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RESEARCH ARTICLE

# Impacts of formal credit on rural household income: Evidence from deprived areas in western China



CHEN Si<sup>1\*</sup>, LUO Er-ga<sup>2\*</sup>, Lita ALITA<sup>3</sup>, HAN Xiao<sup>4</sup>, NIE Feng-ying<sup>5</sup>

<sup>1</sup> College of Mathematics and Informatics, South China Agricultural University, Guangzhou 510642, P.R.China

<sup>2</sup> Department of Agricultural Economics and Management, School of Public Affairs, China Academy for Rural Development (CARD), Zhejiang University, Hangzhou 310000, P.R.China

<sup>3</sup> Environmental Policy Group, Wageningen University, Hollandseweg 16706, KN Wageningen

<sup>4</sup> China Agricultural Science and Technology Press, Chinese Academy of Agricultural Sciences, Beijing 100081, P.R.China

<sup>5</sup> Agricultural Information Institute, Chinese Academy of Agricultural Sciences, Beijing 100081, P.R.China

## Abstract

Financial support is a crucial part of China's poverty alleviation effort. Thus, it is vital to understand how formal credit impacts income growth in rural households. In 2012, 2015, and 2018, a survey was conducted to obtain a panel dataset of 592 rural households from 6 poverty-stricken counties in western China, including counties in Guizhou, Yunnan, and Shaanxi provinces. We use the data to examine the effect of formal credit on rural household income and the mechanism that underlies this effect. We find that formal credit can significantly increase rural households' income in deprived areas in western China. Furthermore, formal credit promotes the reallocation of household labor from the agricultural sector to the non-agricultural sector and changes rural households' decisions about investment-consumption behavior. These are the drivers of changes in the amount and structure of household income. Further analyses show that formal credit may widen income inequality among rural households in western China's deprived areas. The individual characteristics of rural households, such as different levels of material capital, human capital, and social capital, bring about differences in the effects of formal credit on income growth. This study emphasizes that the implementation of formal credit is an essential strategy for poverty alleviation in underdeveloped areas, but policymakers should not excessively interfere with the financial market.

**Keywords:** formal credit, rural household income, rural finance, poverty-stricken areas in western China

## 1. Introduction

Financial support is an essential measure for reducing poverty. Research has shown that rural financing can significantly improve the livelihoods of poor people in developing countries (World Bank 2001; Benti 2019). The Chinese government regards financial support as an important measure for reducing poverty. Since the introduction of its targeted poverty reduction strategy in

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CHEN Si, E-mail: [chensi1005@scau.edu.cn](mailto:chensi1005@scau.edu.cn); Correspondence  
NIE Feng-ying, Tel/Fax: +86-10-82109901, E-mail: [niefengying@caas.cn](mailto:niefengying@caas.cn)

\* These authors contributed equally to this study.

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2013, inclusive finance, as an indispensable part of the poverty alleviation project, has been an important part of the government's strategy for promoting the development of industries and infrastructure in poverty-stricken areas and cultivating the abilities of poverty-stricken populations. In recent years, the consecutive No. 1 central documents issued by the Chinese government clearly state that the inclusive finance policy focused on rural areas promotes precise lending management and emphasizes the important supporting role of access to finance in poverty alleviation. However, academic studies have not produced consistent findings regarding the effects of inclusive finance. Some researchers believe that the development of government-led inclusive finance (such as micro-credit schemes) has alleviated the predicament of socially vulnerable groups in poverty-stricken rural areas who have no access to formal credit due to their lack of collateral or credit records (Galor and Zeira 1993). These studies argue that inclusive finance policies ensure fair access to credit for poor households, helping poverty-stricken populations to increase their income (Greenwood and Jovanovic 1990), and reduce income inequality among rural households (Rajan and Zingales 2003; Demirgüç-Kunt 2009).

In contrast, some scholars believe that rural households in poverty-stricken areas receive marginal benefits from inclusive finance for the following reasons. First, the external environment in which inclusive finance takes effect is one of deprivation. From the supply perspective, formal financial institutions implement credit rationing to poor households to reduce credit risk and to ensure operational efficiency (Barham *et al.* 1996; Vogel 2009). Furthermore, due to the particular characteristics of rural governance structures in China, the phenomenon of "elite capture" (Beath *et al.* 2011; Alatas *et al.* 2013; Wen *et al.* 2016) is expected in the implementation of the rural poverty reduction policy, which leads to a shift in the target. This makes the effects of formal finance on the income of poor rural households insignificant. Second, poverty-stricken rural households cannot use the funds efficiently. From the demand perspective, poor rural households generally have low education level and income (Wang and Wang 2016). Thus, formal finance rarely helps them enhance their income growth (Arestis and Cancer 2004; Wang *et al.* 2014). Furthermore, scholars suggest that the impact of formal credit on rural household income is not absolute. Financial development can only positively affect on rural households' income growth when economic development strategies and financial system arrangements are coordinated with rural economic development and the actual needs of rural households (Nurkse 1953; Kraay and McKenzie 2014).

The impact of formal credit on rural household income and the mechanism of this effect have triggered widespread

discussion among scholars. Most studies focus on the following two aspects. First, some studies examine whether rural households' characteristics explain the varying effects of external financial support on income. For example, over the last 40 years, significant heterogeneity has developed among farmers. This heterogeneity has been transformed into an unequal distribution of financial capital, resulting in variation in fund use efficiency among rural households (Wen and Wang 2005).

Studies also examine whether formal credit narrows the income inequality among farmers. One strand of the literature proposes a linear relationship, suggesting that credit can reduce income inequality and emphasize that capital endowment is an important aspect of rural households' funding usage efficiency. Due to differences in capital endowment (Bourdieu 1986), the benefits generated by formal credit are not homogeneous among rural households, and increasing income inequality is inevitable under certain conditions. Chu *et al.* (2009) use an endogenous conversion model to evaluate the income increase in 372 rural households in Jiangsu Province in 2006. They find that farmers with more material capital, such as productive fixed assets, experience more remarkable income growth. Khanh (2011) applies a qualitative approach to study the role of social capital in credit access at Dinh Cu Village and Van Quat Dong Village in Vietnam, and found that the more social capital farmers own, the greater the effect of credit on their income. De Gregorio (1996) places emphasis on human capital as the prime engine of efficiency in funding usage. Other scholars predict a nonlinear relationship between the two of them. Bauer (2016) used propensity score matching (PSM) to analyze 1 338 rural households in Vietnam in 2012 and found the association between credit and income in rural households to be nonlinear but follows an inverted-U relationship between credit and income distribution. The credit does not significantly contribute to the poorest and wealthiest farmers' outcome, but it benefits the middle-income farmers (Galor and Moav 2004). Wen *et al.* (2016) conduct a two-stage least squares regression and instrumental variable quartile regression to study 20040 rural households in 10 provinces and find that formal credit significantly increases households' income in the top 10% income bracket, i.e., the elite class. Second, some scholars analyzed the mechanism through which formal credit affects rural household income. Wu and Xu (2016) discuss credit as a form of productive or living capital for farmers in different quantiles. They find that credit has a significant impact on farmers' productive uses in the high-income group and a significant impact on farmers' living uses in the low-income group. They conclude that increases in the income of farmers in the high-income group result in increased investment. In contrast, farmers in the

low-income group cannot increase their investment because they use the funds for their living expenses. Chen and Zhai (2015) select PSM to subtract the production investment of rural households in a control group who received no credit from the production investment of the rural households in the experimental group and measures the increase in productive input caused by the credit and the contribution of net income growth of rural households caused by new productive factors.

