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Article

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Open Economics

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De Gruyter

Suggested Citation: Zhao, Jianmei (2021) : Formal credit constraint and prevalence of reciprocal loans in rural China, Open Economics, ISSN 2451-3458, De Gruyter, Warsaw, Vol. 4, Iss. 1, pp. 1-13,
<https://doi.org/10.1515/openec-2020-0110>

This Version is available at:

<https://hdl.handle.net/10419/236612>

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Research Article

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Formal Credit Constraint and Prevalence of Reciprocal Loans in Rural China

<https://doi.org/10.1515/openec-2020-0110>

received September 28, 2020; accepted February 10, 2021.

Abstract: The unique feature of the rural credit market in China is the dominance of zero collateral and zero-interest reciprocal lending and its long-term coexistence with the formal loan. This paper investigates the association between formal credit constraint and prevalence of reciprocal loans in rural China. Based on the identification of rural households' credit constraint status, we examine the effects of credit constraint on the utilization of informal reciprocal loans. We find that formal credit constraint significantly increases rural borrowers' reliance on reciprocal loans, whereas the "debt of gratitude" imposes an uncertain obligation on rural borrowers, and discourages them from borrowing amongst relatives and friends.

Keywords: credit constraint; reciprocal loan; debt of gratitude; sample selection.

JEL classification: Q12, O14, Q18.

1 Introduction

Despite the financial liberalization of rural credit markets in developing economies in recent decades, dichotomies among borrower segments and formal versus informal credit sources have continued as salient and puzzling features. The major explanations for the coexistence of informal and formal finance lie in two aspects. One is supply-side rationing by the lender. Government regulations, in the supply of formal finance, are often structured in a manner that fails to serve its intended clientele. In order to discourage informal lending as usurious, interest rate ceilings or subsidies are usually adopted as control measures in formal agencies (Tsai 2004). Nonetheless, since less wealthy households are riskier and lending to them is not profitable at rates below the ceiling, those who are involuntarily excluded from the formal credit market have had to resort to informal finance (Jappelli and Pistaferri 2010; Tsai 2004).

Another type of credit constraint arises from the borrower's side. Informal loans, in particular reciprocal loans from friends or relatives without interest charges, may be cheaper than formal loans and thus preferred by borrowers (Kochar 1997; Cull et al. 2019). The collateral requirements or screening processes involved in the formal loan application help lenders to overcome asymmetric information, whereas the complex process may induce potential borrowers to waive such an application (Barham, Boucher and Carter 1996; Hou, Hsueh and Zhang 2020). Informal loans may also be preferred because of risk considerations. Risk-averse borrowers may give up formal loans because of the contractual risk (rigidity in terms) implied in the formal contract and voluntarily resort to informal finance with flexible contract terms (Boucher, Carter, and Guirking 2008). In addition, relative to formal loans, most rural borrowers obtain informal loans much more easily due to their smaller size and the friendship between the borrower and lender.

Credit constraint influences households' decision-making extensively in rural China. Existing literature documents that credit constraint affects rural consumption (Li, Lin and Gan 2016), production efficiency (Zhao and Barry 2014), energy usage (Zhang, Li and Ji 2020), and even social stability (Braggion, Manconi and Zhu 2016). Will various types of credit constraint affect rural informal financing choices? The objectives of this study are: to empirically identify

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different types of credit constraint from formal financial institutions; to test whether this credit constraint significantly affects rural households' utilization of informal reciprocal loans in the context of China; and to consider policy implications for improving market performance. Identifying the key factors that result in informal finance's persistence will assist in alleviating imperfections in rural finance markets, revising credit policies, and perhaps institutionalizing the advantageous features of informal finance.

This paper differs from previous literature by examining the association between formal credit constraint and reciprocal loans with zero collateral and zero interest in rural China. Unlike countries such as India (Bell 1993; Tsai 2004), Peru (Guirkinger 2008), Thailand (Giné 2011), and Ghana (Karlán, et al. 2014), where moneylenders provide the majority of informal loans with no collateral requirements, but higher interest charges than formal loans, the dominant informal loans in China are the reciprocal loans that entail neither interest payments nor a collateral requirement. Although the use of these seemingly cheaper informal loans involves non-pecuniary costs, they do create implicit costs through the “debt of gratitude”, which obligates the borrower to provide future benefits to the lender (even though the borrower is uncertain about the exact form of the benefits). On the other hand, various types of credit constraint involved in the formal loans also add invisible costs to the explicit interest charges. The rural borrowers balance between the non-pecuniary costs of “debt of gratitude” and comprehensive costs (composed of formal interest charges and invisible cost implied in the credit constraint) and choose the most “economical” one for their external financing needs.

