, the effect of formal financial participation is −0.2153. Though slightly smaller in magnitude, it remains significant, indicating that formal finance remains significantly associated with lower multidimensional poverty incidence even after accounting for potential initial-condition dependencies. The lagged poverty term of 0.3791 highlights the persistence of multidimensional poverty, consistent with theoretical expectations.

Panel B presents estimates for the impact of informal financial participation on household poverty. The baseline regression indicates that the coefficient and marginal effect of informal financial participation stand at −0.3070 and −0.0533, respectively. After incorporating poverty status dependency, the dynamic probit regression yields a significant coefficient of −0.2601. Although slightly reduced, the negative coefficient remains statistically significant, suggesting that informal finance remains significantly associated with lower multidimensional poverty incidence. Among the dimensions measuring multidimensional poverty, indicators such as household education, health status, and informal economic participation often persist over time. When rural households are constrained in these areas, it becomes challenging to alter their deprivation in the short term. The dynamic probit model accounts for the lagged poverty variable, which moderates the estimated coefficients relative to the benchmark results. This moderation reflects poverty persistence (Layte and Whelan, 2003).

The gap between informal and formal participation's effects narrows after controlling for initial poverty status. Two factors explain this difference. First, initial poverty status significantly influences a household's access to financial services. Households experiencing chronic or initial poverty often lack assets and credit, limiting their access to formal financial services. In contrast, the fewer entry barriers in informal financial services make them more accessible and potentially more strongly associated with reductions in poverty incidence. When controlling for initial poverty status and lag terms, the estimated effects of informal financial services remain robust. Second, formal and informal channels differ in service focus. Formal financial services typically support productive activities, which require time for borrowers to build credit scores and secure loans (Pomeroy et al., 2020). In the dynamic probit model, this long-term effect is tempered. Conversely, informal finance tends to meet more immediate needs through localized, relationship-based lending (Matin et al., 2002). These distinctions highlight the differential timing and mechanisms through which each type of finance can contribute to poverty alleviation.

Endogenous treatment. Endogeneity concerns in this study arise from reverse causality, omitted variable bias, and sample selection. Specifically, multidimensional poverty may affect a household's decision to use formal or informal finance (reverse causality). Moreover, unobserved heterogeneity could influence both financial participation and poverty status (omitted variable bias). Moreover, households may self-select into financial services based on unobserved traits, increasing bias. To address these issues, we use an instrumental variable (IV) approach and a PSM-DID design.

Following Raudenbush (2012), we construct instruments from county-level and age-group averages of formal and informal participation. These averages exclude the focal household. This

Table 4 Instrumental variable estimation.

Variable	RFFP/RIFP	MP
	(1)	(2)
	IV-1	IV-2
Panel A: Rural formal financial participation		
RFFP		−0.7390*** (0.0682)
Peer_FFP	0.3946*** (0.0821)	
Control variables	YES	YES
Weak Instrumental Variable Test F-Statistic	659.22	
Endogeneity test chi-square statistic		97.714
Endogeneity test P-value		0
Sample size	11788	11788
Panel B: Rural informal financial participation		
RIFP		−0.7035*** (0.0758)
Peer_FIP	0.3499*** (0.0159)	
Control variables	YES	YES
Weak Instrumental Variable Test F-Statistic	485.20	
Endogeneity test chi-square statistic		69.363
Endogeneity test P-value		0
Sample size	11788	11788

Values in parentheses are robust standard errors; *** represents significance level at 1%.

Table 5 PSM-DID.

Variable	MP	
	(1)	(2)
	Nearest Neighbor Matching (1-8)	Radius match
Panel A: Rural formal financial participation		
DID	−0.7108*** (0.2630)	−0.8347*** (0.2563)
Control variables	YES	YES
Year fixed effects	YES	YES
Family fixed effects	YES	YES
AIC	2054.34	3938.397
Sample size	3466	3466
Panel B: Rural informal financial participation		
DID	−0.0674 (0.1616)	−0.1475 (0.1593)
Control variables	YES	YES
Year fixed effects	YES	YES
Family fixed effects	YES	YES
AIC	3686.997	3986.088
Sample size	6436	6436

Values in parentheses are robust standard errors; *** represents significance level at 1%.

instrument leverages the rural "peer effect," where neighbors' financial behavior influences household decisions. The key assumption is twofold. First, peers' participation affects a household's financial decisions (relevance). Second, peers' participation does not directly affect its multidimensional poverty status (exogeneity). To refine these instruments, we partition the sample by county and into five age brackets: [18, 30), [30, 40), [40, 50), [50, 60), and [60, ∞). We calculate the average formal and informal participation rates of other households in each stratum. These averages serve as instruments for the household's formal (RFFP) and informal (RIFP) participation. We estimate the model using two-stage least squares (2SLS). The corresponding estimation results are reported in Table 4.