A lack of consensus on the impact of formal credit on rural household income is mainly due to the following: the variation in regional financing returns; the effect of national taxation rules, financial policies, infrastructure, and other external environmental factors on the efficiency of farmers' funding use; and the difference of capital accumulation results in welfare loss for the vulnerable group (Hazari and Mohan 2015).

Existing research is deficient in sample size and is not large enough to be representative. Due to difficulties in sample acquisition, most surveys of poverty-stricken areas in western China are restricted to a single county or province. Thereby, the overall representation of rural areas in western China is insufficient. Moreover, a lack of panel data limits the analysis of the financial support policy's long-term effects.

This paper complements existing literature in the following three aspects. First, in terms of research methods, existing literature used either parametric estimation methods such as OLS, Logit, and QR, or non-parametric estimation methods such as PSM. While each has methodological advantages, the problem of omitted variables with unobservable individual factors or changes over time remains. Therefore, this study tests the impact of formal credit on farmer household income using fixed-effects model by controlling time and individual effects. Moreover, different methods are used to conduct robustness tests to ensure the accuracy of causal identification. Second, in terms of research content, although the existing literature discussed the micro level mechanism of formal credit on farmers' income, the impact of different income sources is neglected. Thereby, this study uses the mediation effects model to explore the mechanism of formal credit on farmer households' internal income structure. Thus, this paper provides strong support for the effectiveness of the formal financial poverty alleviation. Based on this result, this paper further identifies the differences in the income-generating effects of formal credit among farmers with different capital endowments and income levels, and provides a further comparative analysis of the formal credit impact on low-income family and non-poor family to investigate the potential differences. Such findings have policy implications for the government to implement differentiated institutional

arrangements to improve farmers' financial support. Third, in terms of sample representativeness, after three rounds of large-scale poverty alleviation and development projects, the focus of China's poverty alleviation at this stage is focused on the poverty-stricken western region. However, due to the constraints of high costs in survey and difficulties in data collection, most previous studies on poverty-stricken regions of western China were conducted in a single county or within one province using cross-sectional data. Therefore, these studies lack demographic representativeness and dynamics. This study has successfully filled in the current research gap because the sample of this study comprises 592 households in six western national-level poverty-stricken counties in Yunnan, Guizhou, and Shaanxi provinces covering the years 2012, 2015, and 2018.

## 2. Data and methods

### 2.1. Data collection

This study's dataset was a subset of the data collected in an 8-year follow-up survey conducted by the research team of 1368 rural households in 6 state-designated poor counties in Yunnan, Guizhou, and Shaanxi provinces in western China in 2010, 2012, 2015, and 2018. Three criteria were used to select the area for the original survey. First, the selected provinces had to have a high proportion of counties formally designated as poverty-stricken. Second, the incidence and degree of poverty in the selected area had to be relatively high. Third, the reliability and validity of the evaluations undertaken to assess the effectiveness of financial poverty alleviation had to be guaranteed through comprehensive, systematic, and long-term follow-up monitoring of samples in the study area. Using this criteria, 592 counties designated as inferior by the the State Council Leading Group Office of Poverty Alleviation and Development of China were identified. Most of the designated counties were in the western mountainous areas, with about one third in either Yunnan Province (73 poverty counties), Guizhou Province (50 poverty counties), or Shaanxi Province (50 poverty counties). The particular counties to be surveyed were selected using a multi-stage sampling method. In the first stage, expert interviews were conducted to select the following sample provinces and sample counties in impoverished western regions: Wuding County and Huize County in Yunnan Province, Zhenan County and Luonan County in Shaanxi Province, and Panxian and Zhenan counties in Guizhou Province. In the second stage, the probability proportional to size (PPS) sampling method was used to select sample villages, and according to the proportion of the poverty-stricken population, 19 villages

were selected from each county, giving a total of 114 villages. In the third stage, random sampling was used to select 12 rural households from each village, giving a total of 1368 households. This sampling procedure ensured the randomness and representativeness of the sample. The final sample mainly represented the overall characteristics of the poverty-stricken population in rural areas in western China. Finally, any questionnaires with a fill-in rate lower than 90% were excluded from the sample. As there were no data on the use of financial support for rural households in 2010, only observations from 2012, 2015, and 2018 were used in this study, creating a balanced panel dataset of 592 rural households and 1776 observations. The questionnaires for farmers were mainly conducted through interviews of heads of households and other family members. The content included basic household information, housing and living conditions, family property and financial conditions, agriculture, livelihoods and expenditures, food sources, consumption, impact, and coping strategies. The village-level questionnaire survey was administered to the first secretary of the village's poverty alleviation team and the main cadres of the village committee. The content included the social and economic development of the village, the comprehensive poverty alleviation and development situation, and the current problems limiting the development of the village and proposed measures for changing them.

The questionnaire underwent three rounds of revision. Initially, after reviewing the relevant studies in the field, the authors combined the team's previous questionnaire design experience with input from other experts to create a first draft of the questionnaire. In the next step, team members simulated the interviews in pairs. At this stage, the questionnaire was refined to include definitions of concepts and optimize interview paths. Finally, the project team conducted pre-interviews to mitigate potential problems. Besides, the survey team members were intensively trained before the survey and conducted simulated interviews with teammates. During the survey process, the survey team cross-checked the questionnaire between the groups every day to adjust questions to ensure the authenticity and reliability of the survey data.

## 2.2. Variables selection

**Response variable** Rural household income refers to the

total income of rural households, including wage income, family operation income, transfer income, and property income.<sup>1</sup> The net income of a rural household is the income after deducting the expenses incurred in the production and operation of the family, taxes, fees, depreciation of productive fixed assets, depreciation of biological fixed assets, and donation of expenses to relatives and friends in rural areas.