Based on the identification of various types of credit constraint, we first apply a multinomial logit (MNL) model to evaluate the effects of credit constraint on the financing choices among rural households that have borrowed externally. To further consider the sample selection issue resulting from rural households' decisions on whether to use external debt, we specify a multinomial probit model with sample selection (MNPSS) by integrating rural households' external financing decisions into their final financing choice decisions. Empirical evidence shows that the transaction cost constraint and risk constraint induce rural borrowers' usage of informal reciprocal loans; the quantity constraint drives not only rural borrowers' use of reciprocal loans, but also increases rural borrowers' reliance on mixed loans.

The remainder of the paper is organized as follows. Section 2 introduces the dichotomous rural financial market in China. Section 3 describes the rural finance survey data and illustrates the identification of formal credit constraint experienced by rural borrowers. Section 4 employs both an MNL model and an MNLSS model to evaluate the impacts of credit constraint on the multiple financing outcomes. Section 5 concludes and presents policy implications.

2 The dichotomous rural credit market in China

Rural financial markets in China are fragmented in the sense that formal and informal reciprocal loans are observed to be systematically sorted across different lending resources and contract terms according to their distinguishing features.

Formal financial institutions mainly consist of: the Agricultural Development Bank of China, which is responsible for the design of rural policies; Rural Credit Cooperatives (RCCs), the main credit providers to farmers; and the Agricultural Bank of China. In a recent policy initiative, postal savings banks have also begun to provide rural credit to local farmers. These sources have primarily mobilized credit and reduced transaction costs for eligible, established family farms.

The use of formal loan in China is based on legal contracts between the financial institutions and borrowers. The formal loans are exclusively based on production purpose, with the loan application involving not only the necessary paperwork, but also the time duration for the application to be accepted or rejected. The chances for borrowers to obtain the loan rely on multiple uncertainties, such as the financial strength of the applicant, financial policy orientation, and bureaucratic judgements from formal lenders. The maturity of the formal loan is normally over one year. For formal loans, borrowers are required to provide a third-party guarantee or collateral to secure the loan payment. The collaterals are mostly private housing with its value discounted by 70% to protect the formal financial institutions from loan loss (People's Bank of China 2010). When borrowers cannot make timely debt payments, the negotiation space is limited, and further payment delays result in court intervention. Under these conditions, it is logical to expect larger, more commercially-oriented borrowers to be customers of formal lenders.

In parallel with the supply of formal finance, informal lending with interest charges in China is often considered illegal (Guo and Jia 2009). Microcredit provided by some international agencies or NGOs mainly serves poverty-

driven areas. In contrast to the importance of input suppliers as informal credit sources in other countries (Guirkinger 2008; Giné 2011), reciprocal borrowing among friends and relatives with zero interest and zero collateral dominates the informal rural credit market in China (Kumar, Turvey, and Kropp 2013). Jia, Heidhues, and Zeller (2010) find that informal lending accounts for 74.05% of total loans and that more than 97% of informal loans are borrowed amongst friends. These levels are consistent with our survey in this paper that two-thirds of loans are from informal sources, with reciprocal loans accounting for about 94% of those.

Unlike the official procedures in formal financing in China, reciprocal loans amongst friends offer flexibility with few transaction costs. With both borrowing and lending individuals living in the local environment for their whole lives, the updating “reputation” mechanism in rural areas helps an informal creditor to determine whether to issue loans to the borrower, depending on the borrower’s financial strength, credibility, entrepreneurial ability, and available credit history. Previous reciprocal loan experience creates a ‘memory’ in the sense that borrowers with good realizations will be rewarded by easier access to future credit, while delinquent behavior without any compensation to the creditor would be punished by financial isolation and social criticism in the surrounding community. Similar to other developing countries, this “reputation” system works as an effective supervisory and enforcement mechanism for reciprocal loans amongst relatives and friends (Conning and Udry 2007). Therefore, most reciprocal borrowing amongst friends is based on oral commitments. Occasionally, the lender requires an IOU from the borrower without any legal proof. The contents of those IOUs clarify the borrower’s name, borrowing amounts, and the date when the money was borrowed.

Besides the zero-interest rate and open-ended maturity of informal borrowing, another salient feature of informal loans among friends and relatives in China is their reciprocal nature. Although the reciprocal loans only repay the principle and entail no interest payments, they do generate a “debt of gratitude” on the part of the borrower, which obligates the borrower, in the future, to provide additional benefits to the lender. The borrower may be uncertain about the exact form of further benefits offered to the lender, but such additional benefits are critical and impose an “economic burden¹” on the borrower. As a result, the borrower may be discouraged from using interest-free loans from friends.

Reciprocal loans usually occur among mutually acquainted parties in the neighbourhood. Rural households prefer to borrow from those from whom they have borrowed in the past. At some time in the future, the borrower and lender normally switch their positions with bilateral benefits offered to each other. For those without informal loan experience, rural households prefer to borrow from their closest relationships with the necessary financial capacity. Even if the borrower cannot offer similar benefits, he may compensate the lender through “generalized reciprocity”, e.g., the provision of free labor or other services to the lender².