In the first stage, peer formal (Peer_FFP) and informal (Peer_FIP) participation coefficients are positive at the 1% level. Their first-stage F-statistics—659.22 and 485.20— confirm strong instrument relevance. The endogeneity test indicates that endogeneity is indeed present, supporting the presence of endogeneity and the appropriateness of using IV methods. In the second stage, the formal finance coefficient (RFFP) is −0.7390 (1% level), and the informal finance coefficient (RIFP) is −0.7035 (1% level). These estimates remain broadly consistent with the baseline findings, suggesting that both forms of financial participation are associated with lower levels of multidimensional poverty among rural households. The exogeneity tests further confirm that these peer-based measures do not directly influence a household's poverty status, supporting the validity of our instrument choices.

In addition to the IV approach, we use a PSM-DID method to address selection bias from households' self-selection into finance. We first match households on observed traits (e.g., head characteristics, family structure). Then we use the 2016 "Opinions on Financial Support for Poverty Alleviation" policy as an exogenous shock to compare poverty before and after implementation. For formal finance, we classify households with no credit-denial history as treatment and those with denial history as control. We apply a similar grouping based on private borrowing for informal finance.Table 5 shows that, under either nearest neighbor or radius matching, the treatment effect of formal financial participation on multidimensional poverty (MP) remains significantly negative (e.g., −0.7108*** to −0.8347***), providing additional evidence of a significant negative association between formal financial participation and multidimensional poverty. In contrast, informal finance estimates are not significant. This result is unsurprising, as the policy primarily targeted formal channels and informal borrowing relies on private networks. These results suggest that expanding formal financial inclusion did not crowd out the potential contribution of informal finance to poverty alleviation, as the insignificant DID estimates for informal finance remain comparable to our benchmark regressions.

Robustness test. We perform a series of robustness tests following Saltelli et al. (2004). Table 6, columns 1–4 present panel logit estimates with marginal effects after excluding households aged below 22 or above 65 and those in the top or bottom 5% of income. The coefficients remain negative and significant at conventional levels, closely matching our baseline estimates. Column 5 reports a two-way fixed effects regression with a coefficient of −0.2761 ($p < 0.10$). Column 6 replaces the MLE in the dynamic probit model with a maximum simulated likelihood (MSL) estimator. The results remain substantively similar across these alternative specifications.

Taken together, these analyses consistently indicate that both formal and informal financial participation are significantly associated with lower multidimensional poverty incidence, even after controlling for potential endogeneity, policy-induced shocks, sample composition changes, and dynamic effects. While the magnitude of estimated coefficients differs slightly across methods—particularly for formal finance when considering long-term credit-building processes—our overall evidence of significant negative associations between dual financial participation and multidimensional poverty remains robust. We thus find supportive evidence for Hypothesis 1 (H1).

Discussion

Discussion of dual financial participation and single-dimensional multidimensional poverty. Table 7 reports the regression coefficients and marginal effects for dual financial

Table 6 Robustness tests.

Variable	MP			
	Excluding extreme ages	Excluding extreme incomes	Fixed effect	Dynamic probit regression (MSL)
	(1)	(2)	(3)	(4)
Panel A: Rural formal financial participation				
RFFP	−0.4251*** (0.0869)	−0.4282*** (0.0863)	−0.2761* (0.1443)	−0.1963** (0.0885)
MP (lagged term)				0.4629*** (0.0579)
RFFP (Marginal effect)	−0.0732*** (0.0148)	−0.0738*** (0.0147)		
Control variables	YES	YES	YES	YES
Initial conditions exogenous	YES	YES	YES	NO
Initial poverty status	NO	NO	NO	YES
Time-fixed effect	NO	NO	YES	NO
Sample size	9619	11788	6440	8841
Wald statistic	1041.54	1753.53	950.30	1457.99
P-value	0	0	0	0
Panel B: Rural informal financial participation				
RFFP	−0.2425*** (0.0806)	−0.2900*** (0.0785)	−0.3017** (0.1385)	−0.2320** (0.0942)
MP (lagged term)				0.4590*** (0.0579)
RIFP (Marginal effect)	−0.0418*** (0.0138)	−0.0499*** (0.0134)		
Control variables	YES	YES	YES	YES
Initial conditions exogenous	YES	YES	YES	NO
Initial poverty status	NO	NO	NO	YES
Time-fixed effect	NO	NO	YES	NO
Sample size	11788	11788	6440	8841
Wald statistic	1036.61	1170.15	950.19	1453.59
P-value	0	0	0	0

Values in parentheses are robust standard errors; ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively.

Table 7 The unidimensional poverty alleviation effects of dual financial participation.