**Core explanatory variables** This study focuses on the impact of rural households' credit through formal financial channels such as banks and rural cooperative credit cooperatives. Formal credit is obtained through the formal financial channel, which generally needs collateral guarantees and uses interest as the financing mode. Therefore, the core explanatory variable is the annual financial credit of rural households.

**Other control variables** We generated several control variables based on Mincer's income equation (Mincer 1974) and previous empirical studies. First of all, we believe that the household's head, as the household's primary decision maker, has a decisive impact on credit allocation and income growth. Hence, we included the main head of the household's main characteristics as control variables, e.g., age and education level. Second, we included households' internal resource characteristics as control variables, such as household demographic characteristics, human capital, economic capital, natural capital, social capital, and other indicators. These variables comprehensively reflect the capital endowment status of households. Households with high resource endowment have higher efficiency in using funds and can thereby increase their income significantly. Third, the external environment, such as the local agricultural development, natural disasters, and other risks, poses a potential impact on household income growth.

## 2.3. Data description

Fig. 1 shows the trends in the amount of formal credit, income, and income structures of rural households in poverty-stricken areas in western China between 2012 and 2018. First, rural households' income increases 64.5% from 40 936.84 CNY in 2012 to 67 346.95 CNY in 2018, indicating that the continuous development of China's economy and the central government's poverty alleviation measures have benefited rural households in poverty-

<sup>1</sup> Wage income includes the payment from the local non-agricultural sectors, such as engaging in the construction of national infrastructure projects, building houses for other rural households, building collective roads in the village, etc., and salary for positions with long-term fixed wages like village cadres, teachers, doctors, etc. Family operation income includes operational income for farming and non-agricultural operational income, among which agricultural operational income includes income from planting, forestry, aquaculture and household handicraft workshops. Transfer income refers to various government subsidies, external aid remittance income, help from relatives and friends, and other transfer income such as compensation. Property income includes land rent, rental of productive tools, etc.

stricken areas and realized constant income growth. In the 2018 subsample, the primary income sources for rural households are family operation income and wage income, which respectively account for 67.35 and 20.16% of the total household income. Second, transfer income and property income account for 10.43 and 2.05% of total income, respectively. Family operation income and wage income are still the main sources of income for Chinese farmers, and smallholders are still a distinctive feature of the rural economy in western China. In addition, with increasing urbanization and the continuous outflow of rural labor to urban areas, the wage income of migrant workers is still an essential part of household income in poverty-stricken areas. Third, the credit issued by formal financial institutions to rural households in poverty-stricken areas increased by 146.8% from 8 125.73 CNY to 20 054.05 CNY from 2012 to 2018. This result indicates that since the introduction of inclusive finance in 2012 and the promotion of inclusive finance in rural areas in 2015, rural households in poverty-stricken areas have had reasonable access to formal credit.

In summary, increasing access to formal credit increases the income growth of rural households. The availability of formal credit affects income structure as well: it increases both wage income and family operation income. Although the general trend is illustrated in Fig. 1, we still need statistical models and instrumental variables to eliminate endogenous effects and identify causal effects.

### 2.4. Descriptive statistics

As shown in Table 1, the sampled households have a wide income distribution, with a mean value of 50 550.850 CNY.

The mean net income of rural households after deducting production and other costs is 41 971.980 CNY. The value of formal credit ranges from 0 to 800 000 CNY, with a mean value of 13 668.110 CNY. In total, formal credit accounts for 27% of the total income of rural households. In the robustness analysis, this study performs segmented control estimation on sub-samples at different credit amount intervals to eliminate outliers.

The poor household’s dummy variable is based on whether the household’s per capita income is below the local poverty alleviation line. The sample size of poor household observations is 460, and the sample of non-poor household observations is 1 316 in these three years.

### 2.5. Model setting

To measure the impact of formal credit on rural household income growth, this study builds the following fixed-effects model:

$$Y_{it} = \alpha_0 + \alpha X_{it} + \beta Z_{it} + \theta_i + \varphi_t + \varepsilon_i \tag{1}$$

where  $i$  is different rural households;  $Y_{it}$  is household income;  $X_{it}$  is the annual amount of credit that households obtain from formal financial institutions;  $Z_{it}$  is a place holder for the control variables;  $\theta_i$  represents the individual fixed effect;  $\varphi_t$  is the time fixed effect; and  $\varepsilon_i$  is the random interference term.  $\alpha$  represents the impact of formal credit on household income. To control for the impact of factors such as local policies in different regions, this study also adds fixed effects at the village level  $\sigma_v$ , the other symbols represent the same meaning as eq. (1), and modifies the model as follows:

$$Y_{it} = \alpha_0 + \alpha X_{it} + \beta Z_{it} + \theta_i + \varphi_t + \sigma_v + \varepsilon_i \tag{2}$$

This study uses a fixed-effects model, which controls the

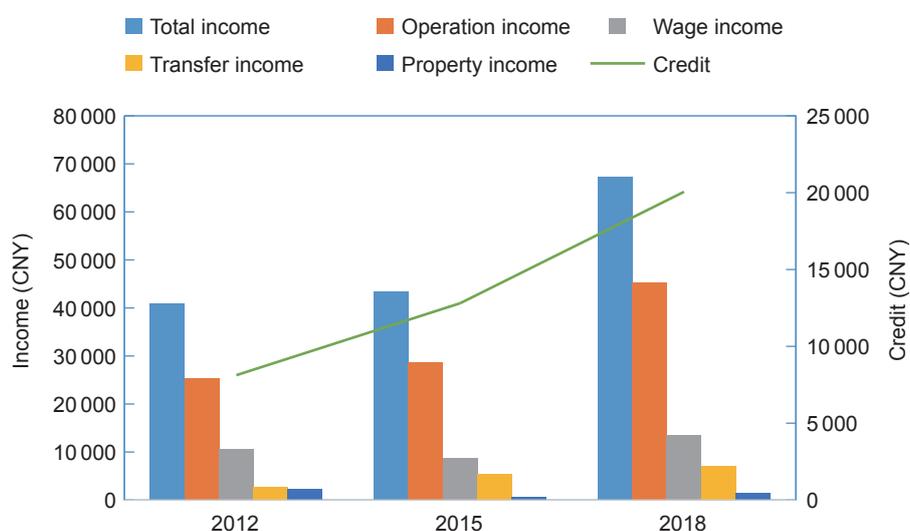


Fig. 1 Trends in formal credit, income level and income structure in the 2012, 2015 and 2018 periods.

individual fixed effects of rural households, time fixed effects, and village-level fixed effects. In addition, we estimate the random-effect model as a comparison (Bai *et al.* 2012).