Despite the dichotomous characteristics in the rural credit market, there are still some households that borrow from a mix of both formal and informal financial sources simultaneously. The most likely reason for the mixed financing is an insufficient loan from the borrower’s first financing choice (which could be either a formal financial institution or an informal financial source). In order to implement their investment, rural households have to resort to their second-best financing choice (informal or formal) to fill the gap of their financial requirements, even though the second-best financing alternative is less preferred. In both cases, the formal and informal loans work together to satisfy the household’s external financing needs. As a consequence, external financing channels include not only the exclusive use of formal loans or exclusive reciprocal loans amongst friends, but also the combination of the two.

3 Research data and recognition of credit constraint

To empirically examine how credit constraint affects rural households’ financing decisions, we require survey data with comprehensive financing information that enable us to identify various types of credit constraint in rural China, such as quantity constraint, transaction cost constraint, and risk constraint (Zhao and Barry 2014).

¹ Such a burden is equivalent to implicit financing costs.

² The reason why people offer such generous financial help to the borrower is that they expect to become recipients in the future, although the exact time and extent of the “repayment” may not be known at the date of the transaction.

3.1 The rural finance survey data

Detailed survey data on types of credit constraint in rural China are rare. The only rural finance data that enable us to accomplish this study date back to the large-scale rural finance survey sponsored by the Hong Kong and Shanghai Banking Corporation Limited (HSBC), and organized by the HSBC-Tsinghua rural finance research team. The sampling method used in the survey was stratified random sampling that covered 16 provinces, 72 counties, and 440 villages in rural China. The survey was carried out in two years. In 2007, surveyed provinces included Anhui, Henan, Heilongjiang, Hubei, Hunan, Jilin, Jiangxi, and Shanxi. In 2008, another four provinces, Liaoning, Inner Mongolia, Shandong, and Shaanxi were covered, total sample size is 2,300.

To better understand the reasons for their use of different types of financing sources, the research team designed detailed credit modules to capture information on household loans that were outstanding at some point during the year. The necessity of including comprehensive information on households' financing decisions, as well as detailed production costs, left us with 1,236 valid household observations.

3.2 Recognition of formal credit constraint

To identify whether rural households experience formal credit constraint, we adopt a direct elicitation method that is widely used (Petrick 2005; Boucher, et al. 2009; Ali, et al. 2014), and recognized as a reliable approach to capture different types of credit constraint status (Gilligan, et al. 2005). This method involves a set of qualitative questions presented to the households. These questions accommodate rural households' production plans, capital requirements, and reasons for their final financing choices.

We assume that rural households are profit maximizers. Each year, they either maintain a self-financing conservative investment (yielding reservation revenue), or expand their production scale (given the expected return is greater than the reservation revenue) through the aid of external financing. The series of questions about the household financing process and recognition of different types of credit constraint are presented in Figure 1.

To justify whether a household is credit constraint, we must first consider its demand for external credit. Lack of profitable projects (NR1) or sufficient internal capital (NR2) indicate non- constraint cases. Once the external funding is needed, the household balances the explicit monetary interest payments in formal finance with the zero interest but non-specific cost of "debt of gratitude" found in reciprocal loans.

"Debt of gratitude" is not zero costs. It is a kind of economic burden that entails either non-pecuniary or monetary costs in the future. There are multiple ways to repay the "debt of gratitude". For example, households that borrow from relatives or friends are obligated to provide similar informal loans to current informal lenders once those informal lenders require external finance in the future. Or the borrower households provide free labor service or free utilization of agricultural machinery to the informal lenders in return. Ignoring the repayment of "debt of gratitude" would be punished by social isolation in the rural community. In this paper, "Debt of gratitude" is a binary variable generated from the question: "The reason you did not apply the formal loan is that "debt of gratitude" is more expensive than the formal loan?". It equals 1 if the answer is "Yes", 0 otherwise.

Given the same amount of expected income, the household chooses the most "economical" one as its first financing choice. If the non-specific cost of "debt of gratitude" is seen to be less than the explicit cost of interest payments, the household considers the reciprocal loan cheaper and will automatically waive the formal finance (NR3). Otherwise, the rural borrower resorts to formal finance and gets his loan request fully funded (NR4). In both cases, the household is not a credit constraint.

Under the condition that the household first resorts to formal finance, it is possible that it experiences quantity constraint, either because it is rejected by formal lenders (QC1) or because the credit granted is less than the requested amount (QC2)³. Sometimes, even though the formal finance is considered cheaper, households will not apply due to the transaction costs or potential risks involved in the loans. Transaction cost constraint occurs when rural households

³ Quantity constraint has been emphasized in both the theoretical and the empirical literature. It arises when a borrower's effective demand exceeds the supply of credit.

