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Access to credit and farmland rental market participation: Evidence from rural China

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ABSTRACT

In this study, we analyze the impact of access to credit on farmland rental market participation of rural households. The study uses a nationally representative survey data of China Family Panel Studies and an endogenous switching probit model that accounts for selection bias for both observed and unobserved factors. Findings reveal that access to credit stimulates farmers' decisions to participate in farmland rental markets by increasing the likelihood of renting in and renting out farmland by about 10% and 20%, respectively. Results also reveal that the impact of access to credit on farmland rental market participation is heterogeneous when it comes to the age of the operator and and geographic locations of farmers. We show that younger credit users have a higher probability of renting in farmland, while their older counterparts have a higher probability of renting out farmland. Besides, credit users residing in central China have a higher probability of renting in farmland, while those living in eastern China have a higher likelihood of renting out farmland. Our findings highlight the importance of improving farmers' access to credit in facilitating the development of rural farmland rental markets.

1. Introduction

Efficient land use has long been considered an important strategy to help increase land productivity and rural incomes (Deininger, Ali, & Alemu, 2013; Li, Li, Lv, & Zhu, 2019; Yu, Zhou, & Yang, 2019; Yuan et al., 2018). However, land-use efficiency is globally challenged by several interesting trends, such as population aging and rural-to-urban migration. It is estimated that about 25% of the U.S. farmers will retire in the next two decades, and as a result, 70% of the private agricultural land needs to be transferred (Plotkin & Hassanein, 2017). In China, the number of people who migrate from rural to urban regions has increased from approximately 221.82 million in 2015 to 288.36 million in 2018, which has resulted in a labour shortage issue in agricultural production (NBSC, 2019). Besides, land fragmentation also negatively affects land-use efficiency because it is a barrier of agricultural modernization and mechanization (Al, Rahman, & Hossain, 2016; Ciaian, Guri, Drabik, & Paloma, 2018; Rahman & Rahman, 2008). Therefore, from a perspective of sustainable agricultural development, it is of great importance to improve land-use efficiency.

Promoting farmland rental in rural areas could benefit smallholders in China. For example, renting in farmland has the potential

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to improve land-use efficiency because it enables land to be transferred from the low-productive households to the high-productive ones or from farmers who are unable to cultivate land to those who desire land for farming activities (Chamberlin & Ricker-Gilbert, 2016). Participation in farmland rental markets also facilitates farmers to achieve the economy of scale, increase production efficiency, use labour-saving technologies such as farm machines, and improve food security and household income (Deininger et al., 2013; Jiang, Paudel, & Mi, 2018; Muraoka, Jin, & Jayne, 2018; Yuan et al., 2018; Zhang, Feng, Heerink, Qu, & Kuyvenhoven, 2018). Given the benefits associated with developing the farmland rental markets, the governments in different countries have made great efforts to facilitate the formation of the markets. For example, in China, the central government pays intense attention to the farmland rental markets. One of the major efforts is the promulgation of the Revised Law of Rural Land Contract in 2018, intending to improve land-use efficiency conditional on the collective ownership of the rural land. Additionally, since 2018, farmers have the contracting rights of land for an additional 30 years. Land ownership, contract rights, and management rights are separate, but management rights are permitted to be rented.

Although the significant benefits associated with farmland transfer and government supports, the participation rate in the farmland rental market among rural farmers remains small. The existing studies have shown that several factors affect farmers' decision to participate in farmland rental markets (e.g., Che, 2016; Deininger et al., 2013; Huang & Ding, 2016; Jiang, Li, Paudel, & Mi, 2019; Ricker-Gilbert & Chamberlin, 2018). For example, in their investigation on farmers in Ethiopia, Deininger et al. (2013) revealed that land rental contract inefficiency is a primary factor preventing farmers from renting in farmland. Huang & Ding, (2016) found that the lack of land rental service centres in rural China is the prime impetus of developing land rental markets. In their study on Tanzania, Ricker-Gilbert and Chamberlin (2018) found that high transaction costs associated with land transfer have impeded farmers from renting in farmland. Apart from the factors that restrict farmers' decisions to participate in farmland rental markets, understanding the incentives that would motivate farmers' decisions to participate in farmland rental markets is also essential in designing sustainable policy instruments.

Few studies have shown that access to credit can drive farmers' decisions to rent in farmland. The two notable studies include Hou, Huo, and Yin (2017) and Jiang et al. (2018). They found that borrowing money from informal sources such as friends and relatives positively affects farmers' decision to rent in farmland. Access to credit enables farmers to invest in farm businesses, such as expanding the scale of agricultural production through renting in farmland. Also, access to credit may affect farmers' decision to rent out farmland. This is because access to credit helps farmers invest in non-farm businesses, such as operating grocery and convenience stores and online stores (Asfaw, Hassen, & Bantider, 2017; Nagler & Naudé, 2017). Operation on non-farming businesses may require farming families to reduce production scale or quit farming. In such a case farming families are more likely to rent out farmland. However, prior studies have overlooked the association between access to credit and farmers' land rental market participation decisions.

Therefore, the objective of this study is to investigate the impact of access to credit on farmers' decisions to participate in farmland rental markets in China. Specifically, we investigate four key research issues. First, what factors affect farmers' decision to access to credit? Second, what factors influence farmers' decision to participate in farmland rental markets? Third, what is the impact of access to credit on farmers' decision to participate in farmland rental markets? Access to credit differs with the age of the operator and regional location of the rural households. Therefore, the fourth research question is: does access to credit have heterogenous impacts on farmers' decision to participate in farmland rental markets? The study uses survey data from 6581 rural Chinese households. The data was collected for the project of China Family Panel Studies by Peking University, China. Since credit is not randomly assigned among rural households, but they decide whether to obtain loan (Bocher, Alemu, & Kelbore, 2017; Anjani Kumar, Mishra, Sonkar, & Saroj, 2020; Swaminathan & Findeis, 2010). A novelty of this study is that it employs an endogenous switching probit model to address the selection bias issue associated with access to credit.