### 3. Results

#### 3.1. Impact of formal credit on rural households' total income

The regression results are shown in Table 2. Model 1 is a fixed-effects model that estimates the time fixed effects. Model 2 is a fixed-effects model that considers time fixed effects and control variables. Model 3 is a fixed-effects model that adds village-level regional fixed effects to Model 2. Models 4 and 5 are random-effects models with or without village-level effects, respectively.

In general, the results obtained by the fixed-effects and random-effects models are consistent. The regression results of (Models 1–5 in Table 2) all show that formal credit has a significantly positive impact on rural households' income. The fixed-effects model's estimated results show that each unit of formal credit can promote approximately

0.97 units of income growth. The random-effects model estimation results show that each formal credit unit can promote approximately 0.89 units of household income growth.

Additionally, the income-increase effect coefficient of formal credit is less than 1, which addresses the potential poverty trap. In addition, due to the differences in the use of funds, there are differences in when the returns on investment are realized. Large-scale investment in productive fixed assets and education has a long-term impact on the rural households' income, whereas productive factors such as funds for chemical fertilizers, pesticides, and seeds impact household income in the concurrent period (Yan and Niu 2017).

This analysis also examines whether there is a time lag in the impact of formal credit on household income. It is reflected in the robustness check that formal credit has no significant influence on income after three years. However, household income is significantly increased in the period when the household received the credit. A possible reason for this pattern is found in the survey and interviews. Due to the high risks they face, most rural households (58.64%)

**Table 1** Definition and summary statistics of the selected variables

Variable	Definition and assignment	Mean	Std. Dev.
Total income	The sum of wage income, family operation income, transfer income, and property income (CNY)	50 550.850	159 752.800
Net income	Total income deducting the expenses, taxes, and fees, depreciation of productive fixed assets and biological fixed assets, etc. (CNY)	41 971.980	148 586.500
Credit	Farmers have obtained from formal financial institutions for their production or livelihood needs (CNY)	13 668.110	43 787.440
Health level	The health level of the head of household, which represents 1=Health; 2=General; 3=Not too healthy; 4=Unhealthy	1.707	1.000
Education	Education level of the household head in years	5.671	3.244
Age	The household head's age in years	52.567	11.003
Children schooling	The number of children of the households attending school	0.573	0.765
Poor	This paper refers to the local government's definition on poverty by drawing lines on net income per capita: 2 300 CNY in 2012, 2 800 CNY in 2015, and 3 300 CNY in 2018	0.741	0.438
Last-year remittance	The remittance is classified by the amount of money as follow: 1=1–500 CNY; 2=501–1 000 CNY; 3=1 001–2 000 CNY; 4=2 001–3 000 CNY; 5=3 001–4 000 CNY; 6=More than 4 000 CNY	1.694	2.455
Remittance	Whether the farmer households receive external remittance income in the current period: Yes=1; No=0	0.369	0.483
Cooperative	Whether farmer households participate in local cooperatives: Participation=1; Non-participation=0	0.139	0.346
Family size	The number of household members actually living with the head of household	3.462	1.533
People migrant	The number of household members out-migrant for work	1.137	1.277
Farm size	The farm size of each household in a hectare	4.803	4.710
Asset value	The original value of the total asset (CNY)	23 716.770	49 558.820
Social expense	The expense to maintain the relationship with friends and relatives (CNY)	4 565.151	7 859.011
Ln(first industry)	The logarithm of the value-added of the primary industry in the sample county (100 million CNY)	12.237	0.511
Drought	Whether the farmer household is hit by natural disasters such as drought: Yes=1; No=0	0.386	0.487

**Table 2** Impact of formal financial credits on rural household income<sup>1)</sup>

Variable	FE			RE	
	Model 1	Model 2	Model 3	Model 4	Model 5
Credit	0.966*** (0.118)	0.970*** (0.117)	0.971*** (0.118)	0.884*** (0.084)	0.901*** (0.090)
Cooperative		-7096 (12400.309)	-7016 (12440.921)	-4154 (10425.562)	-1918 (10833.344)
Education level		1962 (1872.787)	1958 (1877.934)	1899 (1221.231)	1663 (1319.738)
Age		208.2 (664.785)	201.4 (668.098)	300.7 (356.877)	500.1 (385.156)
Land size		1957 (1277.238)	1957 (1282.916)	2524*** (803.215)	1877* (991.164)
Child schooling		-8147 (7658.518)	-8075 (7683.783)	-5334 (4853.869)	-7335 (5230.919)
Poor		415731*** (11075.351)	41656*** (11153.367)	37276*** (8587.277)	34178*** (9112.132)
Last year remittance		6832 (4458.394)	6788 (4477.051)	7158** (3467.371)	7653** (3628.473)
Health level		1193 (5451.695)	1183 (5473.758)	4901 (3678.896)	5033 (3860.441)
Family size		2269 (3961.191)	2257 (3973.026)	6216** (2542.121)	5663** (2698.984)
Ln(first industry)		12542 (13853.745)	12390 (13919.494)	14826 (9106.575)	20719* (12353.583)
Asset value		0.341*** (0.109)	0.341*** (0.109)	0.372*** (0.077)	0.354*** (0.082)
Drought		-643.2 (12235.851)	-460.9 (12335.235)	4036 (8634.667)	6769 (9276.373)
Remittance		-4976 (22590.396)	-5048 (22702.656)	-15265 (17621.214)	-19885 (18358.209)
Year dummy	Yes	Yes	Yes	Yes	Yes
Village dummy	No	No	Yes	No	Yes
Constant	33044*** (6243.687)	-191877 (170089.690)	-182413 (170786.124)	-244684** (111655.869)	-332709** (167689.445)
Obs.	1776	1776	1776	1776	1776
R <sup>2</sup>	0.062	0.099	0.099		
N	592	592	592	592	592

<sup>1)</sup>FE, fixed effects model; RE, random effects model.

\*, \*\*, and \*\*\* indicate significant levels at 10, 5, and 1%, respectively. The brackets are robust standard errors.

would rather maintain simple reproduction than invest in agricultural production with higher potential marginal returns or purchase agricultural production equipment (technology upgrade, etc.). In short, farmers believe that the yields from their agricultural production are low and unstable.

### 3.2. Impact of formal credit on rural households' income structure

By exploring the effect of formal credit on the internal structure of rural household income, it is possible to clarify further the mechanism through which formal credit affects rural households. Models 1–4 in Table 3 show the impact of formal credit on farmers' wage income, property income, transfer income, and operation income. The results show that formal credit has a significantly positive effect on wage

income and operation income. If the operation income of rural households is further subdivided into agricultural operation income and non-agricultural operation income, Models 5–6 in Table 3 shows that formal credit has a significant impact only on agricultural operation income. We can conclude that the formal credit has a stronger impact on rural household total income and agricultural operation income than on wage income.

