

Peng, Yan-ling; Ren, Yanjun; Li, Hou-jian

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RESEARCH ARTICLE

Do credit constraints affect households' economic vulnerability? Empirical evidence from rural China

PENG Yan-ling¹, Yanjun REN², LI Hou-jian¹

¹ College of Economics, Sichuan Agricultural University, Chengdu 611130, P.R.China

² Department of Agricultural Markets, Leibniz Institute of Agricultural Development in Transition Economies, Halle (Saale) 06120, Germany

Abstract

Poverty alleviation is still one of the major challenges in developing countries, especially in transitional economy like China. From the perspective of anti-poverty, this paper examines the impact of formal credit constraints (FCCs) and informal credit constraints (IFCCs) on economic vulnerability (EV) using the data from the China Household Income Project (CHIP) survey for 2013 (CHIPs 2013) of rural households. The potential endogeneity problem of credit constraints (CCs) is addressed by applying the control function approach within an ordered probit model. The results show that both FCCs and IFCCs have a robust positive and significant impact on the EV of rural households and that the impact of FCCs is greater than that of IFCCs. To identify the potential mechanisms through which CCs affect EV, the seemingly unrelated regressions are used and the potential intercorrelation among these mechanisms is examined. We find that the impact of CCs on EV is partly mediated by health, trust, per capita financial assets and per capita income, whereby health and per capita income contribute to most of the total indirect effect. Thus, policies focus on supply-side and demand-side to improve credit accessibility could reduce rural households' EV, especially through its positive effect on health and per capita income.

Keywords: credit constraints, economic vulnerability, causal mediation mechanisms, rural China

1. Introduction

With dramatic changes in globalisation and urbanisation worldwide, household income has experienced remarkable growth. However, poverty alleviation is still

a major challenge in developing countries, especially in transitional economies. In China, there approximate 98.99 million people live under the poverty line since 2013; and all poor people have been lifted out of poverty by the end of 2020, owing to a series of national alleviation strategies. The alleviation of relative poverty has become challenge. Many studies have focused on poverty alleviation, but most of them emphasise ex-post reductions and measures to eliminate poverty (Moore and Donaldson 2016; Liao and Fei 2019). A major component of a forward-looking anti-poverty intervention is to prevent or reduce future poverty rather than merely alleviating current poverty. Hence, ex-ante poverty-alleviation prevention has recently become a frequently discussed topic in economics and in the social sciences (Chaudhuri

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PENG Yan-ling, E-mail: jxianling@163.com; Correspondence LI Hou-jian, E-mail: lihoujianguoying@126.com

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et al. 2003; Yang *et al.* 2018).

The household's vulnerability, as an important antecedent of poverty, has been widely investigated, with a focus on developing countries (Dercon *et al.* 2005; Gaiha and Imai 2008; Azam and Imai 2009). In development economics, the concept of vulnerability emerged from the concept of poverty. The World Development Report of 1990 defines poverty as material deprivation, low attainment in education and worse health outcomes (World Bank 1990). Later, the term 'vulnerability' was introduced in development economics in discussion about the correlation between poverty and income uncertainty (Morduch and Haley 2002). Although the discussion on vulnerability is widespread, no consensus has been reached on the definition of vulnerability. Studies have argued that vulnerability is the exposure to negative shocks (Glewwe and Hall 1998), the degree of exposure to threats and adversity (Cutter *et al.* 2003), the inability of individuals to exert themselves when facing adversity (Moser 1998), and the ex-ante risk that a household will, if currently non-poor, fall below the poverty line, or if currently poor, will remain in poverty (Chaudhuri *et al.* 2003). Highlighting on macroeconomy, Briguglio *et al.* (2009) suggests that the exposure of an economy to exogenous shocks, arising out of economic openness is the vulnerability of economy. In this study, differ from the macro perspective, a microcosmic and subjective measurement of household's income vulnerability is examined as the inability to withstand the effects of external economic shocks (thus overcoming the limitations of monetary measurements), and economic resilience post-shock alongside environmental factors such as structural weaknesses and institutional restrictions are considered.

Referring to the determinants of a rural household's vulnerability, previous studies have exclusively emphasised the downside risks such as changes in the weather, floods, food price changes and illness (Jha *et al.* Kang 2012; Thang 2018), while there is scant knowledge on credit constraints (CCs) in terms of the household's vulnerability. Some studies have indicated that credit accessibility could have impact on household income through creating more employment for farmers and assisting them to engage in entrepreneurial activities (Li *et al.* 2013). However, due to the under-developed capital markets in developing countries, inefficient rural credit markets impose severe CCs on households (Stiglitz and Weiss 1981), especially in China (Zhao and Peter 2014). This could impinge on agricultural productivity and household income, resulting in inefficient production and low profitability (Khandker and Faruquee 2015; Bhuiyan and Ivlevs 2019). Thus, household vulnerability may be affected by CCs.

Rural households have less access to formal credit, which gives rise to increased levels of informal credit, especially in transitional economies such as that of China. Li *et al.* (2013) found that rural households in China suffer more from CCs than rural households in other developing countries do, owing to regulation of the interest rates, transaction costs and the Chinese government's strong intervention in credit markets. A recent study indicated that approximately 44.95% of rural households in China experience formal credit constraints (FCCs) (Li *et al.* 2016). Due to an unstable income, a lack of credit collateral, high transaction costs governed by asymmetric information, an imperfect credit system (Stiglitz and Weiss 1981) and the contractual risk (rigidity of the terms) implicit in formal contracts (Boucher *et al.* 2008), it is common that many individuals actively refuse to apply for formal credit even though they need loans. Especially in China, reciprocal borrowing among friends and relatives is with zero interest, and zero collateral dominates the informal rural credit market in China (Turvey and Kong 2010; Kumar *et al.* 2013). One available estimation by Jia *et al.* (2010) showed that informal lending accounts for 74.05% of total loans in China and more than 97% of informal loans are taken out amongst friends. Although the impact of credit access on income growth and poverty reduction in rural households has been widely discussed in China (Li and Zhu 2010; Li *et al.* 2013; Yang *et al.* 2018), scant attention has been paid to the impact of CCs on rural households' economic vulnerability (EV) with an emphasis on the comparison between FCCs and informal credit constraints (IFCCs).

The impact of CCs on EV might be through affecting the health, trust and economic outcomes of rural households. For instance, CCs could influence household medical expenditure, resulting in more pressure on the households' health, in turn leading to less labour input and a higher level of income instability (Chetty *et al.* 2016). As mentioned above, the capital market in China is under-developed and financing channels are relatively limited (Li *et al.* 2012); thus, only households with qualifying collateral or guarantees can be trusted by the formal institutions. Lacking credit from formal institutions also affects the households' perceived trustworthiness in informal networks and their ability to access credit through these channels, which impinges on the households' economic development and makes them more vulnerable to external shocks. CCs can also negatively affect rural households' agricultural production by reducing the necessary production inputs such as fertiliser, seed varieties, pesticides, animal feed, irrigation services and investments in favourable crops and livestock. This could influence per capita income and per capita financial

assets, making households more vulnerable to natural shocks and social changes (Guiringer 2008). To the best of our knowledge, no existing study has investigated the mechanisms through which CCs could have an impact on the EV of rural households.

This study contributes to the literature in three ways. First, we estimate the impact of FCCs and IFCCs on the EV of rural households in China. Second, we use a control function (CF) approach to address the endogeneity problem of credit constraints due to self-selection bias, unobservable heterogeneity and reverse causality. Finally, we shed light on the mechanisms underlying the impact of CCs by using seemingly unrelated regression (SUR) equations to address the intercorrelations among various mechanisms.

The remainder of this paper is structured as follows. Section 2 introduces the empirical strategies employed in the research. Section 3 describes the data and the main variables. Section 4 presents the empirical results. Section 5 provides the discussion. Section 6 concludes.