The study contributes to the literature in several ways. First, the research focuses on credit and how the access to credit affects rural farmers' decision to participate in farmland rental market. Second, unlike previous studies, this study accounts for selection bias in access to credit in providing a new perspective in explaining the farmland leasing behavior, both renting in and renting out farmland. Third, the study enhances the current understanding of participation in farmland rental market and agricultural industry transformation in China by providing additional information on the potential relationship between access to credit, participation in the farmland rental market, land rentals, and household welfare. This analysis is meaningful because increasing participation in farmland rental markets (both renting in and renting out farmland) is in line with China's current objectives of improving the competitiveness of the agricultural sector and increasing returns to farming (or farm incomes). Fourth, the study explores the potential heterogeneous effect of access to credit on farmers' decisions to participate in farmland rental markets.

The remainder of the paper is structured as follows. In the next section, we present the theoretical framework. Section 3 illustrates the analytical framework and estimation strategy. Data and descriptive statistics are detailed in Section 4. The empirical results and robustness checks are presented and discussed in Section 5. The final section is devoted to conclusions and policy implications.

2. Theoretical framework

The theoretical framework employed in this study is adapted from the derivation presented in Mukasa, Simpasa, and Salami (2017), and it links farmers' access to credit to farm performance. For analytical setting, we assume that farm households maximize the utility from maximizing farm net returns (NR) by investing a vector of variable inputs I at unit price W on the total available land A. Let $f(I, A, Z^q)$ represent the farm production function and P be the price of output, and Z^q represents a vector of production shifters. We further assume that the farmer has certain income M at the start of the production process and allocates C for consumption at a unit price of P^C. If $M \geq P^C C + WI$, this would indicate that farmers can self-finance their consumption and agricultural production

activities. However, in most cases, farmers' income is not sufficient to pay for all production and consumption expenditures, and they have to borrow money from formal sources (e.g., banks) and/or informal sources (e.g., friends and relatives). Suppose that farmers are only able to pay fraction s of variable inputs, with $0 < s < 1$. Then, $(1 - s)$ portion of variable inputs has to be purchased using the loan from lenders. Lenders will determine the credit K to grant to the farmers (i.e., borrowers) and charge interest r on the requested loan.[1] Under these circumstances and assumptions, the farmers' problem is to maximize the utility of net returns (NR) as follows:

$$\text{Max } U[NR] = U[Pf(I, A, Z^q) - sWI - (1 - s)WI \tag{1}$$

subject to:

$$\text{Credit constraint:}(1 - \text{s})WI \leq K(Z^C, Z^q) + (M - P^C C - \text{s}WI) \tag{1a}$$

$$\text{Credit Limit:}0 \leq K(Z^C, Z^q) \leq \tau A \tag{1b}$$

where sWI refers to self-financed expenditure of variable inputs and $(1 - s)WI$ refers to the expenditure of variable inputs purchased through a borrowed loan. Eq. (1a) shows that expenditures on variable inputs I are limited by farmers' initial income M, consumption expenditure $P^C C$, and the credit limit $K(Z^C, Z^q)$. The maximum amount of credit available to the farmers depends on both Z^q (factors affecting production, such as land size) and Z^C(factors influencing consumption, such as household size). Eq. (1b) shows that farmers' credit limit constraint is determined by the land owned A, and the unit price of land τ.

The optimal condition for farmers' problem can be obtained from the first-order conditions of the following Lagrange function:

$$\text{L} = \text{U}[Pf(I, A, Z^q) - \text{s}WI - (1 - s)WI] + \lambda[K(Z^C, Z^q) + (\text{M} - P^C C - sWI) - (1 - \text{s})WI] + \omega[K(Z^C, Z^q) - \tau A] \tag{2}$$

where λ and ω are the shadow prices of credit constraint and credit limit, respectively. We can obtain the following Kuhn-Tucker conditions by solving Eq. (2):

$$\text{U}'(\bullet)[Pf_I(\bullet) - sW - (1 - s)W] + \lambda[-sW - (1 - s)W] = 0, I \geq 0 \tag{3a}$$

$$\lambda[K(Z^C, Z^q) + (M - P^C C - sW) - (1 - s)W] = 0, \lambda \geq 0 \tag{3b}$$

$$\omega[K(Z^C, Z^q) - \tau A] = 0, \omega \geq 0 \tag{3c}$$

If credit constraint is not binding ($\lambda = 0$), Eq. (3a) would result in $\text{U}'(\cdot)[Pf_I(\cdot) - sW - (1 - s)W] = 0$, indicating that $Pf_I(\cdot) = W$. In this case, the maximun quantity of variable inputs I should correspond to the level that equates marginal value product $Pf_I(\cdot)$ with its marginal costs W at the optimum, independent of consumption. However, when credit constraint is binding ($\lambda > 0$), the optimal condition is given by $\text{U}'(\cdot)[Pf_I(\cdot) - W] - \lambda W = 0$. Because both λ and $\text{U}'(\cdot)$ are strictly positive, we can obtain $Pf_I(\bullet) = W\left[1 + \left(\frac{\lambda}{\text{U}'(\bullet)}\right)\right] > W$, indicating that the marginal value product of variable inputs $Pf_I(\cdot)$ is higher than the marginal costs by the factor $\left[1 + \left(\frac{\lambda}{\text{U}'(\bullet)}\right)\right]$. Therefore, credit-constrained farmers may use sub-optimal levels of variable inputs. The higher the shadow price of the credit constraint, the lower the optimal level of variable inputs demanded by the farmer.