There are several possible explanations of the above results. First, formal credit was used to improve the agricultural production efficiency and release some of the labor in the household from agricultural production. The released labors can work in the non-agricultural sector and receive wage income. Second, the formal credit optimizes farm households' investment-consumption structure through resource allocation, thereby increasing the farmer

household income. The paper starts from the rational household's assumption and argues that the households aim to maximize their income by efficiently utilizing the formal credit (Schultz 1966). After receiving formal credit, the farmer households adjust their investment-consumption decision-making to optimize the allocation of production factors and increase their agricultural operation income. Numerous studies have shown that farmers' credit demand in less developed regions is dominated by subsistence consumption (Khandker and Cartwright 2003). In fact, the risk-averse smallholders demand credit mainly to invest in production or human capital to sustain income growth. Therefore, within the constraints of the household budget, rational farmer households always attempt to allocate credit rationally to investment and consumption. According to the general scenario of the production function, assuming that the farmer's labor force remains constant in the short term, the increase in production investment due to credit contributes to an increase in agricultural operation income by upgrading productive factors. That is, farmers take into account the daily consumption needs, repay the principal and interest on time to avoid the risk of credit default, and ultimately achieve the goal of maximizing the farmer households' income.

### 3.3. Mechanism through which formal credit affects rural household income

According to the results presented in Table 3, formal credit positively impacts rural household income. More specifically, formal credit has significant positive effects on wage income and agricultural operation income. Formal credit may influence rural household income through the following mechanisms: 1) reallocation of household labor from the

agricultural to the non-agricultural sector, and 2) adjustment of decision-making behavior related to the investment consumption of rural households. Either of these processes could increase family income and change the structure of rural households. This study uses the stepwise regression method to conduct a mediating effect test (Causal steps approach: Baron and Kenny 1986; Wen and Ye 2014) to examine whether these two paths exist and to further test the mediating effect of credit on household income.

Firstly, we test the mediation effect of rural households' labor resource allocation. The results of Model 1 presented in Table 4 indicate that formal credit has a significant direct impact on rural households' wage income, with an estimated coefficient of 0.183. The estimation results of Model 2 show that formal credit can significantly increase the migrant worker number of farm households, which means that formal credit leads households to increase the labor allocation to the non-agricultural sector. Both variables in Model 3 pass the significance test, indicating that after controlling for the impact of formal credit, the effect of migrant labor input on rural households' wage income remains significant, and the mediating effect accounts for 1.691%<sup>2</sup> of the total effect. This means that about 1.691% of the impact of formal credit on rural households' wage income is achieved through the intermediary role of non-agricultural labor input.

Secondly, we test the mediating effect of changes in the decision making for investment-consumption behavior of households. The results show that formal credit has a significant positive impact on the agricultural operation income with a coefficient of 0.800 (Model 4 in Table 4). The estimation results of Model 5 show that formal credit can significantly change the investment-consumption decision-making of households; that is, formal credit significantly enhances the input of productive factors in

**Table 3** The impact of formal credit on rural household income structure

Variable	Wage	Property	Transfer	Operation	Agri-operation	Non-agri-operation
	income	income	income	income	income	income
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Credit	0.186*** (0.025)	0.009 (0.014)	-0.024 (0.023)	0.800*** (0.108)	0.793*** (0.103)	0.007 (0.014)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Village dummy	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-76274** (36691.36)	-22318 (20795.48)	32427 (33090.13)	-125712 (156410.66)	-112544 (150090.17)	-3168 (19650.38)
Obs.	1776	1776	1776	1776	1776	1776
R <sup>2</sup>	0.080	0.041	0.020	0.073	0.069	0.081
N	592	592	592	592	592	592

\*\* and \*\*\* indicate significant levels at 5 and 1%, respectively. Unless otherwise specified, regression equations are fixed-effects models, the brackets are robust standard errors, and the control variables are consistent with the controlling variables in Table 2.

<sup>2</sup> 100%×0.00146×2.119/0.183≈1.691%.

rural households. Model 6 shows that after controlling for formal credit, decisions to expand productive factor inputs have a significantly positive effect on agricultural operation income. As the relevant parameter estimates in each regression are significant, there is a mediation effect in the change in the decision-making with regards to the investment-consumption of the households. Moreover, the mediation effect accounts for 11.90%<sup>3</sup> of the total effect, which means that about 11.90% of the impact of formal credit on households' agricultural operation income is achieved through expanding the input of productive factors. In summary, the above tests demonstrate how formal credit affects farmers' household income, in particular, how it affects households' internal income structure.

## 4. Discussion

The above analyses reveal that formal credit has a significant positive effect on the household income of farmers. However, the heterogeneity within the farmer household group polarized the income enhance effects of the formal credit. This paper examines the differences in the income enhance effects on farmer households with different income levels. We also compared the effects of formal credit on the income of poor and non-poor households (divided by the national standard for poverty alleviation). On this basis, this study explained the differences in income enhance effects of farmer households. The clarification of the above issues will help the government to improve financial policies

to help farmers and effectively enhance the efficiency of financial poverty alleviation policy.

### 4.1. Analysis of rural households with different income levels

This section uses a panel quantile regression model to investigate the differences in the efficiency of capital use among households with different income levels. Fig. 2 shows that as household income increases, the effect of formal credit on income growth increases. In particular, in the 80% quantile income level, the income growth effect is enormously enhanced. The coefficient increases with each increase in the quantile of the total income of rural households, from 0.036 for the 10% quantile to 0.127 for the 50% quantile and 1.523 for the 90% quantile. Therefore, inclusive poverty alleviation in western China requires more precise matching and coordination with the rural industries and improvements in public service.

### 4.2. Comparative analysis between poor family and non-poor family

The last section exhibits a holistic picture of the differences in the income enhancing effects of formal credit for farmer households at different income levels. By dividing the sample into poor and non-poor households according to the national poverty threshold, this study provides a few relevant policy implications for future poverty alleviation policies.

**Table 4** Impact mechanism of formal credit on rural household income

Variable	Labor resource allocation			Investment-consumption decision making		
	Wage income	Migrant labor input	Wage income	Agri-operation income	Decision making <sup>1)</sup>	Agri-operation income
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Credit	0.186*** (0.025)	0.00146** (0.000)	0.183*** (0.025)	0.800*** (0.108)	0.003*** (0.000)	0.698*** (0.112)
Migrant labor input	–	–	2.119** (1 001.77)	–	–	–
Decision making	–	–	–	–	–	31.74*** (9 575)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Village dummy	Yes	Yes	Yes	Yes	Yes	Yes
Constant	–76274** (36691.36)	2.457** (1.07)	–81479** (36719.50)	–125712 (156410.66)	261.7 (476.72)	–133590 (155863.14)
Obs.	1776	1776	1776	1776	1776	1776
R <sup>2</sup>	0.080	0.154	0.083	0.073	0.091	0.082
N	592	592	592	592	592	592

<sup>1)</sup> It refers to the ratio of productive input and consumption expense.