2. Empirical strategies

2.1. The impact of credit constraints on economic vulnerability

In this study, EV is measured as an ordinal variable with four categories (explained in detail in Section 3)¹. An ordered probit model is employed to estimate the impact of CCs on household's EV. Following Long (1997) and Greene (2012), the model is specified as follows:

$$EV_i^* = \beta_0 + \delta R_i + \beta_1 X_i + \varepsilon_i \quad (1)$$

where EV_i^* denotes EV measured as the inability to withstand the effects of external shocks. R_i is a dummy variable for the CCs and equals one if the rural household has FCCs or IFCCs, and equals zero otherwise. X_i represents variables including individual traits and household characteristics which might affect the household's EV. We also control the regional fixed effect. ε_i is a random error term and is assumed to be normally distributed. The observed variable EV_i is related to the latent variable EV_i^* , as specified in eq. (2):

$$EV_i = \begin{cases} =1 \text{ (null), if } \gamma_0 = -\infty \leq EV_i^* < \gamma_1 \\ =2 \text{ (low), if } \gamma_1 \leq EV_i^* < \gamma_2 \\ =3 \text{ (moderate), if } \gamma_2 \leq EV_i^* < \gamma_3 \\ =4 \text{ (high), if } \gamma_3 \leq EV_i^* < \gamma_4 = +\infty \end{cases} \quad (2)$$

The parameter γ_s ($s=1, 2, 3, 4$) indicates the thresholds or cut-off points to be projected for each level. The maximum likelihood method is applied to estimate the parameters.

However, CCs may be endogenous variables in the EV estimation in eq. (1) due to self-selection bias, omitted unobservable variables and reverse causality. For instance, whether or not households experience CCs depends on their characteristics, their comprehensive economic situation, the formal and informal financing channels in the rural capital market and the local economy. Hence, the likelihood of households suffering from CCs is based on the results of financial rationing and households' self-selection rather than on a random assignment. Furthermore, some households are more likely to experience CCs than others are, and this unobserved heterogeneity creates an endogenous bias. In addition, households may suffer from CCs because they have already experienced socioeconomic shocks. Thus, reverse causality may also result in endogeneity.

To account for the nature of the discrete endogenous explanatory CC variables and the potential endogeneity between CCs and EV, the CF approach is applied within an ordered probit model. The CF approach is more flexible with respect to its functional form than standard instrument variable (IV) estimators are such as the two-stage least squares (2SLS) approach (Verkaart *et al.* 2017; Ogutu and Qaim 2019). This is due to its efficiency in solving the problem of endogenous explanatory variables in both linear and non-linear models, with fewer assumptions than the maximum likelihood model and simpler computation (Wooldridge 2015). Specifically, the CF is identical to the 2SLS estimator in linear models, while it is superior to 2SLS in non-linear models as it parsimoniously handles complicated models with discrete endogenous explanatory variables (Imbens and Wooldridge 2007).

Since CCs (R_i) are discrete variables, a probit model is employed to estimate the first-stage regression in order to obtain generalized residuals from a reduced form. The predicted generalized residual (*resid1* and *resid2*) is then included in eq. (1) as an additional covariate in the second-stage EV regression. A statistically significant coefficient for the residual term would suggest that CCs (R_i) are endogenous. In that case, including the predictive residual term could correct for the endogeneity bias of the coefficient δ . Otherwise, if the null hypothesis is accepted

¹ It includes four ordinal categories: null (household can cope with all external shocks), low (household can cope with most external shocks), moderate (household can withstand the effect of some routine shocks but not most shocks) and high (household cannot withstand the effects of any external shocks, even routine shocks).

whereby that exogenous CCs are viewed as acceptable, then the residual term must be excluded to produce unbiased and more efficient estimates.

For the validity of the IV, it must be correlated with the endogenous variables (CCs) and must not affect the dependent variable (EV) through other mechanisms. The county average CCs excluding the individual household's own CCs status could serve as a potentially valid instrument, as many studies have documented the rationale for using regional average variables as valid instruments for individual-level variables (Lusardi and Mitchell 2014; Peng *et al.* 2018). The relevance of these instruments could be supported by peer effects. For instance, it has been shown that individuals tend to learn from their peers (Krishnan and Patnam 2013; Magnan *et al.* 2015); in our case, it is plausible to assume that households in the same county are likely to be within the same financial network and that one household's access to credit accessibility potentially influences that of peer households. In addition, rural households in the same neighbourhood may also be affected by collective action because this helps to alleviate transaction costs and enhance market participation (Fischer and Qaim 2012). Regarding the untestable exogeneity restriction, it is plausible that the individual household's EV might not be strongly affected by the average CCs of other households. Therefore, the second requirement for a valid instrument is likely satisfied. In order to obtain unbiased results, we also conduct a strict exogeneity test by including IV in eq. (1); if it is insignificant, we can safely say that the exogeneity restriction is satisfied.

2.2. Potential mechanisms underlying the impact of credit constraints

To identify the potential mechanisms underlying the effect of CCs, we define the model as follows:

$$M_{ki} = \omega_{ki} + \phi_{ki} R_i + \psi_{ki} X_i + \xi_i \quad (3)$$

$$EV_i = \beta_0 + \delta_i R_i + \beta_i X_i + \alpha M_{ki} + \vartheta_i \quad (4)$$

where M_{ki} denotes the mediator variables, including health, trust, per capita financial assets and per capita income. All of the control variables are the same as those for eq. (1). As mentioned above, since the studied mechanisms might be correlated with each other, a separate estimation for each mechanism might give biased results. Thus, SUR equations are employed. Compared to using a separate ordinary least squares (OLS) estimation for each equation, SUR equations allow the error terms of the different regressions to be correlated, yet uncorrelated across observations (Nasri and Zhang 2019). Using SUR equations, the regressors can vary from equation to equation depending on the

model specification, making it easier to compare the mediating effects of different mediators through different mechanisms. It should be noted that the CCs in eqs. (3) and (4) might also be endogenous variables in the estimation of various mechanisms. Thus, the CF approach is used to correct the endogeneity of CCs.

3. Data and variables

3.1. Data

The data used in this study are from the China Household Income Project (CHIP) survey for 2013 (CHIPs 2013). It covers the following regions in China: Beijing, Shanxi, Liaoning, Jiangsu, Anhui, Guangdong, Henan, Hubei, Sichuan, Chongqing, Yunnan, Gansu, Shandong, and Hunan. Samples were extracted according to the system's sampling method based on the stratification of east, middle and west. The samples covered 7 175 urban households, 11 013 rural households and 760 migrant households selected from 234 counties in 126 cities of 15 representative provinces. Only rural households and household heads aged between 25 and 65 are included in this article. Finally, 9 183 observations were retained that had detailed information on the covariates under consideration in this study.

3.2. Variables and description

As mentioned, the measurement framework for EV often varies with the topic (Kamanou and Morduch 2002; Chaudhuri *et al.* 2003; Cutter *et al.* 2003; Hoddinott and Quisumbing 2003; Ligon and Schechter 2003; Yang 2012). Ligon and Schechter (2003) proposed that EV is the difference in the utility of the expected values for traditional poverty measures and the risk exposure of households as observed by the econometrician. Cutter *et al.* (2003) pointed out that vulnerability is the rapid decline in consumption when households are exposed to risk shocks as a function of the expected mean of households' consumption or per capita income. However, Ligon and Schechter (2003) and Zhang *et al.* (2016) argued that consumption does not reflect the death, health, debt, institutional restrictions, risk and other handicaps faced by households, while these factors might have a significant influence on the household's EV. Particularly, rural households face numerous disadvantages because of their remoteness: a lack of asset guarantees, information and financial resources (Huong *et al.* 2019); low levels of education and poor technical skills (Yang *et al.* 2012); unstable income resources; and proneness to natural disasters (Briguglio

1995). The consumption of these households often conceals the above realities and may not reflect the ability of households to withstand the effects of adverse change, since different households can experience exposure to specific adversities in different ways. Alternatively, the subjective evaluation of EV may well overcome this limitation as it offers a perspective on how households can cope with negative external shocks based on their income and economic capacity.

In this study, we define household EV as the inability to withstand the effects of external economic shocks, which is not based on consumption or per capita income, but is a comprehensive measurement of a lack of economic resilience arising from the relative inability of rural households to shelter themselves from forces outside their control (Briguglio *et al.* 2009). Precisely, it is a non-monetary evaluation of the households' ability to handle negative external shocks based on their income and economic capacity. It overcomes the limitations of monetary measurements and considers economic resilience post-shock and environmental factors such as structural weaknesses and institutional restrictions.