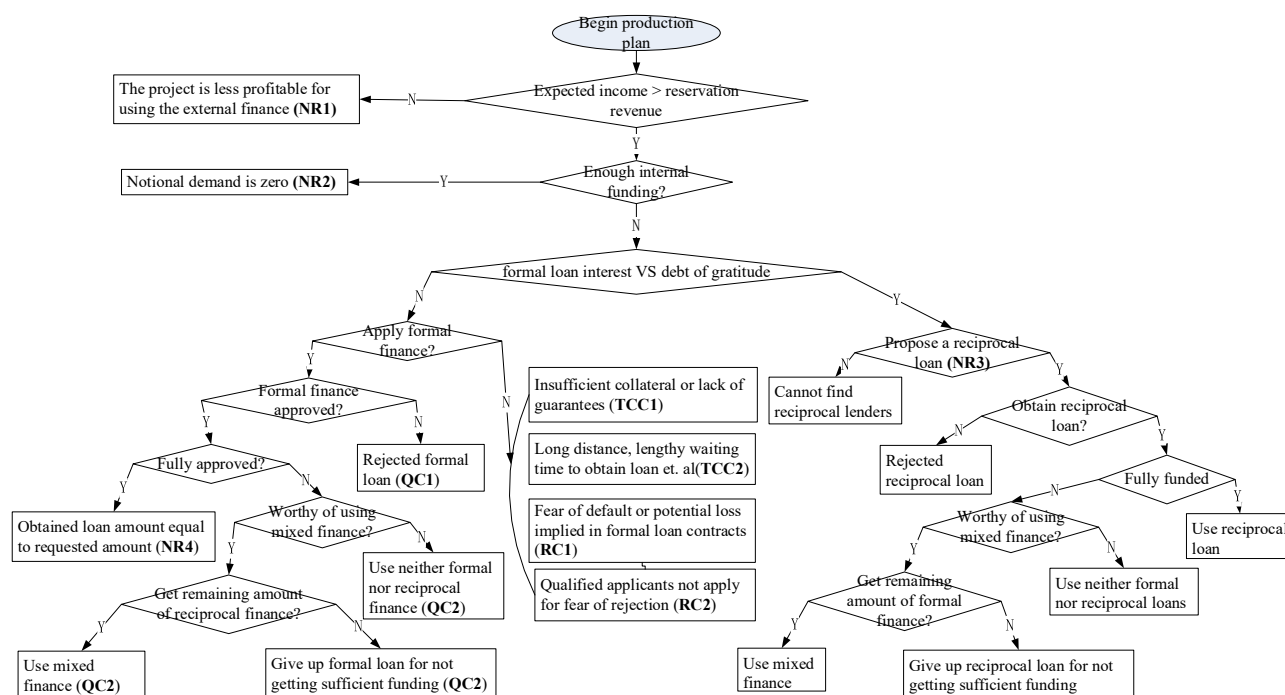


Figure 1: Recognition of formal credit constraint through the direct elicitation method.

Notes: Quantity constraint (QC) includes QC1 and QC2; Transaction cost Constraint (TCC) includes TCC1 and TCC2; Risk constraint (RC) includes RC1 and RC2.

waive a formal loan because of the strict collateral requirements⁴ (TCC1), long distances to financial institutions, tedious paperwork involved in the process of the formal loan application, bureaucratic procedures, and the lengthy waiting time to get loans approved (TCC2). All of these make the acquisition of a formal loan too costly.

In contrast to the transaction cost constraint, risk constraint is less straightforward. In the absence of insurance markets, risk constraint can arise from borrowers' excessive concern about their debt repayment capacity or the potential risks involved in formal credit contracts. When formal lenders, constrained by asymmetric information, shift so much contractual risk to the borrower, the borrower may voluntarily withdraw from the formal credit market, even though he is capable of providing the collateral to qualify for the loan contract (RC1). In addition, risk constraint behavior could also result from "discouraged borrowers" as discussed by Kon and Storey (2003). These borrowers are qualified applicants that require finance, but choose not to apply because they feel their applications will be rejected (RC2) given the stringent conditions of formal loans.

The above-mentioned credit constraint, though formed in different ways, uniformly adds invisible costs to the nominal interest payments on formal loans. As a consequence, the financing cost from formal loans is viewed as a comprehensive cost that is composed not only of interest charges, but also of the implied invisible costs from various types of credit constraint.

In addition to the finance information, the rural finance survey includes information on household demographics (the age and gender of the household's head and family size), household production, consumption, livings, and loan conditions. Credit market participation and credit constraint status for the sample households are presented in Table 1.

While the absolute percentages of rural credit market participation may differ between the two years of 2007 and 2008, the relational patterns are similar. Considering the year 2007, about 28.09% of the respondents used no loan. Among those borrowing, the use of informal loans predominated (43.45% versus 18.54% for formal loans and 9.93% for a mixture). Formal loans were primarily from Rural Credit Cooperatives (86.36%), while reciprocal loans amongst friends

⁴ Or group guarantee.

Table1. Credit market participation and different types of formal credit rationing for sample households.