Variable	MP in one dimension					
	Quality of life	Household asset	Healthcare	Household education	Economic/social participation	Risk resilience
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Rural formal financial participation						
RFFP	−0.3247*** (0.1023)	−0.1519* (0.0803)	−0.7156*** (0.1009)	−0.6204*** (0.1551)	−0.6283*** (0.0768)	−0.8325** (0.3369)
RFFP (Marginal effect)	−0.433*** (0.0135)	−0.0231*** (0.0122)	−0.0835*** (0.0115)	6.2870*** (0.6703)	−0.0781** (0.0095)	0.0026** (0.0011)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	11788	11788	11788	11788	11788	11788
Wald statistic	1108.29	327.75	259.46	1043.94	587.34	83.47
P-value	0	0	0	0	0	0
Panel B: Rural informal financial participation						
RIFP	−0.5484*** (0.0954)	0.1557** (0.0758)	−0.6630*** (0.0942)	−0.3175** (0.1421)	−0.2489** (0.0740)	0.2216 (0.3365)
RIFP (Marginal effect)	−0.0725*** (0.0124)	0.0237** (0.6703)	−0.0772*** (0.0108)	0.0289** (0.0129)	−0.0310*** (0.0092)	0.0007 (0.0011)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	11788	11788	11788	11788	11788	11788
Wald statistic	1113.04	327.15	258.44	1040.64	539.82	98.10
P-value	0	0	0	0	0	0

Values in parentheses are robust standard errors; ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively.

participation. These results cover six poverty dimensions: quality of life, household assets, healthcare, education, economic/social participation, and risk resilience. We first highlight four overarching points before discussing the detailed findings. First, both types of financial participation exhibit significant, negative coefficients in most dimensions, suggesting significant negative associations with multiple dimensions of poverty. Second, formal participation has larger impacts on risk resilience, healthcare, education, and economic/social participation. By contrast, informal participation shows stronger negative effects on quality of life and healthcare but a positive coefficient for household assets. Third, coefficient sizes imply that formal finance supports long-term investments such as asset accumulation and education. Informal finance, in turn, better meets immediate consumption needs, including basic living conditions. Fourth, these patterns offer evidence consistent with Hypothesis 2, which posits heterogeneous effects of dual financial participation on different poverty dimensions.

Panel A highlights formal finance's strongest impacts on risk resilience, economic/social participation, education, and healthcare. The respective coefficients are –0.8325, –0.6283, –0.6204, and –0.7156. Formal finance also negatively affects quality of life (–0.3247) and household assets (–0.1519), though with smaller magnitudes. By contrast, Panel B indicates that informal finance shows stronger negative effects on quality of life (−0.5484) and healthcare (−0.6630) but has weaker impacts on education (−0.3175) and economic/social participation (−0.2489). Notably, informal participation has no significant effect on risk resilience. It even yields a positive coefficient for household assets (0.1557), suggesting informal channels may hinder stable asset accumulation.

These contrasts align with cross-country evidence that formal and informal finance perform distinct functions. For instance, informal finance's convenience and rapid availability directly improve basic living conditions (Manja and Badjie, 2022). However, it may be insufficient for asset building or managing long-term risks. In China, robust poverty alleviation policies and expanding financial infrastructure bolster formal finance (Cai et al., 2019). This support improves healthcare and education access and reduces vulnerability to economic shocks. Formal finance typically provides long-term credit for housing and productive investments. Over time, this support enhances risk resilience and asset accumulation, although its immediate daily impact may lag behind informal finance (Ayyagari et al., 2010).

In sum, Table 7 provides further evidence that formal and informal finance provide complementary but distinct associations with different dimensions of poverty reduction. Formal finance tends to foster durable improvements in economic capacity, education, and healthcare coverage, while informal finance offers crucial flexibility for meeting immediate needs and improving short-run welfare. Although informal finance may under-serve asset accumulation and risk resilience, it remains vital to poverty-alleviation strategies. This is especially true where formal access is limited or slow to meet urgent consumption and healthcare needs.

Discussion of heterogeneity

Heterogeneity of Income: Income disparities play a critical role in shaping financial participation within a market-driven economy. High-income households typically have stronger credit histories and greater asset endowments, facilitating their access to financial resources. This dynamic contributes to an "elite capture" phenomenon in rural finance (Pan and Christiaensen, 2012). In China, however, the government's focus on poverty alleviation has altered the manifestation of this issue. Since late 2013, the Targeted Poverty Alleviation Policy (TPAP) has provided extremely low-income households with formal and informal financial service access.

Drawing on the per capita equivalence income identification standard proposed by Eurostat, this study classifies households into three categories: extremely low-income (below the official poverty line), relatively low-income (between the poverty line and the median), and relatively high-income (above the median)[3]. In Table 8, columns (1)–(3) present the results of the heterogeneity analysis across these subgroups. Panel A shows that formal financial participation (RFFP) is significantly associated with lower multidimensional poverty for both extremely low-income and relatively high-income households (e.g., −0.4437 and −0.0566 in the former group; −0.5505 and −0.0820 in the latter), yet the effect is not significant for the relatively low-income group. Panel B reveals a similar pattern for informal financial participation (RIFP): significant negative effects emerge only for extremely low-income and relatively high-income households, implying that these two subgroups show stronger associations with lower multidimensional poverty through dual financial channels, whereas the relatively low-income group experiences limited benefits.