The above theoretical analysis suggests that relaxing the credit constraint may help farmers to better use productivity-increasing inputs (e.g., improved seeds, fertilizers and pesticides), which subsequently improves production output, efficiency, productivity, and farm net returns. Besides, access to credit can also affect rural farmers' farmland rental market participation decisions through its influence on labor allocation between on-farm and non-farm activities and eventually affecting household welfare.

Fig. 1 illustrates the analytical framework of the underlying pathways regarding the association between access to credit and farmers' farmland rental market participation. The first pathway shows that access to credit can affect farmers' decision to rent in farmland. Access to credit stimulates farmers' decisions to invest in yield-increasing inputs (e.g., fertilizers, pesticides, and improved seeds) to maximize farm output. For example, the study by Nukpezah and Blankson (2017) shows that access to credit enables farmer-entrepreneurs to purchase raw materials, to use improved technologies, and to expand their production, processing, and marketing engagement. Given this, farmers who have benefited from improved agricultural production may have higher incentives to increase production scale by renting in more farmland. Besides, access to credit helps farmers relax capital constraints and allows them to invest in production-related farm businesses by renting in more farmland. For example, farmers may use the rented in farmland to grow cash crops or explore horticulture or agri-tourism business opportunities.

The second pathway demonstrates that access to credit affects farmers' decision to rent out farmland. In addition to its influence on agricultural production and farm business investments, access to credit helps farmers to invest in non-farm businesses such as operating restaurants, grocery stores, and online stores. For example, in their study on six sub-Saharan African countries, Nagler and Naudé (2017) showed that credit is generally associated with a higher likelihood of operating an enterprise. Using data obtained from farmers in north-central Ethiopia, Asfaw et al. (2017) found that access to credit helps rural farmers develop and expand non-farm business activities. However, more time being allocated to non-farm businesses would result in less time being allocated to farming activities, which finally push farmers to reduce farm size or quit from agricultural production by renting out their farmland.

Meanwhile, another issue facing the Chinese rural residents is that access to credit is not homogeneous throughout the county.

[1] There may be a case that farmers do not need to pay an interest when they borrow from informal sources such as friends and relatives. Here, to simplify the analysis, we assume that farmers pay an interest r on the requested loan K.

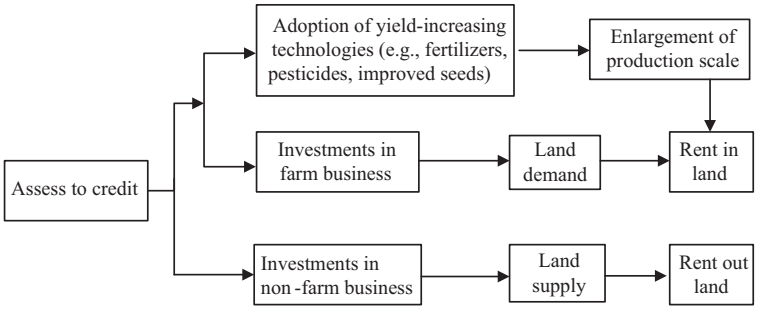

Fig. 1. Relationship between access to credit and farmland rental market participation.

Access to credit differs with the age of the household head and the regional location of the rural households (Chen & Jin, 2017; Dong & Featherstone, 2012; Yuan & Xu, 2015). Using data from a rural financial survey in China, Dong and Featherstone (2012) showed that there exists a nonlinear relationship between age and credit constraint, and young people are more likely to be credit constrained. Chen and Jin (2017) revealed that relative to Western households, those living in Eastern and Central China are more likely to receive credit. Studies in other Asian and African countries have also shown that rural residents' age and location have a significant effect on access to credit. Farmers' age (Heikkilä, Kalmi, & Ruuskanen, 2016; Kumar et al., 2020; Luan & Bauer, 2016) and geographic locations (Kumar, 2013; Swaminathan & Findeis, 2010; Twumasi, Jiang, Ameyaw, Danquah, & Acheampong, 2020) also determine the access to credit. For example, Kumar et al. (2020) show that the age of the household head negatively influences access to credit. In their investigation of Ghana, Twumasi et al. (2020) used location dummies to capture unobserved institutional and socioeconomic factors that may affect credit availability, and they revealed that relative to farmers in the Savannah region, farmers in the Central region are more likely to obtain credit. However, the heterogeneous effects of access to credit on the farmers' decision to participate in farmland rental markets have been overlooked in the literature. Therefore, to obtain further insights, we also disaggregated the effects of access to credit on the participation in farmland rental markets by household heads' age and survey regions.

3. Estimation strategy

3.1. The issue of selection bias

As discussed above, access to credit may directly affect farmers' decision to invest in both farm and non-farm activities and then affect their decisions to participate in farmland rental markets. To link the relationship between access to credit and farmland rental market participation, we assume that the farmland rental market participation is a function of access to credit variable and a vector of explanatory variables as follows:

$$Y_i^* = \eta C_i + \alpha X_i + \vartheta_i, \quad Y_i = \begin{cases} 1, \, if \; Y_i^* > 0 \\ 0, \, if \; Y_i^* \le 0 \end{cases} \tag{4}$$

where Y_i^* is a latent variable representing the propensity that a farmer i chooses to participate in farmland rental markets (i.e., to rent in or rent out farmland); Y_i^* cannot be observed directly, but is observed as a binary variable, Y_i, that takes a value of 1 if the farmer participated in the farmland rental markets, and 0 otherwise; C_i is a binary variable that determines farmers' access to credit (=1 for credit users and 0 for non-users); X_i represents a vector of exogenous variables that affect farmers' farmland rental market participation decisions; η and α are parameters to be estimated; and ϑ_i is a random error term. The effect of access to credit on farmers' decisions to participate in the farmland rental markets is captured by the parameter η.