Various loan sources:	Year 2007		Year 2008	
	Frequency	Percentage	Frequency	Percentage
Households use formal loans only	99	18.539	107	17.147
Households use informal loans only	232	43.446	241	38.622
Households use mixed finance(both formal and informal loans)	53	9.925	47	7.532
Households use no loans	150	28.090	229	36.699
Formal finance:		100		100
Loan from banks	21	13.636	18	11.392
Loan from Rural Credit Cooperatives	133	86.364	140	88.608
Informal finance:		100		100.00
Loan from friends and relatives	267	94.014	253	86.644
Other informal finance sources	17	5.986	39	13.356
Yeah.Types of credit constraint:		100		100
Non-credit constraint (NR= 1)	260	47.706	320	50.314
Quantity constraint (QC =1)	202	37.064	249	39.151
Transaction cost constraint (TCC =1)	32	5.872	18	2.830
Risk constraint (RC=1)	51	9.358	49	7.704

dominated the informal loans in the survey (94.01%). About half of the borrowers experienced credit constraints, while quantity constraint (37.06%) exceeded risk constraint (9.36%) and transaction cost constraint (5.87%).

Grouped by different types of financing patterns (formal loans, reciprocal loans, and mixed financing), rural households' awareness of "debt of gratitude", and recognition of credit constraint, as well as households' demographic characteristics and production situations, are reported in Table 2.

Across these groups, the households' awareness of "debt of gratitude" combined with different types of credit constraint yield corresponding financing patterns. Gender, education, family size, and age exhibit relatively high consistency. The other variables differ sharply across the groups. Household assets, income, farmland, and production costs are each considerably larger, on average, for households that borrow from formal sources. These relationships suggest the credit markets largely serve different types of borrowers, as the econometric analysis will address.

4 Empirical model

The purpose of this paper is to empirically investigate the effects of different types of formal credit constraint on rural households' final financing choices. In particular, we examine whether identified quantity constraint (QC), transaction cost constraint (TCC), and risk constraint (RC) have statistically and economically significant effects on the use of reciprocal loans by private households, *ceteris paribus*, therefore resulting in the coexistence of formal and informal reciprocal loans in rural China. In this part, we first apply a multinomial logit model (MNL) to evaluate the impact of various types of credit constraint on rural financing choices. Since household financing decision is based on external financing requirement, we integrate the external financing demand into the MNL model with the consideration of sample selection issue.

Table 2: Definition and summary statistics of explanatory variables.

Variable	Definition	Overall sample		Use formal finance only		Use informal finance only		Use mixed finance	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gratitude	Dummies representing debt of gratitude if the household uses reciprocal loans	0.031	0.173	0.044	0.205	0.021	0.144	0.01	0.1
QC	Dummies of quantity constraint	0.365	0.482	0.461	0.5	0.598	0.491	0.67	0.473
TCC	Dummies of transaction cost constraint	0.04	0.197	0.019	0.138	0.04	0.197	0.02	0.141
RC	Dummies of risk constraint	0.081	0.273	0.029	0.169	0.087	0.282	0.09	0.288
Gender	Gender of household head (Female=1)	0.075	0.264	0.068	0.252	0.078	0.269	0.12	0.327
Education	Schooling years of household head	7.651	3.283	8.243	2.813	7.144	3.428	8.27	3.081
Age	Age of household head	47.608	10.802	45.767	9.825	47.873	10.556	45.9	9.872
Family size	The number of family members	4.29	1.545	4.248	1.281	4.463	1.707	4.38	1.245
HHAssets	Farm production assets (10,000)	6.776	37.146	13.604	47.412	3.163	14.681	4.531	7.13
HHIncome	Annual household income (10,000)	4.602	14.727	8.478	21.245	2.956	6.61	4.832	8.238
Farmland	Farmland in tillable acres (mu)	26.867	56.129	53.563	72.96	15.529	37.038	31.19	60.005
Productioncost	Variable production costs (10,000)	3.351	16.818	6.267	21.554	2.411	12.518	4.066	14.271
Obs.	Number of observations	1236		206		473		100	

4.1 Multinomial logit model (MNL)

Our main hypothesis is that various types of credit constraint should positively affect the household's usage of reciprocal loans, whereas the "debt of gratitude" may discourage the household from borrowing amongst friends, even though the use of reciprocal loans entails zero interest expenditure. To test the above hypothesis, we model the probability of observing a certain financing mode as a function of credit constraint conditions, the "debt of gratitude", and a set of socioeconomic variables that are considered to be important determinants of financing behavior. The simple MNL regression is specified as follows.

For the case of J financial outcomes, where $J = 1, 2, 3$ represents the usage of formal loans, informal reciprocal loans, and mixed loans from formal and informal sources. Considering the use of formal loans as the benchmark, the probability of observing a particular financing pattern, $P(Y_j)$, is:

$$P(Y_j) = \frac{\exp(X'\beta_j)}{\sum_{n=1}^J \exp(X'\beta_n)} \quad n = 1, 2, \dots, J, j = 1, 2, \dots, J, j \neq n \quad (1)$$

$X'\beta_j$ is a series of explanatory variables and their corresponding coefficients⁵. Our interests lie in the credit constraint variables of quantity constraint (QC), transaction cost constraint (TCC), and risk constraint (RC). A range of control variables includes: the gender, age, age squared, and education of the household's head. At the household level, we control family size, household income, household assets, and household production costs. We also include province dummies (12 provinces) to control the region fixed effects. Table 3 reports the MNL regression results for households that have borrowed externally.