EV is the dependent variable and it is measured by the following questions: 'Which of the following options do you think best describes the income and economic conditions of your family?' If the householder chooses the answer 'We can cope with all external economic shocks', we confirm that the household has no EV. If the householder chooses the answer 'We can cope with most external economic shocks', we confirm that the household has a low level of EV. If the answer 'We can cope with some routine shocks but not with most external economic shocks' is chosen, we confirm that the household has a moderate level of EV. If the chosen answer is 'We cannot handle external economic shocks, even routine shocks', we confirm that the household has a high level of EV. As shown in Table 1, the surveyed rural households have an average EV level of 2.86. Specifically, approximately 5.79% of respondents thought they could cope with all external economic shocks, 11.37% thought they could cope with most external economic shocks, 73.80% thought they could only cope with some routine shocks but not with most external economic shocks and 9.07% thought that they could not handle any external economic shocks, even routine shocks.²

CCs are the determinant variables in this paper. CCs

are equal to one if the household experiences CCs from formal financial organisations or from informal financial networks and zero otherwise. Following the direct elicitation method (DEM) being widely used to capture CCs (Gilligan *et al.* 2005; Ali *et al.* 2014), we identify whether rural households experience CCs from formal institutions or from informal networks. This method involves presenting the respondents with a set of qualitative questions on the rural household's production plans, capital requirements and reasons for their final financing choices.³ To identify whether a household is credit constrained, householders are asked the questions 'Have you applied for formal or informal finance in the past three years?' and 'Was your finance request fully approved?' These questions capture their notional demand for external credit. If the answers are 'Not necessary' or 'Fully funded', we confirm that the household is credit unconstrained; if the answers are 'We applied but were rejected' or 'Needed credit but did not apply', we then confirm that the household is credit constrained. To identify the exact reason for the CCs, participants were asked the questions 'What was the main reason why you were rejected?' and 'What was the main reason why you refused to apply for external finance?' (see Fig. 1-A and B). Table 1 shows that approximately 26.15% of respondents experienced FCCs and 17.55% of respondents experienced IFCCs. In total, 43.7% of respondents experienced either type of CCs. This is in line with the finding of Li *et al.* (2016) that approximately 44.95% of rural households in China experience CCs.

Regarding the control variables, and as shown in Table 1, we find that 92.27% were male, 91.80% were married, 7.27% belonged to a minority group, 11.31% were communist and 5.15% were working as a cadre in a village or town. The average number of years of education for the respondents was about 7 years, and 87.41% of respondents had a pension and most of them evaluated their health as good. Most households thought that their relatives and friends were trustworthy. There were approximately three siblings and four members in each family. The average household financial assets were 11 708 Chinese yuan (CNY) per capita per year and the average household income was 12 784 CNY per capita per year. The average debt was 2 472 CNY per capita per year. The average percentage of male labour

² The total number of observations is 9 183. Among them, 529 households (5.79%) have zero EV; 1 044 households (11.37%) have a low EV level; 6 777 households (73.8%) have a moderate EV level; and 833 households (9.07%) have a high EV level.

³ The questions on rural household financing and the recognition of different types of credit rationing are presented in Fig. 1-A and B.

Table 1 Variables definition and descriptive statistics (*n*=9 183)

Variable ¹⁾	Description	Mean	SD	Min.	Max.
Dependent variable					
EV	Perception about the family to cope with economic shocks: 1=we could cope with all of them; 2=we could handle with most of them; 3=we could only cope with some routine shocks, most of them we couldn't do it; 4=we couldn't handle with shocks, even if they are routine shocks	2.8618	0.6448	1	4
Independent variable					
FCCs	FCCs equals to 1 if household has credit constraints from formal financial organization, 0 otherwise	0.2615	0.4395	0	1
IFCCs	IFCCs equals to 1 if household has credit constraints from informal financial organization, 0 otherwise	0.1755	0.3805	0	1
FICCs	FICCs equals to 1 if household has credit constraints from formal and informal financial organization, 0 otherwise	0.1137	0.3174	0	1
Instrument variable					
FCCs-IV	County average FCCs excluding the household's own status	0.2718	0.1483	0	1
IFCCs-IV	County average IFCCs excluding the household's own status	0.1866	0.1263	0	1
FICCs-IV	County average FICCs and IFCCs excluding the household's own status	0.1228	0.1039	0	1
Individual characteristics					
gender	Gender equals to 1 if responder is male, 0 otherwise	0.9227	0.2671	0	1
marriage	Marriage equals to 1 if responder was married, 0 otherwise	0.918	0.2744	0	1
minority	Minority equals to 1 if responder has a minority nationality, 0 otherwise	0.0727	0.2597	0	1
party	Party equals to 1 if responder is a communist, 0 otherwise	0.1131	0.3168	0	1
cadre	Cadre equals to 1 if responder is a cadre, 0 otherwise	0.0515	0.221	0	1
education	Years of responder's education	7.2148	2.649	0	20
sibling	Numbers of sisters and brothers	3.0762	1.7409	0	12
health	Self-evaluation of health: 1=extremely unhealthy; 2=moderate unhealthy; 3=neutral; 4=moderate healthy; 5=extremely healthy	3.8203	0.9392	1	5
pension	Pension equals to 1 if responder has pension, 0 otherwise	0.8741	0.3317	0	1
trust	Perception of trustworthy from relatives or friends: 1=extremely untrust; 2=moderate untrust; 3=neutral; 4=moderate trust; 5=extremely trust	3.8209	0.8636	1	5
Household characteristics					
fsize	Numbers of family members	3.751	1.4282	1	13
pfinance	Per-capita financial asset (10 000 CNY yr ⁻¹)	1.1708	2.6837	0	140.15
pdebt	Per-capita debt (10 000 CNY yr ⁻¹)	0.2472	1.1468	0	35
pincome	Per-capita income (10 000 CNY yr ⁻¹)	1.2784	1.2398	0.01	53.33
malelabor	Percent of male labors of each family (%)	0.3605	0.2167	0	1
east	Eastern part of China	0.3551	0.4786	0	1
middle	Middle part of China	0.3868	0.487	0	1
west	Western part of China	0.2581	0.4376	0	1

¹⁾ EV, economic vulnerability; FCCs, formal credit constraints; IFCCs, informal credit constraints; FICCs, formal and informal credit constraints. Source: Author's own calculation based on CHIPs 2013 for rural samples.