If access to credit variable is exogenously determined, Eq. (4) can be estimated using a dichotomous choice modeling techniques (such as probit or logit model). However, the access to credit variable is potentially endogenous, because farmers themselves decide whether to access credit (or borrow money). Thus, both observable factors (e.g., age, gender, education, and asset value) and unobservable factors (e.g., innate financial abilities, motivations, and credit risks) may affect farmers' decision to participate in farmland rental markets (Bocher et al., 2017; Ciaian, Fałkowski, & Kancs, 2012; Martey, Wiredu, Etwire, & Kuwornu, 2019). The above arguments lead to a self-selection bias issue. Failing to address the selection bias issue associated with access to credit variable in Eq. (4) would produce biased estimates.

To address the issue of selection bias, the direct effect of access to credit should be investigated by analyzing the differences in farmland rental market participation between credit users and non-users. Rosenbaum and Rubin (1983) proposed the propensity score matching approach to examine the influence of a binary treatment variable on various outcome variables. The method has been widely applied to evaluate policy interventions (see Ciaian et al., 2012; Martey et al., 2019). However, a noticed weakness of the PSM method is that it addresses selection bias by controlling for only observable variables, without considering unobservable factors (Démurger & Wang, 2016; Ma, Abdulai, & Goetz, 2018c). To address the observed and unobserved selection bias a recursive bivariate probit (RBP) modeling technique as been applied in previous studies (Ma, Abdulai, & Goetz, 2018c; Vall Castello, 2012). For example, using the RBP model, Ma, Abdulai, and Goetz (2018c) examined the impact of cooperative membership on the adoption of organic soil amendments and chemical fertilizer in China. However, a limitation of the RBP model is that it only estimates one selection

equation (i.e., access to credit) and one outcome equation (i.e., farmland rental market participation). Alternatively, an endogenous switching probit (ESP) estimation technique addresses the selection bias stemming from both observed and unobserved heterogeneities. The ESP can also estimate two outcome equations (one for credit users and another for non-users) (Lokshin & Sajaia, 2011; Ma, Renwick, Nie, Tang, & Cai, 2018a). Therefore, in this study, we employ the ESP model.[2]

3.2. Endogenous switching probit model

The ESP model is a two-stage estimation approach. In the first stage, we model a credit access function by analyzing the factors that affect farmers' decisions to access to credit. For an analytical setting, we assume that farmers are risk-neutral and they decide whether or not to access to credit by maximizing the expected utility. Let C_i^* represent the difference between the utility obtained from having access to credit (C_{1i}^*) and that obtained from not having access to credit (C_{0i}^*), such that a rational farmer i will choose to access to credit, if $C_i^* = C_{1i}^* - C_{0i}^* > 0$. However, the utility difference cannot be observed directly, but can be expressed by a latent variable model as follow:

$$C_i^* = \gamma Z_i + \mu_i,\ C_i = \begin{cases} 1, & if\ C_i^* > 0 \\ 0, & if\ C_i^* \le 0 \end{cases} \tag{5}$$

where C_i^* represents the propensity that a farmer i chooses to access credit, and it is determined by an observed variable C_i which takes the value of 1 for credit users and 0 for non-users; Z_i is a vector of explanatory variables (e.g., age, gender, household size and asset value) that are expected to influence farmers' decisions to access to credit; γ is a vector of parameters to be estimated, and μ_i is an error term with zero mean and normal distribution.

The second stage of the ESP model estimates two farmland rental market participation equations, respectively, for credit users and non-users. In particular, they are specified as follows:

$$Y_{Ti}^* = \beta_T X_{Ti} + \varepsilon_{Ti},\ Y_{Ti} = \begin{cases} 1, if\ Y_{Ti}^* > 0 \\ 0, if\ Y_{Ti}^* \le 0 \end{cases} \text{ for } C_i = 1 \tag{6a}$$

$$Y_{Ni}^* = \beta_N X_{Ni} + \varepsilon_{Ni},\ Y_{Ni} = \begin{cases} 1, if\ Y_{Ni}^* > 0 \\ 0, if\ Y_{Ni}^* \le 0 \end{cases} \text{ for } C_i = 0 \tag{6b}$$

where Y_{Ti}^* and Y_{Ni}^* are latent variables representing the probabilities of participating in farmland rental markets for credit users and non-users, respectively; Y_{Ti} and Y_{Ni} are observed variables, which take the value of 1 if a farm household i chooses to rent in or rent out farmland, and zero otherwise; X_{Ti} and X_{Ni} are vectors of observed variables (e.g., age, gender, household size, and asset value) that are expected to affect farmers' farmland rental market participation decision; β_T and β_N are vectors of parameters to be estimated; and ε_{Ti} and ε_{Ni} are error terms.