The estimates in Table 3 show that rural households that experience formal quantity constraint (QC), transaction cost constraint (TCC), and risk constraint (RC) increase their chances of using reciprocal loans and mixed loans relative

⁵ $X'\beta_j = \beta_0 + \beta_1 \text{Gratitude} + \beta_2 \text{QC} + \beta_3 \text{TCC} + \beta_4 \text{RC} + \beta_5 \text{Gender} + \beta_6 \text{Education} + \beta_7 \text{Age} + \beta_8 \text{Age}^2 + \beta_9 \text{FamilySize} + \beta_{10} \text{HHAssets} + \beta_{11} \text{HHIncome} + \beta_{12} \text{Productioncosts} + \sum \gamma_k \text{Province}_k$

Table 3: MNL regression.

	Reciprocal/formal	Mixed/formal
Gratitude	-0.752*** (0.003)	-1.115*** (0.001)
QC	0.505*** (0.145)	1.069*** (0.062)
TCC	1.031*** (0.006)	0.631*** (0.003)
RC	1.768*** (0.002)	1.842*** (0.002)
Gender	0.054*** (0.005)	0.518*** (0.003)
Education	-0.085*** (0.031)	0.023 (0.045)
Age	-0.078*** (0.020)	-0.069** (0.029)
Age2	0.001*** (0.0003)	0.001* (0.0004)
FamilySize	0.149** (0.065)	0.090 (0.092)
HHAssets	-0.039*** (0.010)	-0.029*** (0.011)
HHIncome	-0.097*** (0.025)	-0.051** (0.024)
Productioncosts	0.068*** (0.022)	0.057** (0.023)
Province dummies	Yes	Yes
Constant	2.488*** (0.002)	-0.271*** (0.001)
Observations	1236	

Notes: *p<0.1, **p<0.05, ***p<0.01. Standard deviations are in the parenthesis.

to those that exclusively use formal loans. On the contrary, the uncertain obligation implied in the “debt of gratitude” prevents rural households from using reciprocal loans and mixed loans.

Control variables also yield reasonable signs. Households headed by a female are more likely to use reciprocal loans and mixed finance. Better educated households have a smaller chance of using reciprocal loans. As expected, we find a U-shaped relationship between age and reciprocal and mixed finance patterns, implying that relative to middle-aged households, younger and older households are more likely to depend on informal reciprocal loans. Households with a larger family size prefer reciprocal loans over formal loans. In addition, households with greater production

costs increase their chances of using reciprocal and mixed loans, whereas wealthier households with greater assets and household income are less likely to use reciprocal and mixed loans.

4.2 Multinomial probit model with sample selection (MNPSS)

Among the households who have used external finance, the MNL regression reveals that formal credit constraint significantly increases the likelihood of households' utilization of informal reciprocal loans and mixed loans. Nonetheless, one may challenge the issue of ignorance of sample selection in the MNL model. Since the external financing decision is a prerequisite of the household's final financing choice, integrating households' external financing decisions into their final financing choices deserves consideration. In addition, the validity of MNL estimates could also be questioned due to its reliance on the independence of irrelevant alternatives (IIA) assumption⁶. In order to address the above challenges, we specify a multinomial probit model with sample selection (MNPSS) to further check the effects of credit constraint on households' financing decisions. The advantage of the MNPSS model is that it not only incorporates the household's external financing decision in the whole financing process but it is also free of IIA assumption in the estimation.

After the determination of the production plan, the household first determines whether it will borrow externally, then - conditional on its external financing decision - the household chooses the financing source ($Y_i = (Y_i^S, Y_i^O)$), that maximizes its utilities ($U_i = (U_i^S, U_i^O)$), e.g., to minimize the financing cost. It is convenient to think of U_i as being partitioned into two blocks. One block is the utility for the household's decision to borrow externally, relative to the base category of not taking external debt ($Y_i^S = 0$). The other block relates to the utilization of reciprocal finance or mixed finance ($Y_i^O = 2$ or 3), relative to the base category of formal finance ($Y_i^O = 1$), and conditional on the use of debt ($Y_i^S = 1$). If all elements of a particular block of U_i are negative, then the farm household will choose the base category. Otherwise, the household chooses the category with the largest utility. The connection between the household utility U_i and the observed financing behavior Y_i can be formulated as:

$$\begin{aligned} Y_i^S &= \begin{cases} \operatorname{argmax}_{k_1 \in \{0,1\}} U_i^S & \text{if } \max_{k_1 \in \{0,1\}} U_{k_1}^S > 0 \\ 0 & \text{otherwise} \end{cases} \\ Y_i^O &= \begin{cases} \operatorname{argmax}_{k_2 \in \{1,2,3\}} U_i^{Y_i^S} & \text{if } \max_{k_2 \in \{1,2,3\}} U_{k_2}^{Y_i^S} > 0 \\ 0 & \text{otherwise} \end{cases} \end{aligned} \quad (2)$$