Considering policy context explains why relatively high-income households more readily access formal financial services. Formal services require higher credit quality, collateral, and repayment capacity. High-income households more easily meet these standards. Consequently, they gain access to larger loans and a broader array of financial products, thereby enhancing their access to financial services and economic opportunities. By contrast, relatively low-income families face weaker endowments and limited policy support, making it difficult to meet the requirements of formal finance and, in turn, limiting the potential benefits from financial participation. However, under TPAP's intensive assistance, extremely low-income households benefit from fiscal, financial, and village-level support (Zhou et al., 2022), enabling them to leverage both formal and informal finance, which is associated with substantial improvements in multidimensional poverty indicators. Another noteworthy finding is that formal finance shows stronger associations with lower multidimensional poverty compared to informal finance among relatively high-income groups, possibly because these households prefer larger-scale loans with stronger risk controls, while informal finance, despite its flexibility and accessibility, often lacks the funding scale and risk management systems to meet higher-income families' investment and consumption needs (Xu et al., 2022).

Heterogeneity of region: China's vast geography leads to regional disparities in economic development, financial infrastructure, and policy implementation. These disparities shape the impact of dual financial participation on rural multidimensional poverty. Advanced regions benefit from mature markets and diverse financial products, while less-developed areas lack formal coverage and rely more on informal finance (Álvarez-Gamboa et al., 2021; Banerjee and Duflo, 2007). Therefore, we run subgroup regressions for eastern, central, and western regions (Table 8, columns (4)–(6)).

Table 8 results show that formal finance is significantly associated with lower levels of multidimensional poverty across all three regions, with the strongest effect in the central region (coefficient is −0.8108, marginal effect is −0.0720). While the impact remains statistically significant in the east and west, it is more moderate. Informal finance, however, shows a significant negative association with multidimensional poverty only in the central and western regions, likely due to weaker formal financial accessibility in these areas. Notably, policy interventions in the west have bolstered formal financial coverage, enhancing its

Table 8 Heterogeneity of income levels and regions.

Variable	MP					
	Income level			Regions		
	Extremely low income	Lower income	Higher income	East	Central	West
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Rural formal financial participation						
RFFP	−0.4437*** (0.1656)	−0.1644 (0.1472)	−0.5505*** (0.1123)	−0.5464*** (0.1594)	−0.8108*** (0.1815)	−0.5514*** (0.1186)
RFFP (Marginal effect)	−0.0566*** (0.0209)	−0.0282 (0.0252)	−0.0820*** (0.0173)	−0.0969*** (0.0280)	−0.0720*** (0.0273)	−0.0946*** (0.0200)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	2887	3007	5894	4100	3007	4181
Wald statistic	214.78	213.71	358.36	456.38	213.71	451.64
P-value	0	0	0	0	0	0
Panel B: Rural informal financial participation						
RIFP	−0.3321** (0.1430)	−0.1441 (0.1304)	−0.2511** (0.1055)	−0.0644 (0.1326)	−0.3423*** (0.1400)	−0.7150*** (0.1396)
RIFP (Marginal effect)	−0.0423** (0.0180)	−0.0248 (0.0223)	−0.0375** (0.0156)	−0.0114 (0.0236)	−0.0581** (0.0235)	−0.1051*** (0.0198)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	2887	3007	5894	4100	3507	4181
Wald statistic	212.82	213.73	350.20	452.11	391.54	449.79
P-value	0	0	0	0	0	0

Values in parentheses are robust standard errors; *** and ** represent significance levels at 1% and 5%, respectively.

association with poverty reduction. Regional differences stem from two key factors. First, economic development and financial infrastructure shape households' financial choices and credit access. In the east, well-developed branch networks encourage reliance on formal finance, limiting informal credit (Xu et al., 2022). In contrast, the central region's balanced economic conditions and targeted policy support enhance the reach of inclusive finance. Second, policy interventions in underdeveloped regions—particularly the Targeted Poverty Alleviation Program (TPAP)—have expanded financial access, mitigating poverty traps linked to financial exclusion. These findings highlight the interplay between market forces and policy frameworks in shaping financial participation's role in rural poverty reduction.

Heterogeneity of household head characteristics: Household heads play a central role in resource allocation and economic decisions. As managers of family finances, they shape financial choices and poverty-alleviation outcomes. Prior studies show that women face greater barriers in mobility, social expectations, and financial literacy, limiting their access to financial markets (Demirguc-Kunt et al., 2013). Age differences also influence financial behavior: while younger individuals are more receptive to fintech, they often lack asset reserves and credit histories; older individuals, despite lower adaptability, tend to possess broader social networks and richer financial experience, may make them more effective in leveraging financial services (Xiao and Valdez, 2015; Nguyen et al., 2022). Education also shapes financial literacy. Lower-educated heads may misinterpret policies and prematurely abandon formal finance (Meier and Sprenger, 2013). In contrast, higher-educated heads trust institutions more and have stronger risk assessment skills, securing larger, safer financing (Xu et al., 2022).