In the ESP model framework, a full information maximum likelihood (FIML) estimator is used to estimate Eqs. (5), (6a) and (6b) simultaneously (Lokshin & Sajaia, 2011). For model identification, the ESP model requires the inclusion of at least one instrumental variable (IV) that appears only in the first-stage of estimation (i.e., Eq. (5)) (Lokshin & Sajaia, 2011). In this study, we include household expenditure (premium) on the children's insurance as an IV. Note that households' financial status determines farmers' insurance purchasing behavior. However, purchasing insurance products is not necessarily correlated with farmers' decision to participate in farmland rental markets. To test the validity of the IV we separately run three probit models (i.e., access to credit equation, farmland rent in Equation and farmland rent out Equation) by including the insurance variable as a regressor. Results (see Table A1 in the Appendix) show that the coefficient of the insurance variable in the access to credit equation is 0.042 and statistically significant at the 1% level. However, the coefficients of the insurance variable in the other two equations are insignificant, even at the 10% significance level of significance. The findings suggest that the insurance variable can serve as a valid instrument for the ESP model identification.

3.3. Estimating the treatment effects

After estimating the first and second stages of the ESP model, the coefficients of the variables can be used to calculate the treatment effects of access to credit on farmland rental market participation. Following Lokshin and Sajaia (2011), the average treatment effect on the treated (ATT) is calculated in this study, using the following Equation:

$$\text{ATT} = \frac{1}{N_T}\sum_{i=1}^{N_T}\{P_r(Y_T = 1 \mid C = 1, X = x) - P_r(Y_N = 1 \mid C = 1, X = x)\} = \frac{\Phi_2(X_T\beta_T, Z\gamma, \rho_1) - \Phi_2(X_N\beta_N, Z\gamma, \rho_0)}{F(Z\gamma)} \tag{7}$$

where Φ_2 is a cumulative function of a bivariate normal distribution, and $F(Z\gamma)$ is a cumulative function of the univariate normal distribution; $N_T$is the number of treated groups ($C = 1$); $P_r(Y_T = 1|C = 1, X = x)$ refers to a probability that a credit user chooses to

[2] Although the ESP model can help mitigate selection bias originating from both observed and unobserved factors, it can only be used to analyze the impact of a binary treatment on a binary outcome variable. When the outcome variable is continuous or it is a count variable, the ESP is not applicable.

Table 1
Sample distribution by access to credit and farmland rental market participation decisions.

Category	Credit users	Non-users	Total
Renting in farmland	714	171	885
Renting out farmland	1257	364	1621
Autarky (non-participants)	2912	1163	4075
Total	4883	1698	6581

participate in farmland rental markets in an observed context, while $P_r(Y_N = 1|C = 1, X = x)$ represents a probability that a credit user chooses not to participate in farmland rental markets in a counterfactual context.

4. Data and descriptive statistics

This study uses open-access data collected for the China Family Panel Studies (CFPS) project by Peking University (Beijing, China) in 2016. The survey covers 25 provinces, which is nationally representative. The dataset comprises of 14,020 observations, including 7103 rural households and 6917 urban households. The survey questionnaire covers a range of detailed information on individual and household-level characteristics, household farmland rental market participation, access to credit, and asset ownership. Given the focus of this study, we excluded urban households from our analysis. After data cleaning (dropping observations with missing information and those with both renting in and renting out farmland), we finally use data from 6581 rural households in the empirical analysis. Among them, 885 rented in farmland, while 1621 rented out farmland (Table 1).[3]

Access to credit is measured as a binary variable, which equals to one if a farm household has access to credit for farm and/or non-farm activities in 2015, and zero otherwise. Of the total 6581 samples, 4883 households have access to credit (see Table 1). We use two binary variables to measure farmland rental market participation decisions, including renting in farmland and renting out farmland. The two choices are mutually exclusive because farmers can only choose one of them to maximize their expected benefits. For each option, a value of one is given if a farm household selects the option in 2015, and zero otherwise. Furthermore, based on the existing literature on access to credit (e.g., Fletschner, 2009; Heikkilä et al., 2016; Kumar, 2013; Kumar et al., 2020; Luan & Bauer, 2016; Okoruwa, Abass, Akin-Olagunju, & Akinola, 2020; Shoji, 2012; Swaminathan & Findeis, 2010; Twumasi et al., 2020; Wydick & Kempf, 2011; Yuan & Xu, 2015), we include age, gender, marital status, education, household size, non-farm work, asset value, social network, deposit and location dummies as control variables.[4]

Regarding the personal characteristics of the household heads, the age of household heads can influence their access to credit, and the empirical findings are mixed. For example, Wydick and Kempf (2011) found that the age of household heads negatively affected access to credit from formal sources (such as banks and microfinance institutions) and positively affected access to credit from informal sources (such as friends, relatives and local moneylenders). Thus, we include age as an explanatory variable without assigning any prior sign expectations. There exists a gender dimension in credit access. Compared with men, women are more likely to be credit constrained (Fletschner, 2009; Okoruwa et al., 2020). We also expect that men are more likely to obtain a loan than their female counterparts. Heikkilä et al. (2016) revealed that married household heads are more likely to access to credit in Uganda. The finding is further supported by the result of Okoruwa et al. (2020). They showed that marital status (single) has a negative impact on access to credit in their study of cassava farmers in Nigeria. Thus, the same influence of marital status on access to credit is expected in this study.