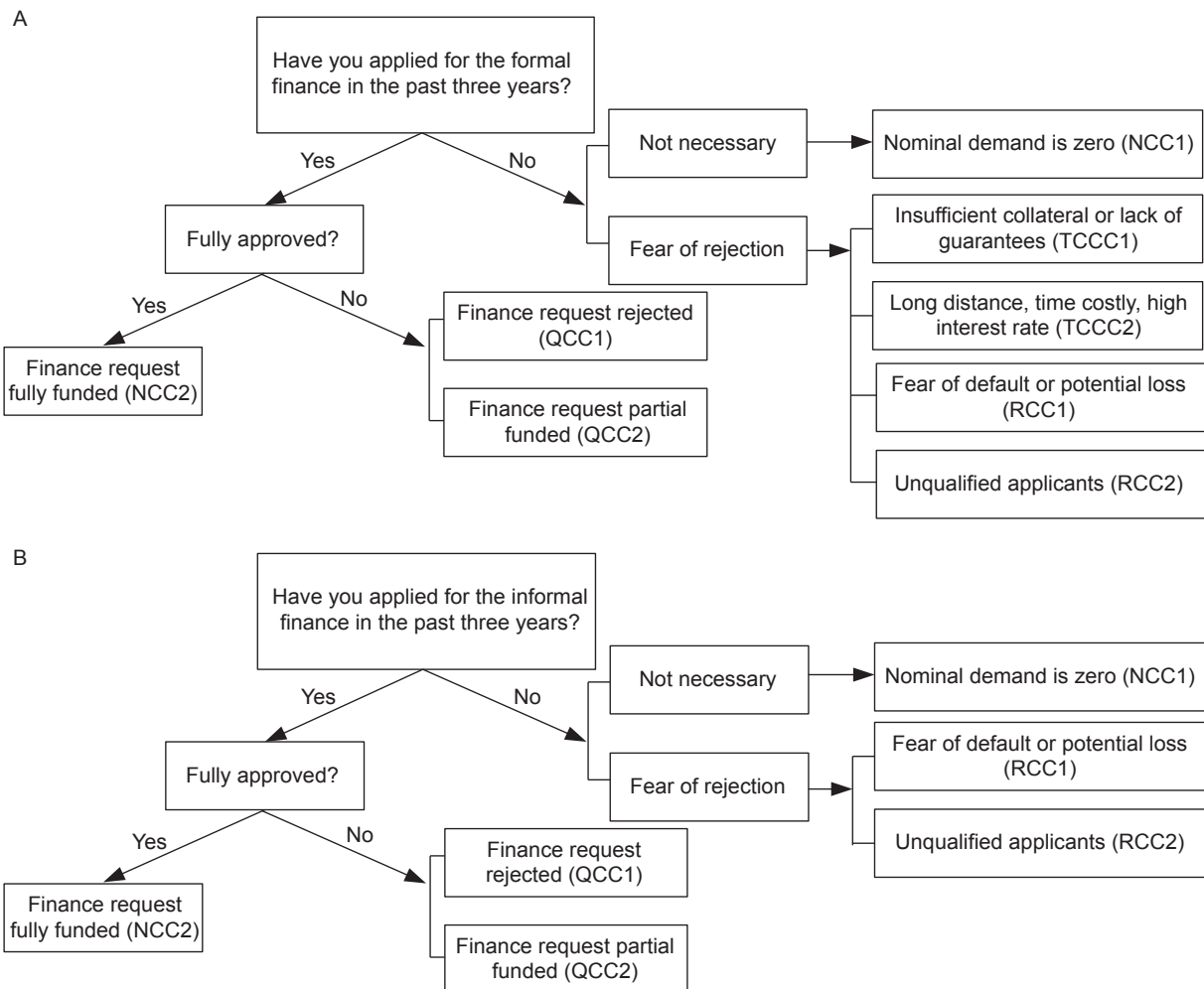


Fig. 1 Identification of formal (A) and informal (B) credit constraints. Non-credit constraints (NCC) includes NCC1 and NCC2; quantity credit constraints (QCC) includes QCC1 and QCC2; transaction cost credit constraints (TCCC) includes TCCC1 and TCCC2; risk credit constraints (RCC) includes RCC1 and RCC2.

in each family was 36.05%.

3.3. *t*-test of sample characteristics

Table 2 presents the differences in the characteristics between rural households with CCs and those without CCs. It shows that the EV differences between rural households who do not experience CCs and those who experience CCs from either formal or informal networks are significant at the 1% level. Specifically, the EV of rural households without CCs is lower than that of those with CCs from formal financial institutions or informal networks, implying that the rural households with CCs are more likely to experience a higher EV level. Compared to constrained rural households, unconstrained rural households have longer periods of education and health days, and higher levels of pension, trust, per capita financial assets and per capita income.

4. Results

4.1. Impact of credit constraints on economic vulnerability

The impact of CCs on the EV of rural households is estimated by gradually introducing individual rural traits and household characteristics, and regional effects using the ordered probit model combined with the CF approach. The results and marginal effects are presented in Tables 3 and 4, respectively.

Table 3 shows that both FCCs and IFCCs have a positive effect on rural households' EV in all model specifications; this suggests that increasing the FCCs or IFCCs results in a higher EV level for rural households. The results of the CF estimation also show that FCCs and IFCCs have a significant and positive effect on rural households' EV, while it should be noted that the

Table 2 Summary of mean difference in characteristic¹⁾

Variable	FCCs group			IFCCs group		
	Samples unconstrained	Samples constrained	Mean Diff.1	Samples unconstrained	Samples constrained	Mean Diff.2
Dependent variable						
EV ²⁾	2.816	2.992	−0.176***	2.834	2.993	−0.159***
Individual characteristics						
gender	0.920	0.931	−0.011*	0.923	0.923	0.000
marriage	0.922	0.908	0.014**	0.923	0.893	0.030***
minority	0.069	0.084	−0.015**	0.069	0.089	−0.020***
party	0.120	0.093	0.027***	0.116	0.102	0.014
cadre	0.055	0.041	0.014***	0.053	0.043	0.010
education	7.299	6.978	0.320***	7.245	7.072	0.173**
sibling	3.069	3.096	−0.026	3.089	3.017	0.072
health	3.887	3.631	0.256***	3.861	3.630	0.231***
pension	0.879	0.861	0.018**	0.878	0.855	0.023**
trust	3.849	3.742	0.107***	3.861	3.630	0.231***
Household characteristics						
fsize	3.724	3.828	−0.105***	3.733	3.836	−0.103***
pfinance	1.325	0.737	0.588***	1.248	0.810	0.438***
pdebt	0.193	0.401	−0.208***	0.205	0.444	−0.239***
pincome	1.329	1.135	0.194***	1.304	1.158	0.146***
malelabor	0.356	0.374	−0.018***	0.359	0.367	−0.008
middle	0.374	0.424	−0.050***	0.384	0.401	−0.017
west	0.234	0.327	−0.093***	0.240	0.344	−0.104***
Observations	6 781	2 402		7 571	1 612	

¹⁾ FCCs, formal credit constraints; IFCCs, informal credit constraints.

²⁾ EV, economic vulnerability.

***, $P < 0.01$; **, $P < 0.05$; *, $P < 0.1$. Source: Author's own calculation based on CHIPs 2013 for rural samples.

coefficients of the residual terms introduced in the CF, as shown in columns (5) and (10) in Table 3, are not significant. This indicates that the null hypothesis that CCs are exogenous cannot be rejected, and the results from the regular ordered probit model estimation without the residual terms is preferred for our interpretation because it produces more efficient estimates. Thus, in line with existing studies in developing countries (see Do and Siegfried 2016; Li *et al.* 2016), we conclude that improving credit access for rural households could have a positive impact on reducing their EV. Precisely, as shown in Table 4, CCs from formal institutions (informal networks) reduce the probability of households having the ability to cope with all external economic shocks (null EV) by 1.98% (1.85%) and of coping with most external economic shocks (low EV) by 3.14% (2.97%), but they increase the probability of households not being able to handle most external economic (moderate EV) shocks by 1.69% (1.45%), and of not handling external economic shocks (high EV), even routine shocks, by 3.43% (3.37%), respectively. More importantly, the marginal effect of CCs on high EV is larger than other samples. It confirms the conclusion that credit constraints are important factors in perpetuating poverty among the poor (Collins *et al.* 2009). That is, credit accessibility is the critical factor

to help farmers to release the EV, especially for the poor individuals to jump out the vicious loop of poverty. Above all, we conclude that both FCCs and IFCCs have a robust positive and significant impact on the EV of rural households and that the impact of FCCs is greater than that of IFCCs.

In terms of the control variables, we find that a minority status and per capita debt are significant and positively associated with households' EV, suggesting that households with a minority status and a high level of per capita debt tend to have a higher EV level. One possible explanation for this is that most of the minority households are in remote areas with frequent weather disasters (Xing and Li 2019); this makes them more vulnerable to external shocks. The high per capita debt increases the risks and burdens of rural households, which render the economies of these households extremely vulnerable to external shocks that are outside of their control. Marital status, party membership, being a cadre, education, health, trust, family size, per capita financial assets, per capita income and the percentage of male labour are significant and negatively associated with households' EV. The possible explanations for these findings may be that being married, having a communist status, cadre experience, a high level of education, high trust levels and being healthier means

Table 3 Impact of credit constraints (CCs) on household's economic vulnerability (EV) using ordered probit (OP) model and control function (CF) ($n=9\ 183$)¹⁾