\*\* and \*\*\* indicate significant levels at 5 and 1%, respectively. Unless otherwise specified, regression equations are fixed-effects models, the brackets are robust standard errors, and the control variables are consistent with the controlling variables in Table 2.

<sup>3</sup> 100%×0.003×31.74/0.800=11.90%.

To answer this question, we divide the sample into poor and non-poor subsets and use the fixed-effects model to test whether formal credit impacts the income growth of poor and non-poor households. From the results in Table 5 (Models 1 and 2), we can observe that formal credit has significantly enhanced the income of non-poor households. At the same time, it shows no significant positive impact on the income of poor households. Comparing the results in Table 5 for poor and non-poor households (Models 3 and 4), it can be found that formal credit possibly has a higher income enhancing effect on non-poor households than on poor households.

We further investigate whether differentiated households' capital endowments are responsible for the differences in income enhancing effects and test the difference between

poor and non-poor households. The results indicated that non-poor households have significantly higher capital endowments, such as human capital, physical capital, and social capital, than poor households. Such a conclusion reminds us that poverty alleviation policies may widen the income gap between poor and non-poor households in poverty-stricken areas in western China without proper adjustment in the local context.

### 4.3. Impact of formal credit on household income under different capital attributes

This section uses a fixed-effects model to examine the effects of different capital attributes and their interaction

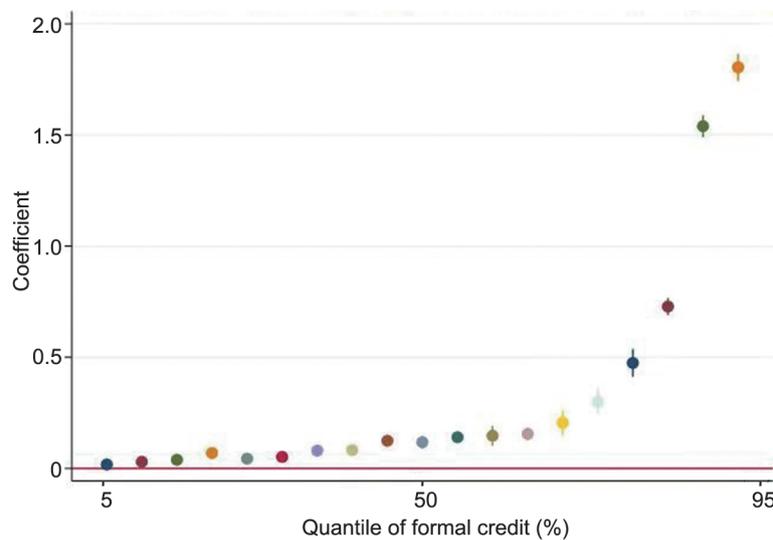


Fig. 2 Coefficient and 95% confidence intervals of formal credit on rural household income at different quantile levels.

Table 5 Impact of formal credit on household income of poor and non-poor households<sup>1)</sup>

Variable	Poor family	Non-poor family	Full-sample	
	Model 1	Model 2	Model 3	Model 4
Credit	0.0853 (0.062)	0.874** (0.425)	0.598** (0.285)	
Credit×Poor			0.463 (0.401)	1.040** (0.407)
Poor			36 508*** (13 694.354)	30 534** (12 834.309)
Control variable	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Village dummy	Yes	Yes	Yes	Yes
Constant	-29 331 (24 678.424)	-155 904 (155 746.139)	-197 236* (114 747.400)	-195 498* (114 497.066)
Obs.	460	1 316	1 776	1 776
R <sup>2</sup>	0.337	0.148	0.103	0.099
N	319	571	592	592

<sup>1)</sup> The differences in the mean and variance characteristics of poor households and non-poor households are not reported in the article due to space limit. \*, \*\*, and \*\*\* indicate significant levels at 10, 5, and 1%, respectively. Unless otherwise specified, regression equations are fixed-effects models, the brackets are robust standard errors, and the control variables are consistent with the controlling variables in Table 2. The result of the consistency check between poor and non-poor households is available on requirement.

**Table 6** Impact of formal credit on household income under different capital attributes

Variable <sup>1)</sup>	Total income					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Credit	1.051*** (0.122)	0.300* (0.166)	0.994*** (0.191)	0.918*** (0.122)	0.782*** (0.182)	0.687*** (0.129)
Age_dum×(Credit–Mean(credit))	–0.664** (0.284)	–	–	–	–	–
Age_dum	–1197 (12856.90)	–	–	–	–	–
Health_dum× (Credit–Mean(credit))	–	1.169*** (0.207)	–	–	–	–
Health_dum	–	5764 (10875.72)	–	–	–	–
Social expense_dum× (Credit–Mean(credit))	–	–	–0.0417 (0.220)	–	–	–
Social expense_dum	–	–	19723* (11676.72)	–	–	–
Cash help_dum× (Credit–Mean(credit))	–	–	–	0.427 (0.323)	–	–
Cash help_dum	–	–	–	26997* (13812.39)	–	–
Asset value_dum× (Credit–Mean(credit))	–	–	–	–	0.261 (0.224)	–
Asset value_dum	–	–	–	–	41156*** (13926.17)	–
Land size_dum× (Credit–Mean(credit))	–	–	–	–	–	1.188*** (0.240)
Land size_dum	–	–	–	–	–	2326** (11483.364)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Constant	–185489 (168149.39)	–162022 (169789.42)	–203225 (172639.13)	–188051 (171879.57)	–174597 (171767.80)	–188578 (170448.26)
Obs.	1776	1776	1776	1776	1776	1776
R <sup>2</sup>	0.103	0.122	0.101	0.103	0.098	0.110
N	592	592	592	592	592	592

<sup>1)</sup> “\*\_dum” is a dummy variable, which assign “1” to the value above the average value and “0” to the value below the average value. (Credit–Mean(credit)) is the credit minus the mean of credit.