Higher education level indicates higher human capacity (Heikkilä et al., 2016; Okoruwa et al., 2020; Shoji, 2012; Twumasi et al., 2020). Better education increases farmers' awareness of the loan types and loan processing, which contributes to credit availability. Thus, we expect a positive relationship between education and access to credit. A large household size usually indicates either more labour endowments or a high dependency ratio (Kumar et al., 2020; Okoruwa et al., 2020; Twumasi et al., 2020; Yan Yuan & Xu, 2015). If more members of the household are involved in farm and/or non-farm businesses, the high capacity of the businesses means more needs for credit to support the operation. From the dependency ratio perspective, responsibility of taling care of family members could drive the household heads to secure loan for family expenses such as on food, medical care, children education, and agriducltural production. No matter which case, large household size increases the demand of credit. Thus, we expect that household size increases the probability of credit access among rural households. Non-farm work participation helps relax rural farmers' credit constraints, and thus, non-farm work participants are less likely to access to credit (Heikkilä et al., 2016; Kumar et al., 2020). However, it might a case that non-farm work participants are more likely to acquire loans for business expansion/investment as they believe they are solvent to the loan. Thus, non-farm work variable is included as an explanatory variable, without assigning nay a

[3] Only 99 respondents simultaneously rented in and rented out farmland (i.e. farmland replacememt for better usage) in 2015. As one anonymous reviewer pointed out, from the perspective of market equilibrium, farmers' rent-in and rent-out behavior will face the possibility of zero marginal revenue and the simultaneous renting in and renting out behavior cannot be theoretically explained. Thus, the 99 samples are excluded in our analysis.

[4] As suggested by one reviewer, Table A2 in the Appendix shows the Pearson correlation analysis between the explanatory variables used in this study. The table reveals that causality in variables may not be an issue in the explanatory variables in assessing the impact of access to credit on farmers' decisions to rent in and rent out farmland after our rigorous estimations using the ESP model.

Table 2
Definitions of the variables and descriptive statistics.

Variables	Definitions	Mean	Std. Dev.
Dependent variables			
Land rented in	1 if farmer rented in farmland in 2015, 0 otherwise	0.134	0.341
Land rented out	1 if farmer rented out farmland in 2015, 0 otherwise	0.246	0.431
Access to credit	1 if farmer had access to credit in 2015, 0 otherwise	0.742	0.438
Independent variables			
Age	Age of the household head in years	47.497	17.496
Gender	1 if farmer is male, 0 otherwise	0.489	0.500
Marital status	1 if farmer got married, 0 otherwise	0.637	0.481
Illiteracy	1 if farmer is illiterate or semi-illiterate, 0 otherwise	0.162	0.368
Primary school	1 if farmer received primary school education, 0 therwise	0.510	0.500
Junior school	1 if farmer received junior school education, 0 otherwise	0.192	0.394
High school	1 if farmer received high school education, 0 otherwise	0.093	0.291
College	1 if farmer received college or above education, 0 otherwise	0.043	0.202
Household size	Number of people residing in a household	3.960	1.874
Non-farm work	1 if farmer is engaged in non-farm activities, 0 otherwise	0.470	0.499
Asset value	Farmers's self-reported house value (10,000 yuan)[a]	17.093	29.538
Social network	Expenditure spent on giving gift money to relatives or friends in the last 12 months (1000 yuan)	4.032	6.399
Deposit	1 if farmer has a fixed-term deposit, 0 otherwise	0.567	0.496
Eastern	1 if farmer resides in Eastern China, 0 otherwise	0.353	0.478
Central	1 if farmer resides in central China, 0 otherwise	0.288	0.453
Western	1 if farmer resides in western China, 0 otherwise	0.359	0.480
Insurance	The expenditure spent on the children' insurance premium in 2015 (1000 yuan)	1.044	3.424

[a] 1 USD = 6.89 Yuan in July 2019.

prior sign expectation.

In regards to physical assets, previous studies have shown that ownership of livestock and agricultural assets exert a positive impact on the probability of accessing credit (Kumar, 2013; Kumar et al., 2020; Shoji, 2012; Twumasi et al., 2020). In this study, we use farmers' self-reported house value as a proxy variable for asset value, and we expect a positive impact of this variable on access to credit. Social capital/network is an important factor explaining why some households perform better than others (Luan & Bauer, 2016; Shoji, 2012; Twumasi et al., 2020; Wydick et al. Wydick & Kempf, 2011; Yuan & Xu, 2015). In their investigation of rural Vietnam, Luan and Bauer (2016) showed that access to credit is positively affected by the number of acquaintances. Thus, we include a social network variable and expect it has a positive impact on access to credit. Rural farmers may acquire credit for investing and improving farm and non-farm business operations, while deposit reduces the risks of repaying the loan. Thus, we include a deposit variable and expect a positive relationship between collateral and access to credit. Finally, we divide the survey zone into eastern, central, and western areas. We include three location dummies to capture the location fixed-effects that may affect farmers' decisions to access to credit.

Table 2 presents the definitions and descriptive statistics of the variables used in the empirical analysis. Around 13.4% of the households chose to rent in farmland and 24.6% rented out farmland in 2015. About 74% of the sampled households obtained credit from either formal financial institutions (e.g., banks and credit cooperatives) and/or informal sources (e.g., friends, relatives and neighbours). The mean age of farmers in the sample was about 47 years. Nearly half of the respondents were male, while most of them (64%) were married. About 51% of the respondents received a primary school education. In comparison, 19%, 9%, and 4% of respondents received junior school education, high school education, and college or university education, respectively. The average household size was about 4 persons. The survey also shows that about 47% of the household heads had worked off the farm. The asset value variable was measured by the house value reported by the household heads, and it has a mean of 170,930 yuan. The information related to social network variables shows that the mean expenditure on social network activities (i.e., gift money to relatives or friends) in 2015 was just over 4000 yuan. About 57% of the respondents' reported having fixed-term deposits in the banks.