Variable	FCCs group					IFCCs group				
	OP				CF	OP				CF
	(1) EV	(2) EV	(3) EV	(4) EV	(5) EV	(6) EV	(7) EV	(8) EV	(9) EV	(10) EV
FCCs/IFCCs	0.3574*** (0.0288)	0.2871*** (0.0294)	0.2187*** (0.0306)	0.2332*** (0.0307)	0.1874* (0.1047)	0.3341*** (0.0330)	0.2582*** (0.0337)	0.2081*** (0.0345)	0.2233*** (0.0346)	0.2597* (0.1403)
gender	–	0.0280 (0.0496)	0.0011 (0.0506)	–0.0068 (0.0506)	–0.0071 (0.0526)	–	0.0339 (0.0495)	0.0025 (0.0505)	–0.0054 (0.0506)	–0.0055 (0.0527)
marriage	–	–0.4270*** (0.0492)	–0.3503*** (0.0508)	–0.3422*** (0.0509)	–0.3417*** (0.0557)	–	–0.4178*** (0.0491)	–0.3422*** (0.0508)	–0.3338*** (0.0509)	–0.3339*** (0.0558)
minority	–	0.1309*** (0.0492)	0.0446 (0.0500)	0.0851* (0.0505)	0.0837* (0.0507)	–	0.1306*** (0.0491)	0.0400 (0.0500)	0.0797 (0.0505)	0.0800 (0.0506)
party	–	–0.1166*** (0.0444)	–0.1124** (0.0450)	–0.1035** (0.0451)	–0.1032** (0.0472)	–	–0.1231*** (0.0444)	–0.1157** (0.0450)	–0.1071** (0.0450)	–0.1071** (0.0471)
cadre	–	–0.1229** (0.0626)	–0.1153* (0.0633)	–0.1106* (0.0633)	–0.1103 (0.0674)	–	–0.1255** (0.0626)	–0.1185* (0.0632)	–0.1142* (0.0633)	–0.1142* (0.0672)
education	–	–0.0200*** (0.0050)	–0.0077 (0.0052)	–0.0108** (0.0052)	–0.0107** (0.0052)	–	–0.0210*** (0.0050)	–0.0085 (0.0052)	–0.0116** (0.0052)	–0.0116** (0.0052)
sibling	–	–0.0073 (0.0073)	–0.0059 (0.0074)	–0.0061 (0.0074)	–0.0061 (0.0080)	–	–0.0061 (0.0073)	–0.0053 (0.0074)	–0.0055 (0.0074)	–0.0054 (0.0080)
health	–	–0.2435*** (0.0142)	–0.1980*** (0.0146)	–0.2033*** (0.0146)	–0.2035*** (0.0155)	–	–0.2490*** (0.0141)	–0.2013*** (0.0145)	–0.2066*** (0.0146)	–0.2065*** (0.0156)
pension	–	–0.0519 (0.0383)	–0.0493 (0.0386)	–0.0630 (0.0388)	–0.0633 (0.0425)	–	–0.0539 (0.0382)	–0.0496 (0.0386)	–0.0635 (0.0388)	–0.0635 (0.0424)
trust	–	–0.0568*** (0.0147)	–0.0548*** (0.0148)	–0.0615*** (0.0149)	–0.0620*** (0.0156)	–	–0.0524*** (0.0147)	–0.0511*** (0.0149)	–0.0575*** (0.0150)	–0.0574*** (0.0157)
fhsz	–	–	–0.0890*** (0.0094)	–0.0869*** (0.0094)	–0.0868*** (0.0100)	–	–	–0.0896*** (0.0094)	–0.0875*** (0.0094)	–0.0875*** (0.0100)
lnpfinance	–	–	–0.0273*** (0.0054)	–0.0284*** (0.0055)	–0.0286*** (0.0060)	–	–	–0.0288*** (0.0054)	–0.0298*** (0.0055)	–0.0297*** (0.0060)
lnpdebt	–	–	0.0211*** (0.0040)	0.0223*** (0.0040)	0.0222*** (0.0041)	–	–	0.0239*** (0.0039)	0.0252*** (0.0039)	0.0252*** (0.0041)
lnpincome	–	–	–0.2703*** (0.0192)	–0.2940*** (0.0197)	–0.2941*** (0.0209)	–	–	–0.2732*** (0.0192)	–0.2964*** (0.0197)	–0.2963*** (0.0209)
malelabor	–	–	–0.1835*** (0.0622)	–0.1466** (0.0626)	–0.1459** (0.0639)	–	–	–0.1691*** (0.0621)	–0.1321** (0.0625)	–0.1327** (0.0643)
middle	–	–	–	–0.0930*** (0.0310)	–0.0889*** (0.0323)	–	–	–	–0.0871*** (0.0309)	–0.0880*** (0.0314)
west	–	–	–	–0.2161*** (0.0353)	–0.2096*** (0.0368)	–	–	–	–0.2119*** (0.0352)	–0.2139*** (0.0356)
resid1/resid2	–	–	–	–	0.0495 (0.1093)	–	–	–	–	–0.0378 (0.1401)
Constant cut1	–1.4983*** (0.0220)	–3.3153*** (0.1031)	–3.6432*** (0.1155)	–3.7981*** (0.1186)	–3.8119*** (0.1324)	–1.5259*** (0.0216)	–3.3358*** (0.1031)	–3.6606*** (0.1155)	–3.8118*** (0.1186)	–3.8043*** (0.1335)
Constant cut2	–0.8671*** (0.0167)	–2.6643*** (0.1016)	–2.9759*** (0.1141)	–3.1287*** (0.1171)	–3.1424*** (0.1305)	–0.8979*** (0.0162)	–2.6869*** (0.1017)	–2.9945*** (0.1140)	–3.1437*** (0.1171)	–3.1362*** (0.1315)
Constant cut3	1.4477*** (0.0208)	–0.2405*** (0.0977)	–0.4750*** (0.1097)	–0.6203*** (0.1125)	–0.6341*** (0.1248)	1.4074*** (0.0199)	–0.2709*** (0.0977)	–0.4972*** (0.1096)	–0.6392*** (0.1124)	–0.6317*** (0.1261)
Pseudo R^2	0.0099	0.0461	0.0706	0.0730	0.0730	0.0066	0.0437	0.0696	0.0719	0.0719

¹⁾ FCCs, formal credit constraints; IFCCs, informal credit constraints.

Standard errors are in parentheses. The standard errors for the CF estimates in Model 5 and Model 10 is based on 1 000 bootstrap replications. ***, $P<0.01$; **, $P<0.05$; *, $P<0.1$. Source: author's own calculation based on CHIPs 2013 for rural samples.

that individuals become more skilful at and capable of handling risks and external shocks, thus alleviating losses due to shocks. The higher levels of per capita financial assets and per capita income are beneficial in terms of improving the quality of life, generating substantial income

stability and relieving the economic difficulties threatening survival (Yang *et al.* 2012). In addition, rural households in the middle and western parts of China are less likely to be economically vulnerable than those in the eastern part of China.

Table 4 Marginal effects of impact of credit constraints (CCs) on household's economic vulnerability (EV) using ordered probit (OP) model ($n=9\ 183$)¹⁾

Variable	FCCs group				IFCCs group			
	Null EV	Low EV	Moderate EV	High EV	Null EV	Low EV	Moderate EV	High EV
FCCs/IFCCs	−0.0198*** (0.0025)	−0.0314*** (0.0040)	0.0169*** (0.0020)	0.0343*** (0.0049)	−0.0185*** (0.0026)	−0.0297*** (0.0044)	0.0145*** (0.0017)	0.0337*** (0.0058)
gender	0.0006 (0.0047)	0.0009 (0.0071)	−0.0007 (0.0048)	−0.0009 (0.0069)	0.0005 (0.0047)	0.0008 (0.0071)	−0.0005 (0.0048)	−0.0007 (0.0069)
marriage	0.0249*** (0.0030)	0.0432*** (0.0057)	−0.0113*** (0.0026)	−0.0568*** (0.0101)	0.0246*** (0.0030)	0.0422*** (0.0058)	−0.0115*** (0.0025)	−0.0553*** (0.0101)
minority	−0.0074* (0.0041)	−0.0116* (0.0067)	0.0069** (0.0033)	0.0121 (0.0076)	−0.0070* (0.0042)	−0.0109 (0.0068)	0.0066* (0.0034)	0.0114 (0.0076)
party	0.0103** (0.0048)	0.0148** (0.0066)	−0.0119** (0.0060)	−0.0132** (0.0054)	0.0107** (0.0048)	0.0153** (0.0066)	−0.0124** (0.0060)	−0.0137** (0.0054)
cadre	0.0112 (0.0069)	0.0159* (0.0093)	−0.0131 (0.0089)	−0.0139* (0.0074)	0.0116* (0.0070)	0.0164* (0.0093)	−0.0137 (0.0090)	−0.0144* (0.0074)
education	0.0010** (0.0005)	0.0015** (0.0007)	−0.0010** (0.0005)	−0.0015** (0.0007)	0.0011** (0.0005)	0.0016** (0.0007)	−0.0011** (0.0005)	−0.0016** (0.0007)
sibling	0.0006 (0.0007)	0.0008 (0.0010)	−0.0006 (0.0007)	−0.0008 (0.0010)	0.0005 (0.0007)	0.0008 (0.0010)	−0.0005 (0.0007)	−0.0007 (0.0010)
health	0.0189*** (0.0015)	0.0284*** (0.0022)	−0.0198*** (0.0019)	−0.0275*** (0.0021)	0.0193*** (0.0015)	0.0289*** (0.0022)	−0.0201*** (0.0019)	−0.0281*** (0.0021)
pension	0.0056* (0.0033)	0.0087* (0.0053)	−0.0055* (0.0030)	−0.0088 (0.0056)	0.0057* (0.0033)	0.0088* (0.0053)	−0.0055* (0.0030)	−0.0089 (0.0057)
trust	0.0057*** (0.0014)	0.0086*** (0.0021)	−0.0060*** (0.0015)	−0.0083*** (0.0020)	0.0054*** (0.0014)	0.0080*** (0.0021)	−0.0056*** (0.0015)	−0.0078*** (0.0020)
fhsz	0.0081*** (0.0009)	0.0122*** (0.0014)	−0.0085*** (0.0011)	−0.0118*** (0.0013)	0.0082*** (0.0009)	0.0122*** (0.0014)	−0.0085*** (0.0011)	−0.0119*** (0.0013)
lnpfinance	0.0026*** (0.0005)	0.0040*** (0.0008)	−0.0028*** (0.0006)	−0.0038*** (0.0007)	0.0028*** (0.0005)	0.0042*** (0.0008)	−0.0029*** (0.0006)	−0.0041*** (0.0007)
lnpdebt	−0.0021*** (0.0004)	−0.0031*** (0.0006)	0.0022*** (0.0004)	0.0030*** (0.0005)	−0.0024*** (0.0004)	−0.0035*** (0.0006)	0.0025*** (0.0004)	0.0034*** (0.0005)
lnpincome	0.0273*** (0.0020)	0.0411*** (0.0029)	−0.0286*** (0.0026)	−0.0398*** (0.0028)	0.0277*** (0.0020)	0.0414*** (0.0029)	−0.0289*** (0.0026)	−0.0403*** (0.0028)
malelabor	0.0136** (0.0058)	0.0205** (0.0088)	−0.0143** (0.0062)	−0.0199** (0.0085)	0.0123** (0.0058)	0.0185** (0.0087)	−0.0129** (0.0061)	−0.0179** (0.0085)
middle	0.0088*** (0.0030)	0.0131*** (0.0044)	−0.0095*** (0.0033)	−0.0124*** (0.0041)	0.0083*** (0.0030)	0.0122*** (0.0044)	−0.0089*** (0.0033)	−0.0117*** (0.0041)
west	0.0220*** (0.0040)	0.0311*** (0.0052)	−0.0259*** (0.0051)	−0.0271*** (0.0041)	0.0216*** (0.0040)	0.0304*** (0.0052)	−0.0253*** (0.0051)	−0.0267*** (0.0042)