Y_i^S represents the observed credit access in the selection equation, and Y_i^O indicates the household's financing sources in the outcome equation, given its decision to take external debt. Next, we assume that each household's utility is linear in observed covariates up to an additive normal error:

$$U_i = X_i \beta + \varepsilon_i, \text{ with } \varepsilon_i \sim N(0, \Sigma) \quad (3)$$

Where X_i is covariate matrix (with intercept terms), and β is a vector of regression parameters. The determinants that affect both credit access and financing sources are similar to the above MNL model, except that we add two more variables, farmland acres and 2008 year dummy, to satisfy the condition of exclusion restriction.

The estimation of the MNPSS model is a challenge. Available applications of the MNP model use maximum likelihood estimation, relying on asymptotic normality in making inferences about the error variance and covariance parameters. However, asymptotic approximation results in the convergence problem during the maximum likelihood optimization process⁷. Following Munkin and Trivedi (2003), we solved the convergence problem by using the Bayesian approach based on data augmentation, wherein the latent U_i are treated as unknown parameters, and the parameter space is augmented with the latent U_i . McCulloch and Rossi (1994) argue that the Bayesian approach based on the Gibbs

⁶ IIA implies that the ratio of selection probabilities for two outcome categories can depend on the characteristics of another category.

⁷ We also suffer the convergence problem by using the maximum likelihood estimation.

sampling is appropriate for the relatively small dataset available to our household survey. In this paper, our model is fit through Markov chain Monte Carlo (MCMC) simulation, using Gibbs sampling algorithm, rather than being analytically integrated.

In Bayesian computation, MNP models are not identifiable unless the covariance matrix (Σ) is restricted⁸. Imai and van Dyk (2005) solve this identification problem by requiring the (1,1) element of Σ to be fixed at unity. Besides the computational complexity of MNP models, our model involves the sample selection issue. Therefore, exclusion restriction variables should be introduced to ensure a more robust identification of causal parameters (Bhattacharya, Goldman, and McCaffrey 2006; Heckman 2000;). As a result, we introduce two more variables, farmland acres and 2008 year dummy, in the selection equation to satisfy the exclusion restriction. These two variables influence rural households' borrowing decisions but are unrelated to their financing outcomes.

In China, rural households obtain their farmland through the village allocation. The amount of farmland assigned to a farm family is based on the number of family members with rural *Hukou*⁹. Farmland acres do not affect the household financing source decision. Nonetheless, operating on more farmland implies the greater use of seasonal production inputs, which necessitates increased outside financing, meaning that more farmland may increase debt use.

In addition, the 2008 year dummy is also introduced as an exclusion-restriction variable because, in 2008, the effects of the global financial crisis passed through to China's export-dependent economy. The economic shock halted production in factories across China, leading to large unemployment in the rural migrant labor force (Huang et al. 2011). The sudden unexpected loss of wage income and the return of the unemployed labor force-induced rural financing demand (either formal or reciprocal) to survive the crisis. On the other side, the Chinese government took rapid countermeasures to mitigate the impact of the global financial crisis. Based on its strong fiscal position, China adopted a combination of an active fiscal policy and a loose monetary policy by introducing an RMB 4 trillion (\$580 billion) stimulus package in 2008. Those efforts prompted a surge in bank lending funneled into the nation's stock and property market while remaining stable lending to the real economic activities. As a result, although the 2008 financial crisis fairly affected the financial demand of rural residents, its impact on the lending policy of financial institutions was quite limited (Chan 2010; Huang 2010; Li, Willett and Zhang 2012).

Table 4 reports the posterior means and 95% Bayesian credible intervals of the parameters in our MNPSS model. Results from the selection equation indicate that better education and higher levels of income are significantly associated, at the level of 95%, with negative signs, indicating a lower tendency to borrow as education and income reach higher levels. Alternatively, rural households with larger families, higher production costs, and more land bases are more likely to borrow externally.

In line with the MNL regression presented in Table 3, MNPSS estimates provide similar results on the effects of formal credit constraint on the use of reciprocal loans, but the MNPSS estimates deny the effects of transaction constraint and risk constraint on the utilization of mixed finance. Meanwhile, the significance of the "debt of gratitude" variable disappears. Coefficients in outcome Eq.1, Table 4, indicate that, *ceteris paribus*, rural households experiencing formal quantity constraint, transaction constraint, and risk constraint increase their likelihood of using reciprocal loans relative to formal finance, whereas the "debt of gratitude" significantly discourages the households' utilization of reciprocal loans. In outcome Eq.2, the quantity constraint still positively affects rural households' reliance on mixed finance. The effects of transaction cost constraint and risk constraint on the mixed loans are not significant.