Table 3 presents the mean differences in the characteristics of credit users and non-users. The table reveals that there exists observed significant differences between credit users and non-users regarding farmland rental market participation, as well as socio-demographic and household-level characteristics. The mean percentage of renting in farmland variables for credit users was around 45% higher than that for non-users, and the average percentage of renting out farmland for credit users was 20% higher than that for non-users. These differences tend to indicate that access to credit plays a significant role in affecting farmers' decisions to participate in farmland rental markets. However, the mean comparisons are not indicative of the net effects of access to credit on the participation in the farmland rental market. Recall that such analysis does not take into account the confounding factors that may affect farmers' decisions to access credit and to participate in farmland rental markets. Table 3 shows that credit users and non-users are systematically different in terms of observed characteristics. These characteristics include age, marital status, education, household size, non-farm work participation, asset value, social network, and deposit ownership, suggesting the presence of potential selection bias.

Table 3
Mean differences in characteristics between credit users and non-users.

Variables	Credit users (N = 4980)	Non-users (N = 1700)	Mean-diff.	t-value
Land rented in	0.146 (0.353)	0.101 (0.301)	0.045***	4.743
Land rented out	0.257 (0.437)	0.214 (0.411)	0.043***	3.550
Age	48.163 (17.276)	45.582 (17.987)	2.581***	5.247
Gender	0.485 (0.500)	0.499 (0.500)	−0.014	−0.956
Marital status	0.652 (0.476)	0.594 (0.491)	0.058***	4.302
Illiteracy	0.141 (0.348)	0.220 (0.414)	−0.079***	−7.691
Primary school	0.511 (0.500)	0.508 (0.500)	0.003	0.192
Junior school	0.208 (0.406)	0.146 (0.353)	0.062***	5.634
High school	0.099 (0.298)	0.078 (0.268)	0.021**	2.560
College	0.041 (0.198)	0.048 (0.213)	−0.007	−1.184
Household size	3.990 (1.869)	3.872 (1.885)	0.118**	2.239
Non-farm work	0.533 (0.499)	0.287 (0.453)	0.246***	17.890
Asset value	18.419 (31.512)	13.280 (22.513)	5.139***	6.193
Social network	4.471 (6.695)	2.770 (4.130)	1.701***	9.494
Deposit	0.590 (0.492)	0.501 (0.500)	0.089***	6.352
Eastern	0.352 (0.478)	0.354 (0.478)	−0.002	−0.111
Central	0.290 (0.454)	0.284 (0.451)	0.006	0.480
Western	0.358 (0.479)	0.362 (0.481)	−0.004	−0.342
Insurance	1.203 (3.738)	0.588 (2.231)	0.615***	6.395

Notes: Standard deviations in parentheses.
*, ** and *** indicate significance levels at 10%, 5% and 1%, respectively.

5. Empirical results

The second columns of Tables 4 and 5 present the results showing the factors affecting farmers' decisions to access to credit. The third and fourth columns of Tables 4 and 5 present parameter estimates of factors affecting credit users and non-users' decisions to rent in farmland and rent out farmland, respectively. In the lower parts of Tables 4-5, we report the estimates of the selectivity correction terms. The statistically significant and negative coefficients of ρ_1 and/or ρ_0 in Tables 4-5 suggest the presence of a negative selection bias originating from the unobserved heterogeneities (Lokshin & Sajaia, 2011; Ma, Abdulai, & Goetz, 2018c). Failure to address the bias would result in underestimated effects of access to credit on farmland rental market participation. Furthermore, the Wald tests for $\rho_1 = \rho_0 = 0$ are statistically significant, suggesting that the null hypothesis that access to the credit variable is exogenous is rejected. These findings indicate that the employment of the ESP model is appropriate.

5.1. Determinants of access to credit

The estimates of the determinants of access to credit are presented in the second columns of Tables 4 and 5. The coefficients of age variables are positive and statistically different from zero, indicating that older farmers are more likely to have access to credit. Our result is consistent with the findings of Ricker-Gilbert and Chamberlin (2018). It is expected that membership in savings and credit cooperatives increases with the age of the head of households. The significant and positive coefficients of the marital status variable suggest that, compared with unmarried people, married couples are more likely to have access to credit. Being married is a positive predictor of self-employment for women, while it can motivate men to participate in paid employment (Menon & van der Meulen Rodgers, 2011). The significant coefficients of the education category variables suggest that relative to illiterate or semi-illiterate farmers, better educated farmers are more likely to have access to credit. The positive and statistically significant coefficients of the non-farm work variable suggest that non-farm work by the farm operator increases the probability of having access to credit. This may be attributed to the fact that income obtained from non-farm work activities may increase farmers' debt repayment capacity and decrease riskiness in the loan.

The coefficient of asset value variable is positive and statistically significant, suggesting that wealthy farmers are more likely to have access to credit. Results from this study are consistent with the findings of Martey et al. (2019), who concluded that credit demand is positive and significantly associated with asset index. A possible explanation is that assets or wealth could be used as collateral toward credit. Social network variable exerts a positive and significant impact on access to credit, suggesting that households with a higher social network (those spending more gift money for social network activities) are more likely to have access to credit. Furthermore, higher expenditures on gifts would increase farm households' financial burdens because it may push households to borrow money in the maintenance of social networks. Note that social networks also improves knowledge transfer, which results in decreased loan risk and costs. Our result is consistent with the findings of Heikkilä et al. (2016). The authors found a positive relationship between an individual's social capital and the probability of accessing loans from formal financial institutions. The coefficient of deposit variable is positive and significant, indicating that farmers with fixed-term deposits are more likely to have access to credit. Fixed-term deposits decrease riskiness in credit usage. Fixed-deposits may signal liquid wealth, and lenders may consider these farmers less risky when lending monies. Finally, the coefficients of the insurance variable are positive and statistically

Table 4
Determinants of access to credit and determinants of renting in farmland.