\*, \*\*, and \*\*\* indicate significant levels at 10, 5, and 1%, respectively. Unless otherwise specified, regression equations are fixed-effects models, the brackets are robust standard errors, and the control variables are consistent with the controlling variables in Table 2.

terms with formal credit. The results show a more significant income growth effect in rural households where the head’s education level is above the mean value (Model 1 in Table 6). The household head’s health level is above the mean value (Model 2 in Table 6). For social capital, the income growth effect is significantly higher when the household receives more than the mean value of cash gifts for weddings and funerals (Model 3 in Table 6) or the relative relief is above the mean (Model 4 in Table 6) (Narayan and Pritchett 1997). For physical capital, the income growth effect increases with the original value of the households’ fixed assets (Model 5 in Table 6). Model 6 in Table 6 shows

greater efficiency in credit use in households that own more than the mean amount of land. In conclusion, Table 6 reports the marginal impact of credit on income growth under different capital attributes.

In summary, the results reveal that capital endowments such as material capital, human capital, and social capital (Bourdieu 1986) mediate the effect of formal credit on income growth. Inclusive finance policies in rural areas in China have polarized income growth opportunities in rural households in most regions. Moreover, access to credit has become an important source of income disparity among rural households. As Li (2018) and Wang *et al.* (2019) point

out, lack of capital endowment has replaced financial scarcity as an important obstacle to rural households' financial income growth.

**4.4. Robustness check**

**Robustness Test 1** Using the net income of rural households. The results reported above use rural household income as the response variable. Some scholars argue that the net income of households is a better reflection of the livelihood of farmers and more directly reflects households' capacity to pay off debt and indirectly reflects households' production capacity, etc. (Gustafsson and Li 2002; Gao and Yao 2006; Zhang et al. 2012; Cheng et al. 2015). Net income is an important basis for households' investment decisions. Hence, we replace the response variable rural household income in the above model with net income to test the model's robustness. The results of the regression are shown in Model 1 in Table 7. We find that the core variables' results and their significance are basically the same when we use household net income as the response variable. Thus, the main findings are robust.

**Robustness Test 2** Excluding the transfer income and controlling income improvement plans and various subsidies' potential influences. In recent years, the Chinese government has implemented a large number of poverty alleviation policies and plans. To eliminate the impact of these policies and plans, we re-test the model by excluding transfer income from farmers' total income. In this paper, the transfer income includes various governmental subsidies, including funds from external sources, such as income from remittances, help from relatives and friends, gifts from personal favors; and other transfer income, for instance, compensation, etc. The authors also controlled the other poverty alleviation policies in the model that can potentially affect farmers' income: including education preferential policies, e.g., education funding for poor student and exemption of tuition and fees, etc.; medical aid and housing project grants, e.g., renovation of a dilapidated house. As shown in Table 7, the regression results of Models 2 and 3 remain robust.

**Robustness Test 3** Excluding samples with informal credit. A dual financial structure in which both formal and informal finance coexist is common in rural China. As a micro-foundation, farmer households usually have two financing modes: formal and informal channels. To eliminate the interference of informal financial lending on farmers' income, we use a sample consisting of households that have only engaged in formal financial lending to improve the accuracy and precision of our identification. The regression results given in Model 4 in Table 7 show that the effect is still significant, and the estimated coefficient is greater than 1, indicating that formal finance has a significant positive effect on the income of rural households and that it can generate more than liabilities in the concurrent period.

**Robustness Test 4** Different sub-sample interval sections. There is strong heterogeneity among the farmers in the surveyed area, and a large range of loan amounts. Some large-scale farmers in the sample take out large loans, and some farmers do not borrow

**Table 7** Robustness test of the impact of formal credit on household income<sup>1)</sup>

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Credit	0.512*** (0.113)	1.026*** (0.367)	0.947*** (0.358)	1.082*** (0.150)	0.783*** (0.144)	1.296*** (0.236)	1.288*** (0.228)	0.993*** (0.179)
Credit_lag3years <sup>2)</sup>	-	-	-	-	-	-	-	0.154 (0.326)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Policy dummy	No	No	Yes	No	No	No	No	No
Constant	-169004 (165287.65)	-230045** (115450.341)	-179523* (103450.689)	-268270 (297324.67)	-138868 (170598.28)	-1.140e+06 (710494.49)	-1.167e+06* (690519.95)	-71536 (68533.55)
Obs.	1776	1776	1776	1242	1772	347	365	1776
R <sup>2</sup>	0.067	0.103	0.115	0.117	0.065	0.414	0.403	0.090
N	592	592	592	568	592	232	243	592

<sup>1)</sup> Models 5 to 7 stand for sub-sample of borrowing amount less than 300,000 CNY, between 1,000 and 10,000 CNY, and greater than 5,000 CNY, respectively.

<sup>2)</sup> Credit\_lag3years is the three-year lag of credit.

\*, \*\*, and \*\*\* indicate significant levels at 10%, 5%, and 1%, respectively. Unless otherwise specified, regression equations are fixed-effects models, the brackets are robust standard errors, and the control variables are consistent with the controlling variables in Table 2.

any money. To exclude the impact of these extreme values, this study performs the regression on sub-samples divided by loan sample intervals (Models 5–7 in Table 7). The regression results remain robust.

**Robustness Test 5** Lag effect of formal credits rural household income. Farmers borrow funds for different reasons, and the subsequent cash flow benefits may be long-term or short-term. For example, when farmers invest their loans in industries with long payback periods or large-scale fixed asset investments, depreciation or amortization are taken into consideration in a timely manner, but the ratio of production factors may take time to reach the optimal level, and there is no immediate income increase. Thus, this study adds the loan amount of rural households three years after receiving a formal financial credit to measure the lagged effect of the loan. We find that the formal credit has no significant effect on the income growth effect of the peasant households after a three-year lag (Model 8 in Table 7). Therefore, the impact of financial credit on peasant households' income is mainly short-term.

#### 4.5. Endogenous analysis

The endogeneity problem may exist in the analysis of the relationship between formal credit and rural household income. Higher-income households usually have explicit signals such as collateral and basic financial capacity. They are more likely to obtain credit from financial institutions (known as “elite capture”) (Wen *et al.* 2016). In summary, formal credit and household income may both be increased by mutual causality. If this consideration is not comprehensively examined, estimation bias may occur.

In this paper, the authors use farmers' formal credit in the previous period as the instrumental variable for the current period's formal credit for the following reasons. In general, formal financial institutions need to assess the credit basis of the farmer household before releasing the credit. Farmer households' former credit history is used as a reference for banks to approve the credit in the current period (Jiang and Xie 2016). In addition, obtaining formal credit in the previous period may encourage the farmer to apply for the credit in the current period (Cao and Luo 2019). Furthermore, the manuscript exhibits that the formal credit in the previous period is uncorrelated with current income. The formal credit enhances the farmer's household income by increasing the wage income and agricultural operation income. However, both of them show cyclical and seasonal characteristics. More specifically, farmers receive the wage by month and the agricultural production such as rice, wheat and other crops appear seasonal characteristics that mainly harvested within one year (Du *et al.* 2009). We also examined the

exogeneity of instrumental variables and the possibility of weak instrumental variables empirically. The results are shown in Table 8 (Models 1 and 2). The exogeneity and correlation of the instrumental variables of formal credit are all satisfied and the instrumental variables are valid (Cragg and Donald 1993; Heckman and Navarro-Lazano 2004; Stock and Yogo 2005). Model 2 in Table 8 shows that the estimated result using the instrumental variables indicates that the income growth per unit of formal finance is about 0.728.