¹⁾ FCCs, formal credit constraints; IFCCs, informal credit constraints.

Standard errors are in parentheses; ***, $P<0.01$; **, $P<0.05$; *, $P<0.1$. Source: author's own calculation based on CHIPs 2013 for rural samples.

4.2. Heterogeneity in the impact of credit constraints on households' economic vulnerability

As average differences may hide the heterogeneity within the groups of unconstrained and constrained households or with different types of CCs, in this section, we use the ordered probit model and the CF approach to investigate heterogeneity by introducing the interaction terms between CCs and marriage, education and family size.

As shown in columns (1), (3), (5), (7), (9) and (11) in Table 5, the estimations from the regular ordered probit model indicate that significantly negative interaction effects exist between CCs and marriage, education

and family size for both the FCCs and IFCCs groups. Similar results can also be found from the CF estimation in columns (2), (4), (6), (8), (10) and (12), although the residual terms that were introduced are not statistically significant. This implies that we cannot reject the null hypothesis that the CCs' variable is exogenous. Hence, we prefer the estimation results from the regular ordered probit model for interpretation as it is more efficient. We conclude that the impact of FCCs and IFCCs on households' EV shows heterogeneity across marriage status, family size and education. This implies that households with a married household head and a larger family size tend to have lower EV; the possible reason

Table 5 Heterogeneity in impact of credit constraints (CCs) on household's economic vulnerability (EV) cross marriage, education, and farm size ($n=9183$)¹⁾

Variable	FCCs group				IFCCs group							
	(1) OP	(2) CF	(3) OP	(4) CF	(5) OP	(6) CF	(7) OP	(8) CF	(9) OP	(10) CF	(11) OP	(12) CF
FCCs/IFCCs	0.4800 ^{***} (0.0997)	0.4365 ^{***} (0.1402)	0.4784 ^{***} (0.0835)	0.4308 ^{***} (0.1280)	0.4317 ^{***} (0.0856)	0.3874 ^{***} (0.1284)	0.4776 ^{***} (0.1080)	0.5174 ^{***} (0.1724)	0.2988 ^{***} (0.0946)	0.3345 ^{***} (0.1659)	0.4973 ^{***} (0.0981)	0.5325 ^{***} (0.1718)
Others fixed	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
FCCs/IFCCs×marriage	-0.2702 ^{***} (0.1038)	-0.2697 ^{***} (0.1038)	-	-	-	-	-0.2820 ^{***} (0.1134)	-0.2822 ^{***} (0.1164)	-	-	-	-
FCCs/IFCCs×education	-	-	-0.0346 ^{***} (0.0110)	-0.0347 ^{***} (0.0110)	-	-	-	-	-0.0106 (0.0124)	-0.0106 (0.0121)	-	-
FCCs/IFCCs×fsize	-	-	-	-	-0.0520 ^{***} (0.0209)	-0.0520 ^{***} (0.0218)	-	-	-	-	-0.0714 ^{***} (0.0239)	-0.0714 ^{***} (0.0259)
resid1/resid2	-	-	-	-	-	-	-	-0.0410 (0.1389)	-	-0.0372 (0.1403)	-	-0.0366 (0.1439)
Constant cut1	-3.7342 ^{***} (0.1211)	-3.7474 ^{***} (0.1247)	-3.7304 ^{***} (0.1205)	-3.7448 ^{***} (0.1240)	-3.7549 ^{***} (0.1199)	-3.7683 ^{***} (0.1359)	-3.7597 ^{***} (0.1204)	-3.7516 ^{***} (0.1393)	-3.7973 ^{***} (0.1198)	-3.7900 ^{***} (0.1348)	-3.7603 ^{***} (0.1198)	-3.7531 ^{***} (0.1345)
Constant cut2	-3.0645 ^{***} (0.1197)	-3.0776 ^{***} (0.1233)	-3.0609 ^{***} (0.1191)	-3.0752 ^{***} (0.1226)	-3.0854 ^{***} (0.1184)	-3.0987 ^{***} (0.1336)	-3.0912 ^{***} (0.1190)	-3.0831 ^{***} (0.1362)	-3.1293 ^{***} (0.1183)	-3.1220 ^{***} (0.1328)	-3.0920 ^{***} (0.1184)	-3.0848 ^{***} (0.1318)
Constant cut3	-0.5553 ^{***} (0.1152)	-0.5684 ^{***} (0.1190)	-0.5507 ^{***} (0.1147)	-0.5650 ^{***} (0.1183)	-0.5760 ^{***} (0.1139)	-0.5893 ^{***} (0.1264)	-0.5863 ^{***} (0.1144)	-0.5782 ^{***} (0.1312)	-0.6247 ^{***} (0.1137)	-0.6174 ^{***} (0.1270)	-0.5864 ^{***} (0.1138)	-0.5792 ^{***} (0.1258)
Pseudo R ²	0.0734	0.0734	0.0736	0.0736	0.0734	0.0734	0.0723	0.0723	0.0720	0.0720	0.0725	0.0725

¹⁾ FCCs, formal credit constraints; IFCCs, informal credit constraints. FCCs/IFCCs×marriage, FCCs/IFCCs×education, and FCCs/IFCCs×fsize are interactions terms.

Standard errors for ordered probit (OP) model are robust to heteroskedasticity. The standard errors for the control function (CF) estimates are based on 1 000 bootstrap replications. ***, **, * , P<0.01 and **, P<0.05. Source: author's own calculation based on CHIPs 2013 for rural samples.

could be that these households could create more networks and increase their probability of accessing loans, thus alleviating their EV (see also Turvey and Kong 2010). The heterogeneity across various levels of education could be explained by the fact that education is helpful in improving households' knowledge and skills, which increases their ability to obtain income and overcome asymmetric information.

4.3. Robustness test

To check the robustness of our estimation results based on subjective EV measurements, we further estimate the impact of CCs on EV using objective measurements, defines as the difference between the minimum subsistence amount and disposable income divided by disposable income. Thus, the objective EV measure is a continuous variable ranging from zero to one; the larger the difference is, the higher the EV. The variables relating to per capita financial assets and per capita income, which could potentially introduce reverse causality, are excluded. As shown in Table 6, the estimation results from the OLS and CF approaches indicate the same sign and significance level for the coefficients of CCs on EV for both formal and informal credit, while the residual terms introduced in the CF estimation are statistically significant, suggesting that CCs are endogenous and the results from the CF estimation should be used for interpretation. Our conclusion holds, in that FCCs and IFCCs have significantly positive impacts on households' EV, regardless of whether subjective or objective EV measurements are used.