Table 9 presents the heterogeneity results across gender, age, and education. Columns (1)–(2) show that both male- and female-headed households benefit from financial participation. Male-headed households experience stronger poverty-reduction effects, especially via formal finance. Traditional social structures and men's greater access to assets and collateral may explain this disparity (Roy and Patro, 2022). Columns (3)-(4) indicate that older household heads are associated with greater reductions in multidimensional poverty, likely due to stronger social ties, asset accumulation, and financial expertise. While younger heads adopt fintech more readily, they often lack credit histories and financial resources, limiting their access to productive financing (Nguyen et al., 2022). Columns (5)-(6) show that financial services partially bridge the education gap, benefiting both highly and less-educated households. However, higher-educated heads exhibit a stronger preference for formal finance, leveraging superior financial products more effectively.

Heterogeneity of family structure: Family structure profoundly influences resource allocation, risk sharing, and economic decision-making in rural households (Rao and Malapit, 2015). I In rural China, variations in kinship structures and intergenerational ties shape the demand for financial services. Similarly, differences in intra-household economic relations affect households' tolerance for financial risk. These differences, in turn, affect how dual (formal and informal) financial participation is associated with change in multidimensional poverty. Accordingly, we classify households into four types: small (couples or single individuals), nuclear (parents with unmarried children), main (parents with married children), and extended (parents with multiple married children). This classification enables us to capture the heterogeneous effects of family structure on financial participation and poverty outcomes.

Columns (1)-(4) in Table 10 report the heterogeneity results by family structure. Overall, formal financial participation is significantly associated with lower levels of multidimensional poverty in small, nuclear, main, and extended families, with the strongest impact in extended families. Informal financial participation likewise shows a significant negative effect for

Table 9 Heterogeneity of household head characteristics.

Variable	MP					
	Gender		Age		Education	
	Male	Female	Younger	Older	Lower education	Higher education
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Rural formal financial participation						
RFFP	−0.5342*** (0.1078)	−0.4536*** (0.1232)	−0.3627*** (0.1075)	−0.6047*** (0.1214)	−0.4838*** (0.1144)	−0.5130*** (0.1243)
RFFP (Marginal effect)	−0.0914*** (0.1078)	−0.0798*** (0.0215)	−0.0626*** (0.0184)	−0.1012*** (0.0201)	−0.0760*** (0.0178)	−0.0791*** (0.0190)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	6659	4826	5527	6261	6631	5157
Wald statistic	722.23	584.96	579.25	659.21	548.54	436.03
P-value	0	0	0	0	0	0
Panel B: Rural informal financial participation						
RIFP	−0.3696*** (0.1018)	−0.2023* (0.1150)	−0.2194** (0.1011)	−0.3142*** (0.1081)	−0.3193*** (0.1028)	−0.2238** (0.1173)
RIFP (Marginal effect)	−0.0634*** (0.0173)	−0.0349* (0.0198)	−0.0380*** (0.0174)	−0.0524*** (0.0179)	−0.0502*** (0.0160)	−0.0345** (0.0149)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	6659	4826	5527	6704	6631	5157
Wald statistic	720.96	539.69	558.97	650.92	543.61	428.96
P-value	0	0	0	0	0	0

Values in parentheses are robust standard errors; ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively.

Table 10 Heterogeneity of family structure characteristics.

Variable	MP					
	Family structure				Labor mobility	
	Small family	Nuclear family	Main family	Extended family	Outbound labor	Local labor
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Rural formal financial participation						
RFFP	−0.4475** (0.1078)	−0.3325* (0.1718)	−0.3870* (0.2128)	−0.4919*** (0.1156)	−0.3227*** (0.1180)	−0.5448*** (0.1064)
RFFP (Marginal effect)	−0.0730** (0.1078)	−0.0574* (0.0295)	−0.0657* (0.0355)	−0.0823*** (0.0191)	−0.0514*** (0.0187)	−0.0923*** (0.0178)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	2495	2279	1719	5295	5020	6768
Wald statistic	314.27	250.33	164.15	535.91	413.79	755.48
P-value	0	0	0	0	0	0
Panel B: Rural informal financial participation						
RIFP	0.0184 (0.1712)	−0.2899* (0.1616)	0.1530 (0.1767)	−0.3988*** (0.1101)	−0.1367 (0.1110)	−0.2824*** (0.0949)
RIFP (Marginal effect)	−0.0030*** (0.0280)	−0.0501* (0.0277)	0.0265 (0.0307)	−0.0667*** (0.0182)	−0.0218 (0.0176)	−0.0480*** (0.0160)
Control variables	YES	YES	YES	YES	YES	YES
Sample size	2495	2279	1719	5295	5020	6768
Wald statistic	316.14	250.41	168.31	534.89	412.86	754.34
P-value	0	0	0	0	0	0

Values in parentheses are robust standard errors; ***, **, and * represent significance levels at 1%, 5%, and 10%, respectively.

nuclear and extended families—again most pronounced in extended families—but is not statistically significant for small or main families. Further analysis suggests that small families, especially single-person or elderly-couple households, often lack sufficient scale and social networks to secure adequate informal finance. Their weaker labor or collateral capacity also makes formal finance more important for supporting their access to financial resources and reducing poverty risk. By contrast, main families generally require larger, longer-term investments (e.g., housing, farm expansion), making small, short-term, and relatively riskier informal finance less relevant (Xu et al., 2022). Nuclear families, similar in size to main families, have smaller, short-term needs such as education or healthcare for unmarried children. These needs align with the flexibility and rapid disbursement of informal finance. Extended families, housing multiple married children, benefit from broader resource endowments and social networks, enabling them to utilize both formal and informal finance, which is associated with lower levels of multidimensional poverty.