In addition, we attempt to use other complementary methods to overcome potential endogeneity problems. We refer to Qi (2011) and Cheng *et al.* (2014) to use the mean of formal credit at the village level as an instrumental variable for the following two concerns: First, the high mean of formal credit at the village level means a high amount of financial resources are input by the local government and the potential impact of the financial poverty alleviation policy. Second, the high mean of formal credit at the village level implies high financial literacy possessed by the local farmer households. All of these factors have an impact on formal credit received by farmer households without a direct link to their income. There may be a correlation between the mean of formal credit at the village level and the per capita income of the same village. However, the village's mean of formal credit has no correlation with single household income because the sample households were randomly selected in the village. In the empirical results, we use the mean of formal credit at the village level as an instrumental variable, and it passes the corresponding weak instrument robust inference. Therefore, from both theoretical and empirical perspectives, the mean of formal credit at the village level has been proven to be an appropriate instrumental variable. The empirical results in Table 8 (Models 3 and 4) show that the impact of formal credit on farmer household income is significant and robust. Moreover, to make the empirical results more robust, the two variables mentioned above, together, are used as instrumental variables in Table 8 (Models 5 and 6) to measure the impact of formal credit on farmer household income. Through the weak instrument robust inference and Sargan test, the regression results further prove that the impact of formal credit on income remains significantly positive and robust.

In summary, this paper adopts the following methods to reduce the impact of endogeneity: (1) Proxy variables: For some factors that are difficult to observe but may have an impact on farmers' income, corresponding proxies are included in the model to minimize the endogeneity caused by the missing variable; (2) Instrumental variables: To overcome the potential endogeneity problems, we use previous period of formal credit and the mean of village-level credit

**Table 8** Instrumental variable test of the impact of formal credit on rural household income

Variables	Credit (IV_first)	Total income (IV)	Credit (IV_first)	Total income (IV)	Credit (IV_first)	Total income (IV)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Credit		0.728*		1.522***		1.228***
		(0.438)		(0.268)		(0.314)
Mean(credit)			0.997***		0.852***	
			(0.061)		(0.087)	
Credit_lag3years	-0.696***				-0.577***	
	(0.071)				(0.067)	
Constant	52 342***		123.7		34 338**	
	(16 060.030)		(38 078.013)		(14 994.540)	
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald Wald F	96.956		280.078		110.471	
10% Maximal IV size	16.38		16.38		19.93	
Sargan					2.653	
P-value					0.103	
Obs	1 184	1 184	1 776	1 776	1 184	1 184
R <sup>2</sup>	0.176	0.087	0.218	0.083	0.294	0.085
N	592	592	592	592	592	592

Credit\_lag3years is the three-year lag of credit. Mean(credit) represents the mean value of credit at the village level. \*, \*\*, and \*\*\* indicate significant levels at 10, 5, and 1%, respectively. Unless otherwise specified, regression equations are fixed-effects models, the brackets are robust standard errors, and the control variables are consistent with the controlling variables in Table 2.

as instrumental variables (Ren *et al.* 2019); and (3) Panel data: Considering the characteristics of the panel data in this paper, both time and individual effects are controlled in the equation for fixed effects model analysis. Hence, the impact of endogeneity is minimized.

## 5. Conclusion and implication

This study uses a panel dataset covering 592 rural households from six poverty-stricken counties in Guizhou, Yunnan, and Shaanxi provinces in western China. The data were collected in 2012, 2015, and 2018. The author investigates the impact of formal credit on the income enhancing effect and adequately addresses the endogeneity and the heterogeneity of farmer households. The main conclusions are as follows: First, formal credit has a significant positive impact on farmer household income, while it has not led to a sustained increase in income yet. Second, from the structural point of view, formal credit has a significant positive impact on both operation income and wage income, not on property income and transfer income. The increase in operation income is stronger than that in wage income.

Further, our analysis, based on the mediating effects model, shows that formal credit raises the income from migrant workers and agricultural operation income by releasing more laborers to migrant work. Third, from the point of view of heterogeneity, on the one hand, the income enhancing effect of formal credit is greater for those whose capital endowments (the age and education level

of the household head, land area, original value of fixed assets, and social expenses) are above the mean level. On the other hand, the income enhancing effect of formal credit increases as the income of the farmer's household increases, especially for elite households. In addition, formal credit has a significant positive effect on the income of non-poor households, while it does not have a significant effect on the income of poor households. As a result, formal credit has further widened the income gap within farm households and has not yet had a long-term poverty-reducing effect.

Results indicated that: (1) Formal credit has created opportunities for farmers, while the injection of financial resources has also become an effective way for farmers to increase their income. Therefore, the government should continue implementing policies on financial poverty alleviation and inclusive financial development to increase credit availability for farmers continuously. The government should also introduce policies to encourage farmers to use credit to invest in upgrading agricultural production technology and equipment. We expect that farmers can achieve sustainable income growth by investing in innovation with financial support; (2) the government should strengthen vocational training for farmers to enhance their employability and effectively transfer the surplus labor force. Furthermore, the government should vigorously promote the development of rural specialty agriculture in poverty-stricken areas. Modern agricultural industrial parks should be built to form a "demonstration-diffusion" feedback loop, which can in turn create a favorable external environment for farmers to engage in agricultural production. It will also create an

environment in which farmers are keen to use credit to invest in agricultural development, creating a sustainable path of poverty alleviation and income generation through development; (3) the accumulation of rural human capital needs to be emphasized, especially public goods such as education and medical care for the low-income population in a poverty-stricken area. Much more efforts should be concentrated on the development of human capital to strengthen the endogenous development capability; and (4) it is necessary to innovate the financial poverty alleviation model. The ability of farmers access to modern agriculture is enhanced by exploring the establishment of enterprise+financial institutions+farmers integrated industry chain, which could benefit farmer's production and operation efficiency upgrading that will bring about a sustained and dynamic increase in agricultural operation income. Furthermore, farmers can be hired as an employee of leading enterprises and smoothly and naturally participate in the integrated supply chain. Hence, the rural household can expect stable and long-term wage income.

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## Declaration of competing interest

The authors declare that they have no conflict of interest.

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