To further check the robustness of our estimation results, we conduct the estimation for farmers who have CCs from both formal financial institutions and informal network. We always consider these samples but now we want to separate this from the pooled sample. Approximately 11.37% farmers do suffer CCs from both formal credit institutions and informal network. Table 7 presents the impact of CCs on EV of households suffering both FCCs and IFCCs. The residual terms in column (3) are not statistically significant. This implies that we cannot reject the null hypothesis that the CCs' variable is exogenous. Hence, we prefer the estimation results from the regular ordered

Table 6 Robustness test of the impact of credit constraints (CCs) on household's economic vulnerability (EV) ($n=9\ 149$)¹⁾

Variable	FCCs group		IFCCs group	
	(1) OLS	(2) CF	(3) OLS	(4) CF
FCCs/IFCCs	0.0015*** (0.0005)	0.0071*** (0.0014)	0.0014** (0.0006)	0.0052** (0.0023)
gender	0.0002 (0.0009)	0.0002 (0.0008)	0.0002 (0.0009)	0.0002 (0.0008)
marriage	0.0006 (0.0009)	0.0005 (0.0008)	0.0005 (0.0009)	0.0005 (0.0008)
minority	0.0004 (0.0009)	0.0005 (0.0008)	0.0004 (0.0009)	0.0004 (0.0009)
party	−0.0012 (0.0008)	−0.0012* (0.0007)	−0.0012 (0.0008)	−0.0012* (0.0006)
cadre	0.0003 (0.0012)	0.0003 (0.001)	0.0003 (0.0012)	0.0003 (0.001)
education	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)
sibling	−0.0001 (0.0001)	−0.0001 (0.0001)	−0.0001 (0.0001)	−0.0001 (0.0001)
health	−0.0009*** (0.0003)	−0.0009*** (0.0003)	−0.0010*** (0.0003)	−0.0010** (0.0004)
pension	0.0006 (0.0007)	0.0006 (0.0006)	0.0006 (0.0007)	0.0006 (0.0006)
trust	0.0001 (0.0003)	0.0002 (0.0003)	0.0001 (0.0003)	0.0001 (0.0003)
fsize	−0.0003 (0.0002)	−0.0003* (0.0002)	−0.0003 (0.0002)	−0.0003 (0.0002)
lnpdebt	0.0003*** (0.0001)	0.0003*** (0.0001)	0.0003*** (0.0001)	0.0004*** (0.0001)
malelabor	−0.0048*** (0.0011)	−0.0048*** (0.0009)	−0.0046*** (0.0011)	−0.0047*** (0.001)
middle	0.0034*** (0.0005)	0.0028*** (0.0005)	0.0035*** (0.0005)	0.0033*** (0.0006)
west	0.0021*** (0.0006)	0.0013*** (0.0005)	0.0023*** (0.0006)	0.0020*** (0.0004)
resid1/resid2	—	−0.0061*** (0.0013)	—	−0.0053** (0.0023)
Constant	0.0193*** (0.0019)	0.0179*** (0.0019)	0.0199*** (0.0019)	0.0190*** (0.0019)
R-squared	0.0137	0.0148	0.0128	0.0133

¹⁾ FCCs, formal credit constraints; IFCCs, informal credit constraints.

Standard errors for OLS are robust to heteroskedasticity. The standard errors for the CF estimates are based on 1 000 bootstrap replications. ***, $P<0.01$; **, $P<0.05$; *, $P<0.1$. Source: author's own calculation based on CHIPs 2013 for rural samples.

probit model for interpretation as it is more efficient. As it is reported in Table 7, the result further confirms the conclusion that CCs from both formal financial institutions and informal network have a positive and significant impact on the EV of rural households. Precisely, as shown in Table 8, CCs from both formal institutions and informal networks reduce the probability of households having the ability to cope with all external economic shocks (null EV) by 2.39% and of coping with most external economic shocks (low EV) by 4.04%, but they increase the probability of households not being able to handle most external economic (moderate EV) shocks by 1.35%, and of not handling external economic shocks (high EV), even routine shocks, by 5.09%, respectively. Thus, the main conclusions above are robust.

4.4. Causal mediation mechanisms

To estimate the mediating causal mechanisms through which CCs could impact EV, the SUR combine with CF approaches are employed. This provides initial empirical evidence to make precise comparisons between the mediating effects of different mediators through various mechanisms with the endogeneity bias having been corrected. All the control variables are the same across the four models.

As reported in Table 9, the residual terms introduced in the SUR are significant, indicating that CCs are endogenous in the estimation for the mechanisms under consideration. Both FCCs and IFCCs negatively affect the household's health, trust, per capita financial assets and

Table 7 Impact of credit constraints (CCs) on economic vulnerability (EV) of households suffering both formal credit constraints (FCCs) and informal credit constraints (IFCCs) ($n=9183$)¹⁾

Variable	OP		CF	
	(1) EV	(2) SD	(3) EV	(4) SD
FICCs ²⁾	0.3155***	0.0414	0.4458***	0.1537
gender	−0.0077	0.0506	−0.0101	0.0507
marriage	−0.3310***	0.0509	−0.3247***	0.0514
minority	0.0875*	0.0505	0.0908*	0.0507
party	−0.1090**	0.0451	−0.1089**	0.0451
cadre	−0.1082*	0.0633	−0.1049*	0.0634
education	−0.0112**	0.0052	−0.0112**	0.0052
sibling	−0.0053	0.0074	−0.0048	0.0075
health	−0.2059***	0.0146	−0.2031***	0.0149
pension	−0.0636	0.0388	−0.0621	0.0389
trust	−0.0570***	0.0150	−0.0532***	0.0156
fhsz	−0.0875***	0.0094	−0.0880***	0.0095
lnpfinance	−0.0294***	0.0055	−0.0281***	0.0056
lnpdebt	0.0261***	0.0039	0.0253***	0.0040
lnpincome	−0.2951***	0.0197	−0.2937***	0.0198
malelabor	−0.1381**	0.0625	−0.1429**	0.0628
middle	−0.0898***	0.0310	−0.0941***	0.0313
west	−0.2120***	0.0352	−0.2183***	0.0359
resid3	—	—	−0.0742	0.0842
Constant cut1	−3.8061***	0.1185	−3.7569***	0.1309
Constant cut2	−3.1376***	0.1170	−3.0887***	0.1295
Constant cut3	−0.6295***	0.1123	−0.5803***	0.1254

¹⁾ OP, ordered probit model; CF, control function.

²⁾ FICCs, formal and informal credit constraints.

***, $P<0.01$; **, $P<0.05$; *, $P<0.1$. Source: authors' own calculation based on CHIPs 2013 for rural samples.

Table 8 Average treatment effect (ATE) of credit constraints (CCs) on economic vulnerability (EV) of households suffering both formal credit constraints (FCCs) and informal credit constraints (IFCCs)

Variable	Group suffering both FCCs and IFCCs			
	Null EV	Low EV	Moderate EV	High EV
ATE	−0.0239*** (0.0026)	−0.0404*** (0.0049)	0.0135*** (0.0019)	0.0509*** (0.0078)

***, $P<0.01$. Standard errors are in parentheses. Source: authors' own calculation based on CHIPs 2013 for rural samples.

per capita income. This implies that higher CCs result in a higher probability of having worse health, inferior trust, lower levels of household's financial assets and a lower household's income, all of which increase the probability of having a higher EV level for rural households. Thus, we conclude that the effect of CCs on EV is partly mediated by health, trust, per capita financial assets and per capita income. As shown in Table 10, keeping other factors unchanged, the total indirect mediating effects of these mechanisms accounts for 15.09 and 17.46% of the total effect of FCCs (IFCCs) on EV; the indirect effects of health, trust, per capita financial assets and per capita

income are 0.0488 (0.0543), 0.0169 (0.0132), 0.0382 (0.0467), and 0.0470 (0.0604), accounting for 32.34% (31.10%), 11.20% (7.56%), 25.31% (26.75%), and 31.15% (34.59%) of the effect, respectively. Importantly, among these mechanisms, health and per capita income take the leading role in mediating the effect of FCCs and IFCCs, accounting for 63.49 and 65.69% of the effect, respectively. The possible explanation could be that a bad health status would lead to less labours input in agricultural production activities, thereby less output result in a lower income level and ability to handle external economic shocks.