Moreover, rural households often experience labor migration. Migration reshapes income structures and influences financial needs and participation choices (Wang and Conesa, 2022). To explore this issue further, we split the sample into two groups depending on whether a household includes out-migrating labor, and we report the corresponding regression results in columns (5) and (6) of Table 10.

Columns (5) and (6) of Table 10 present heterogeneity results based on out-migrating labor. The estimates show that formal

financial participation significant association with lower multidimensional poverty for both groups. However, migrant households have a smaller coefficient (–0.3227) and marginal effect (–0.0514) than non-migrant households (–0.5448; –0.0923). This suggests that out-migration income partly substitutes for external financial resources, while the willingness or capacity of left-behind family members to engage with formal finance is diminished. By contrast, informal financial participation shows a significant negative association on multidimensional poverty for local-labor households (coefficient is −0.2824; marginal effect is −0.0480; both significant at 1%), yet shows no significance for out-migrating households. One explanation is that migrant families often enjoy more stable and diversified income sources and weaker community ties, limiting their ability to leverage informal finance for effective poverty alleviation.

Discussion of the institutional factors. Table 11 reports the moderating effects of key institutional factors on the link between financial participation and multidimensional poverty. These factors are agricultural insurance penetration, social credit system maturity, and financial regulatory intensity.These institutional factors influence the effectiveness of both formal and informal financial services through mechanisms related to risk management, creditworthiness, and market accessibility.

Panel A (1) of Table 11 introduces agricultural insurance penetration and its interaction with formal financial participation. The interaction term is −58.5034 and statistically significant, indicating that higher agricultural insurance coverage strengthens the negative association between formal financial participation and multidimensional poverty. Agricultural insurance stabilizes income expectations and mitigates concerns about default risk, thereby improving households' access to credit. As borrowers build credit histories via premium payments and claims, information asymmetry decreases. This reduction enhances institutions' ability to assess borrower risk. Conversely, Panel B (1) shows that the interaction between informal financial participation and agricultural insurance penetration is not statistically significant. This suggests that informal finance does not benefit from insurance-based risk management mechanisms. Unlike formal finance, which integrates credit scoring and structured lending, informal finance remains largely relationship-based and short-term oriented, limiting its ability to leverage credit-enhancing effects from insurance markets.

Panel A (2) includes the maturity of the social credit system and its interaction with formal financial participation. The interaction term is −0.3639 and statistically significant, implying that a more developed social credit system enhances financial institutions' ability to allocate credit efficiently. In regions where credit histories and repayment records are systematically integrated into lending decisions, financial institutions rely less on traditional collateral-based lending. This expands credit availability, particularly for borrowers with limited physical assets but strong repayment capacity. As a result, the association between formal finance and lower multidimensional poverty is strengthened in areas with a more mature social credit system. However, Panel B (2) shows that the interaction term between social credit system maturity and informal financial participation is not statistically significant. This suggests that the development of the social credit system does not significantly affect the poverty-reduction role of informal finance. A possible explanation is that informal finance primarily relies on personal lending relationships rather than formal credit assessment mechanisms. Even in regions with well-developed social credit systems, informal lending remains outside institutionalized credit evaluation frameworks, making it less responsive to improvements in the formal credit system.

Panel A (3) examines financial regulatory intensity and its interaction with formal financial participation. The interaction term is not statistically significant, suggesting that stricter financial regulations do not significantly alter the association between formal financial participation and multidimensional poverty of formal finance. Since formal financial institutions already operate under regulatory compliance, increased regulatory stringency does not substantially affect their lending behavior. However, Panel B (3) shows a positive and significant interaction between regulatory intensity and informal financial participation (11.5857). This result indicates that tighter regulations erode the marginal returns of informal finance in reducing multidimensional poverty. Increased compliance costs, stricter licensing requirements, and enhanced disclosure obligations raise entry barriers for informal lenders. As a result, rural households experience reduced access to small-scale, short-term credit, weakening informal finance's role as a poverty-alleviation tool.

Overall, the estimation results indicate that agricultural insurance penetration and social credit system maturity significantly moderate the relationship between formal financial participation and multidimensional poverty. Improvements in both factors strengthen the association between formal financial participation and lower multidimensional poverty. Additionally, financial regulatory intensity plays a significant moderating role in the impact of informal financial participation on multidimensional poverty. As regulatory intensity increases, the mitigating association of informal financial participation with lower multidimensional poverty may be partially constrained. These findings are broadly consistent with Research Hypothesis 3.