By integrating rural households' external financing decisions into their final financial choice decisions, the estimates from the MNPSS seem more reasonable. It suggests that an imposed limit on the amount of credit from formal institutions either induces rural households to rely exclusively on informal reciprocal loans, or triggers some constrained borrowers to turn to the informal sector for additional credit. The transaction cost constraint and risk constraint affect the households' utilization of reciprocal loans, but have no effect on the usage of mixed loans.

Summarizing, the estimates from both the MNL and the MNPSS models demonstrate that various types of formal credit constraint increase a household's likelihood of using reciprocal loans. In contrast, the awareness of the "debt of gratitude" discourages rural families from using reciprocal loans. In addition, quantity constraint induces the

⁸ The trace restriction is necessary because we only observe the index of the maximum of the latent utilities that define the model.

⁹ *Hukou* refers to the household registration system in mainland China. The *Hukou* system normally divides family members into urban versus rural types. Only household members registered as rural *Hukou* are allocated farmland.

Table 4: Posterior means and 95% Bayesian credible intervals for the parameters of the MNPSS.

	SelectEq. (Borrow=1)	OutcomeEq.1 (Reciprocal/formal)	OutcomeEq.2 (Mixed/formal)
Gratitude	-0.182 (0.208)	-0.223** (0.228)	-0.435 (0.621)
QC	-	0.073** (0.062)	0.447** (0.168)
TCC	-	0.212** (0.199)	-0.040 (0.497)
RC	-	0.214** (0.192)	0.350 (0.305)
Gender	0.131 (0.141)	0.038 (0.099)	0.256 (0.265)
Education	-0.026** (0.012)	-0.023** (0.018)	0.050** (0.027)
Age	0.030 (0.022)	-0.002 (0.017)	-0.023 (0.050)
Age ²	0.000 (0.000)	0.000 (0.000)	0.000 (0.001)
Family size	0.077 (0.025)	0.047** (0.035)	-0.019 (0.064)
HHAssets	-0.002 (0.002)	-0.006** (0.004)	-0.009 (0.005)
HHIncome	-0.011** (0.006)	-0.022** (0.015)	-0.006 (0.013)
Productioncosts	0.014** (0.005)	0.017** (0.011)	0.011 (0.012)
Land acres	0.002** (0.001)	-	-
year 2008	-0.116** (0.063)	-	-
Province dummies	Yes	Yes	Yes
Constant	-0.320 (0.550)	0.002 (0.422)	-0.862 (1.375)
Observations	1236		

Notes: The significant estimates are highlighted in bold (inclusion of zero values within the 95% Bayesian credible intervals implies the insignificance of the estimates).

household to use both reciprocal loans and mixed loans, whereas transaction cost constraint and risk constraint only impose significant effects on the usage of reciprocal loans, but not on mixed loans.

5 Conclusion and policy implications

A worthwhile question is why formal and informal finance persistently coexist in developing countries. This article investigates the association between various types of formal credit constraint and the widely observed zero cost, zero collateral reciprocal loans in rural China. We implicitly incorporate different types of credit constraint into the household's financing costs from formal finance and evaluate the potential costs from the "debt of gratitude" in informal reciprocal borrowing. Given the same amount of expected income, rural households' final financing outcomes hinge on the comparison between the comprehensive costs (nominal interests and the invisible cost from different types of credit constraint) in the formal loans, and the implicit cost through the "debt of gratitude" in the reciprocal loans.

Based on the empirical identification of rural households' credit constraint status in our rural finance survey, we apply both the MNL and the MNPSS models to test the impact of formal credit constraint on rural borrowers' final financing outcomes. Empirical findings from rural China provide microeconomic evidence that formal credit constraint significantly constrains the use of formal loans, and results in the prevalence of informal reciprocal loans.

The evidence in this article yields several useful policy insights. First, informal reciprocal finance continues to play an important role in rural China, because of the weaker financial positions of some borrowers and because of formal financial institutions' inability to meet the credit demand from rural areas. Increasing the availability of formal credit could improve credit market efficiency through the reduction of quantity constraint, but not necessarily in favour of smaller, less wealthy, and more risk-averse borrowers. This is because, besides quantity constraint, poor households also suffer self-imposed risk constraint, meaning that merely increasing the formal credit supply may not reach the targeted population in rural China.

Our findings also influence the design of credit policies aimed at improving the functioning of the rural credit market, and innovative efforts should be implemented in financial institutions to meet the capital demand for diverse rural borrowers. For example, formal sectors should seek to better respond to the demand from households for exactly the loan attributes that the reciprocal loans seem to offer, such as low transaction costs or a rapid decision on loan approval. Faced with the importance of risk constraint, the comprehensive reform of agricultural credit markets in China requires the innovation of instruments that directly reduce risk. Current efforts to promote weather insurance and underwrite an agricultural economy in which markets work for both large- and small-scale producers may resolve this problem.

Financial Support: This research received no specific grant from any funding agency, commercial or nonprofit sectors.

Conflict of Interests Statement: The author has no conflicts of interest to disclose.

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