5. Discussion

Both FCCs and IFCCs have a robust positive and significant impact on the EV of rural households in China. Also, there is significant heterogeneity in terms of the impact of CCs across marital status, education and family size. Prior research has demonstrated that rural households in China not only suffer from supply-side CCs but also from demand-side CCs as a result of transaction costs and risk rationing (Zhao and Peter 2014). Regarding the supply side, increasing the supply of formal credit could help to ease the CCs of rural households. For instance, more international financial agencies or non-governmental organisations could be motivated to get involved in the credit market in rural areas, in particular, in poverty-stricken villages (Xing and Li 2019). The role of informal credit should also be noted, and policies focusing on opening the financial market to informal financial institutions (such as increasing subsidies or reducing taxes) and innovating around the financial poverty-alleviation model by, for example, creating mutual fund cooperatives, could also improve the supply of informal credit (Yang *et al.* 2018). In terms of the demand side, policies focusing on improving the financial literacy of rural households and establishing sharing-credit systems for rural households are beneficial as they reduce transaction costs and risk (Zhao and Peter 2014), thus increasing the demand for more credit to engage in investment activities. In addition, innovative forms of credit could be developed such as land-right mortgages and internet finance technologies. Prior research has demonstrated that farmland right mortgaging could be an important and effective tool with which to increase credit accessibility, since 2013 policies of farmland right reform involving transacting and mortgaging of farmland rights have been promulgated in rural China (Su and Kong 2018).

The impact of CCs on households' EV is partly mediated by health, trust, per capita financial assets and

Table 9 Results of Causal Mediation Mechanism of health, trust, per capita financial asset, and per capital income ($n=9\ 183$)

Group ¹⁾	Dependent variable ²⁾		Coef.	SE	Z	P> Z	[95% Conf. interval]
FCCs group	health	FCCs	−0.4992***	0.0735	−6.79	0.000	[−0.6432, −0.3552]
		others fixed	Yes	—	—	—	—
		resid1	0.3095***	0.0762	4.06	0.000	[0.1602, 0.4588]
	trust	constant	2.9766***	0.0602	49.42	0.000	[2.8585, 3.0946]
		FCCs	−0.6326***	0.0702	−9.01	0.000	[−0.7702, −0.4950]
		others fixed	Yes	—	—	—	—
	Inpfinance	resid1	0.5775***	0.0728	7.93	0.000	[0.4348, 0.7201]
		constant	3.6728***	0.0575	63.83	0.000	[3.5600, 3.7855]
		FCCs	−2.8558***	0.1965	−14.54	0.000	[−3.2409, −2.4707]
	Inpincome	others fixed	Yes	—	—	—	—
		resid1	2.3690***	0.2037	11.63	0.000	[1.9696, 2.7683]
		constant	9.0332***	0.1611	56.08	0.000	[8.7175, 9.3488]
	EV	FCCs	−0.3301***	0.0555	−5.95	0.000	[−0.4388, −0.2214]
		others fixed	Yes	—	—	—	—
		resid1	0.2415***	0.0575	4.20	0.000	[0.1288, 0.3542]
		constant	0.1342***	0.0455	2.95	0.003	[0.0451, 0.2233]
		health	−0.0978***	0.0072	−13.58	0.000	[−0.1120, −0.0837]
		trust	−0.0267***	0.0075	−3.57	0.000	[−0.0414, −0.0121]
		Inpfinance	−0.0134***	0.0027	−4.88	0.000	[−0.0187, −0.0080]
		Inpincome	−0.1425***	0.0098	−14.54	0.000	[−0.1617, −0.1233]
		FCCs	0.1025***	0.0152	6.75	0.000	[0.0727, 0.1322]
IFCCs group	health	others fixed	Yes	—	—	—	—
		constant	3.8080***	0.0562	67.71	0.000	[3.6978, 3.9183]
		IFCCs	−0.5441***	0.1034	−5.26	0.000	[−0.7469, −0.3414]
	trust	others fixed	Yes	—	—	—	—
		resid2	0.3691***	0.1046	3.53	0.000	[0.1641, 0.5741]
		constant	2.9654***	0.0609	48.72	0.000	[2.8461, 3.0848]
	Inpfinance	IFCCs	−0.5105***	0.0986	−5.18	0.000	[−0.7037, −0.3173]
		others fixed	Yes	—	—	—	—
		resid2	0.3053***	0.0997	3.06	0.002	[0.1100, 0.5007]
	Inpincome	constant	3.6311***	0.0580	62.60	0.000	[3.5174, 3.7448]
		IFCCs	−3.2290***	0.2775	−11.64	0.000	[−3.7729, −2.6852]
		others fixed	Yes	—	—	—	—
		resid2	2.7797***	0.2806	9.91	0.000	[2.2299, 3.3296]
		constant	8.9845***	0.1633	55.03	0.000	[8.6645, 9.3045]
		IFCCs	−0.4190***	0.0780	−5.37	0.000	[−0.5719, −0.2661]
	EV	others fixed	Yes	—	—	—	—
		resid2	0.3632***	0.0789	4.60	0.000	[0.2086, 0.5178]
		constant	0.1358***	0.0459	2.96	0.003	[0.0458, 0.2257]
		health	−0.0997***	0.0072	−13.85	0.000	[−0.1138, −0.0856]
		trust	−0.0259***	0.0075	−3.45	0.001	[−0.0406, −0.0112]
		Inpfinance	−0.0145***	0.0027	−5.29	0.000	[−0.0198, −0.0091]
		Inpincome	−0.1441***	0.0098	−14.70	0.000	[−0.1633, −0.1249]
		IFCCs	0.0921***	0.0172	5.36	0.000	[0.0584, 0.1258]
		others fixed	Yes	—	—	—	—
		constant	3.8250***	0.0563	67.93	0.000	[3.7146, 3.9353]

¹⁾ FCCs, formal credit constraints; IFCCs, informal credit constraints.

²⁾ EV, economic vulnerability.

***, $P<0.01$; **, $P<0.05$; *, $P<0.1$. Source: authors' own calculation based on CHIPs 2013 for rural samples.

per capita income. Huang (2013) and Fang and Zou (2013) have proven that health shocks are one of the most serious causes of poverty, especially in rural China. Many poor households lack reasonable treatment from the public health system (Xiao 2019). Policies that focus on improving credit could help households reduce their

EV through better health care and through increasing household income. Additionally, Li *et al.* (2007) and Yang *et al.* (2018) have demonstrated that inadequate financial assets are critical to the poor's EV. Policies that focus on improving financial literacy could also facilitate individuals to engage in the capital markets and increase

Table 10 Causal mediation effect of health, trust, per capita financial asset, and per capital income ($n=9\ 183$)

Group ¹⁾	Indirect effect	Coef.	SE	Z	P> Z	[95% Conf. interval]
FCCs group	health	0.0488***	0.0082	5.99	0.000	[0.0329, 0.0648]
	trust	0.0169***	0.0054	3.11	0.000	[0.0063, 0.0275]
	lnpfinance	0.0382***	0.0093	4.13	0.000	[0.0201, 0.0563]
	lnpincome	0.0470***	0.0083	5.64	0.000	[0.0307, 0.0634]
	total	0.1509***	0.0158	9.57	0.000	[0.1200, 0.1819]
IFCCs group	health	0.0543***	0.0109	4.99	0.000	[0.0330, 0.0756]
	trust	0.0132***	0.0049	2.71	0.007	[0.0037, 0.0227]
	lnpfinance	0.0467***	0.0114	4.11	0.000	[0.0245, 0.0690]
	lnpincome	0.0604***	0.0123	4.90	0.000	[0.0362, 0.0845]
	total	0.1746***	0.0209	8.33	0.000	[0.1335, 0.2157]

¹⁾FCCs, formal credit constraints; IFCCs, informal credit constraints.

***, $P<0.01$; **, $P<0.05$; *, $P<0.1$. Source: authors' own calculation based on CHIPs 2013 for rural samples.

their investment profits and thus stabilise their income, as financial literacy is one of the most important factors restricting credit access (Lusardi and Mitchell 2014; Lyons *et al.* 2017).

A higher level of education is highly useful in terms of reducing EV. Hence, policies that focus on fundamental education and training for improving the financial literacy of rural households would be useful as this would help with the ability to access credit and reduce liquidity constraints (see also Yang *et al.* 2012), thus facilitating sustainable development and increasing the households' ability to withstand shocks.

6. Conclusion

Using the cross-sectional data from the CHIPs 2013, this study examines the impact of both FCCs and IFCCs on the EV of rural households in China. Results indicated that both FCCs and IFCCs have a robust positive and significant impact on the EV of rural households in China, regardless of whether subjective or objective EV measurements are employed. Also, we observe that households with a married household head, a high level of education and a larger family size tend to have lower EV. In addition, the impact of CCs on households' EV is partly mediated by health, trust, per capita financial assets and per capita income. The mediating effects of health and per capita income explain the largest amount of the total CC impact. Policies targeted at improving credit accessibility would help to reduce the EV of rural households.

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Declaration of competing interest

The authors declare that they have no conflict of interest.

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