Conclusions and policy suggestions

Conclusions. This study examines the impact of dual financial participation on multidimensional poverty alleviation in rural households and explores strategies to optimize both formal and informal financial access. Using panel Logit estimations and dynamic Probit models, the analysis is conducted within the unique context of rural China's development.

The benchmark results confirm that both formal and informal financial participation are significantly associated with lower levels of multidimensional poverty, with findings remaining robust after controlling for poverty dependence and addressing endogeneity concerns. Formal finance contributes to long-term investment and productive asset accumulation but has a weaker impact on living standards. In contrast, informal finance appears more effective in improving consumption and health outcomes but is less reliable for asset growth and risk mitigation. These distinctions highlight their complementary roles: formal finance supports long-term stability, while informal finance fills short-term funding gaps.

The effects of dual financial participation exhibit significant heterogeneity across income groups, regions, household characteristics and family structure. Extremely low-income and high-income households show the largest associations with reductions in poverty, while low-income households not covered by targeted poverty programs experience limited benefits, possibly due to policy blind spots or barriers to financial access. Regional disparities also shape outcomes: in the central region, stronger infrastructure amplifies the impact of formal finance, while in the west, informal finance plays a larger role due to weaker formal financial coverage. In the east, higher economic development leads rural households to favor less risky formal financial services. Household characteristics further influence financial participation's effectiveness. Male and older household heads show stronger responses to financial access, likely due to greater resource control and experience. Differences in education levels have little impact on the multidimensional poverty reduction

Table 11 Moderating effects of institutional factors.

Variable		MP	
	(1)	(2)	(3)
Panel A: Rural formal financial participation			
RFFP	0.0704 (0.1640)	1.5431 (0.7758)	−0.3644*** (0.1166)
RFFP	0.0121 (0.0283)	0.2604 (0.1308)	−0.0628*** (−0.0200)
(Marginal effect)			
Agricultural insurance penetration	−9.6086*** (6.1369)		
Maturity of the social credit system		−0.8475*** (0.0691)	
Level of financial regulation			−15.6671*** (3.8239)
Interaction term	−58.5034*** (15.2178)	−0.3639** (0.1536)	−10.3212 (7.5498)
Control variables	YES	YES	YES
Sample size	11788	11788	11788
Wald statistic	1285.54	1383.12	1297.01
P-value	0	0	0
Panel B: Rural informal financial participation			
RIFP	−0.1077 (0.1460)	0.4718 (0.7347)	−0.4014*** (0.1070)
RIFP	−0.0185 (0.0250)	0.0796 (0.1239)	−0.0692*** (0.0183)
(Marginal effect)			
Agricultural insurance penetration	−18.4931*** (6.0957)		
Maturity of the social credit system		−0.9291 (0.0711)	
Level of financial regulation			−22.9679*** (4.0166)
Interaction term	−19.3062 (14.0660)	−0.0999 (0.1449)	11.5857* (6.9356)
Control variables	YES	YES	YES
Sample size	11788	11788	11788
Wald statistic	1274.10	1377.44	1290.15
P-value	0	0	0

Values in parentheses are robust standard errors; ***, ** and * represent significance levels at 1%, 5%, and 10%, respectively.

effects of formal financial participation in rural households, but higher-educated individuals exhibit a stronger preference for utilizing formal finance. Family structure and labor mobility also matter—extended families and locally employed households benefit more due to broader resource endowments, stronger social networks, and a higher propensity to utilize both financial channels.

Institutional factors—particularly agricultural insurance penetration, social credit system maturity, and financial regulatory intensity—exert heterogeneous moderating effects on the moderating effects on the association between financial participation and poverty outcomes of formal and informal financial participation. Higher agricultural insurance penetration and greater social credit system maturity enhance the poverty-alleviation effects of formal financial participation, while increased financial regulatory intensity may constrain the effectiveness of informal finance in reducing multidimensional poverty.

Overall, the main finding of this study is that dual financial participation is significantly associated with improvements in the multidimensional poverty status of rural households, underscoring the complementary roles of formal and informal financial services. Theoretically, this study broadens existing research on poverty reduction mechanisms by situating financial participation within a multidimensional poverty framework. It further highlights how heterogeneity in institutional factors, family characteristics, and regional contexts can differentially shape poverty outcomes. Empirically, it contributes to the literature by employing panel Logit estimations and dynamic Probit models to address endogeneity concerns, thus providing stronger empirical evidence while addressing endogeneity concerns of dual financial participation's effects.

Policy suggestions. First, policymakers should optimize formal finance's poverty-alleviation pathways. While formal finance improves education, healthcare, and risk resilience, its impact on asset accumulation and quality of life remains limited. Expanding credit subsidies for durable assets—such as low-interest loans for housing upgrades or agricultural equipment—along with flexible repayment schemes aligned with agricultural income cycles, could enhance its effectiveness. Integrating mandatory health or asset insurance into loan programs would further mitigate risk. Given informal finance's role in poverty reduction, its small-scale and high-risk nature necessitates improvements. Supporting community-based informal financial institutions and formalizing local cooperatives (e.g., rotating savings and credit associations) could provide more reliable and structured financial services. Simplifying dispute-resolution mechanisms and recognizing informal finance's role within rural financial systems would facilitate hybrid financial products, leveraging both formal and informal finance.

Second, policies should target heterogeneous financial needs. Since formal and informal finance effectively reduce poverty among the poorest and higher-income households but have limited impact on lower-income groups, interventions must be better calibrated. Introducing intermediate credit products and partial guarantees for households ineligible for direct poverty-relief loans—such as "stepping-stone" loans with lower collateral requirements—could improve accessibility. Linking these loans to entrepreneurship training (e.g., e-commerce tutorials) would mitigate credit risk while fostering asset accumulation. Expanding digital microloan platforms and using alternative credit-scoring systems based on utility and telecom payment histories could help lower-asset households establish creditworthiness. Smartphone-based microloans and micro-insurance products, subsidized by government resources, could meet short-term financing needs with minimal collateral requirements.

Third, financial strategies should account for regional economic disparities. In the east, collaboration with commercial banks could promote agricultural modernization financing (e.g., precision agriculture loans). Training programs on financial

technology would further integrate rural households into formal financial systems. In the central region, extending credit coverage to small rural enterprises and incentivizing bank-cooperative partnerships could enhance financial inclusion. Moderate government-backed credit guarantees could encourage lending to "mid-tier" households. Given the central region's reliance on informal finance, formalizing community-based lending through cooperatives or credit unions with clear governance structures could improve financial security. In the west, where policy-driven finance dominates, similar cooperative-based lending models could be developed with minimal regulatory oversight. Integrating formal insurance products (e.g., drought coverage) into these local networks would further reduce credit risk and encourage long-term investment.

Fourth, family structure influences financial participation's effectiveness. Small-scale households may require short-term, small-value loans with simplified procedures. Deploying local financial agents to offer on-site guidance could enhance repayment capacity. Partnerships with community lenders could facilitate small-scale education or healthcare loans backed by local associations. Given rural China's labor migration patterns, formal financial institutions could develop remittance-linked savings accounts, allowing migrant workers' families to leverage deposit records for formal credit access. Establishing "community accounts" would also enable left-behind family members to secure small-scale informal credit for emergencies, addressing the social capital erosion caused by migration.

Fifth, institutional factors moderate the effectiveness of financial policies. Higher agricultural insurance penetration and a more developed social credit system strengthen the poverty-reduction effects of formal finance. Policies should integrate insurance with rural credit, such as offering interest discounts or bundled financial products. Expanding rural credit infrastructure and broadening credit records to cover more households can lower assessment barriers and improve access to formal financial services. Excessive financial regulation may constrain informal finance. Regulators should distinguish community-based financial institutions from shadow banks, lower entry barriers, and facilitate linkages between informal and formal finance through licensed cooperatives.

These policy suggestions aim to leverage the distinct roles of formal and informal financial participation, ensuring their complementary strengths are harnessed to achieve sustainable and comprehensive poverty reduction in rural China.

This study investigates the impact of rural household financial participation on multidimensional poverty in China, providing empirical evidence and insights for global poverty alleviation. However, several limitations warrant further research. First, the study uses CFPS data from 2014 to 2020, which captures initial pandemic effects but not the long-term impacts of COVID-19. Given that CFPS only covers Chinese residents, the external validity of the findings across countries remains uncertain. Future work should incorporate post-pandemic data and conduct cross-country comparisons to test the generalizability and heterogeneity of the results. Second, the measurement of financial participation is constructed from a supply-side perspective, which captures access but not underlying demand characteristics. Future studies should adopt a demand-side approach, using micro-level data to refine measures of participation motives, frequency, and preferences, thus better capturing heterogeneous effects. Finally, while the study identifies a direct relationship between financial participation and multidimensional poverty, it does not fully explore the underlying mechanisms. Future research should employ broader theoretical frameworks and mediation analyses to uncover the transmission pathways and the dynamic evolution of financial participation's impact on poverty.

Data availability

The data used in this study are derived from the China Family Panel Studies (CFPS). The original datasets are publicly available at https://opendata.pku.edu.cn/dataverse/CFPS. The specific dataset constructed for the analysis, as well as the estimation files, are available from the corresponding author upon reasonable request.

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Notes

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Author contributions

ZC conceptualized the study. QW developed the methodology and implemented the software. ZC and QW conducted validation. ZC performed formal analysis and investigation. LG provided resources and curated the data. QW wrote the original draft. QW and LG carried out manuscript review and editing. ZC created the visualizations, supervised the project, administered the project, and acquired the funding. All authors have read and approved the published version of the manuscript.

Competing interests

The authors declare no competing interests.

Ethical approvals

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

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