		Farmland rented in	
Variable	Access to credit	Credit users	Non-users
Age	0.005 (0.001)***	−0.003 (0.001)**	−0.001 (0.003)
Gender	−0.029 (0.035)	0.034 (0.044)	−0.030 (0.085)
Marital status	0.080 (0.037)**	0.036 (0.051)	−0.018 (0.097)
Primary school	0.246 (0.048)***	0.016 (0.084)	−0.029 (0.165)
Junior school	0.440 (0.059)***	0.052 (0.081)	−0.278 (0.272)
High school	0.348 (0.072)***	0.056 (0.093)	−0.117 (0.251)
College	0.140 (0.091)	0.057 (0.086)	0.239 (0.210)
Household size	0.009 (0.010)	0.058 (0.013)***	0.031 (0.023)
Non-farm work	0.580 (0.036)***	−0.186 (0.076)**	0.065 (0.351)
Asset value	0.004 (0.001)***	0.000 (0.001)	0.003 (0.003)
Social network	0.033 (0.005)***	0.002 (0.004)	0.010 (0.022)
Deposit	0.204 (0.035)***	0.199 (0.062)***	0.277 (0.157)*
Eastern	−0.005 (0.042)	−0.006 (0.054)	−0.017 (0.100)
Central	−0.004 (0.044)	0.046 (0.056)	−0.138 (0.106)
Insurance	0.038 (0.012)***		
Constant	−0.437 (0.085)***	−2.357 (0.284)***	−1.642 (0.332)***
ρ_1		−0.706 (0.268)***	
ρ_0			−0.122 (0.793)
Log pseudo likelihood	−5722.962		
Wald test of indep. eqns.	chi2 (2) =7.33, Prob. > chi2 = 0.026		
Obs.	6581		

Notes: Robust standard errors in parentheses.
*, ** and *** indicate significance levels at 10%, 5% and 1% respectively.
The reference region is eastern China and the reference education level is Illiteracy.

significant, suggesting that households with children's insurance are more likely to have access to credit. Note that the insurance variable is used as an instrument in the ESP estimation.

5.2. Determinants of farmland rental market participation decisions

Table 4 (columns 3 and 4) presents the estimates of factors affecting farmers' decisions to rent in farmland. The age variable has a

Table 5
Determinants of access to credit and determinants of renting out farmland.

		Farmland rented out	
Variables	Access to credit	Credit users	Non-users
Age	0.004 (0.001)***	0.001 (0.001)	−0.004 (0.002)*
Gender	−0.033 (0.035)	−0.010 (0.040)	−0.008 (0.065)
Marital status	0.081 (0.037)**	−0.070 (0.043)	−0.070 (0.066)
Primary school	0.245 (0.048)***	0.543 (0.097)***	−0.139 (0.085) *
Junior school	0.434 (0.059)***	0.584 (0.119)***	−0.108 (0.126)
High school	0.364 (0.072)***	0.577 (0.116)***	−0.301 (0.141)**
College	0.161 (0.093)*	0.490 (0.715)	0.041 (0.162)
Household size	0.006 (0.009)	−0.099 (0.013)***	−0.133 (0.022)***
Non-farm work	0.579 (0.036)***	−0.098 (0.087)	−0.007 (0.130)
Asset value	0.004 (0.001)***	0.002 (0.001)**	0.000 (0.001)
Social network	0.032 (0.005)***	0.005 (0.004)	−0.008 (0.009)
Deposit	0.205 (0.035)***	−0.074 (0.047)	−0.025 (0.072)
Eastern	−0.004 (0.042)	0.337 (0.057)***	0.400 (0.090)***
Central	−0.002 (0.044)	0.264 (0.056)***	0.352 (0.090)***
Insurance	0.038 (0.013)***		
Constant	−0.420 (0.084)***	−1.543 (0.279)***	−0.767 (0.164)***
ρ_1		−0.580(0.336)*	
ρ_0			−0.644 (0.325)**
Log pseudo likelihood	−6653.505		
Wald test of indep. eqns.	chi2(2) =7.84, Prob. > chi2 = 0.019		
Obs.	6581		

Notes: Robust standard errors in parentheses.
*, ** and *** indicate significance levels at 10%, 5% and 1%, respectively.
The reference region is western China and the reference education level is illiteracy.

negative and statistically significant coefficient in the credit user specification, which suggests that older farmers with access to credit are less likely to rent in farmland. Compared with younger farmers, the older farmers are usually in poor health conditions, shorter time horizon, and have fewer incentives to expand agricultural production by renting in farmland. The coefficient of household size variable in the third column is positive and statistically significant, suggesting that large household size increases the probability of renting in farmland. To some extent, large household size indicates more labor endowments, which are essential requirements of extensive farm size cultivation. The coefficient of non-farm work variables are negative in the specifications for both credit users and non-users, but only statistically significant for credit users. The finding is in line with the lost-labor effect of non-farm work (Ma, Abdulai, & Goetz, 2018c). More time allocated to non-farm work would reduce the time allocation to farm work, which may negatively affect farm performance. Here we show that because of the lost-labor effect of non-farm work, farmers have fewer intentives to rent in farmland.

Table 5 (columns 3 and 4) presents the estimates of factors affecting farmers' decisions to rent out farmland. Education category variables tend to have differential impacts on farmers' decisions to participate in farmland rental markets. In particular, credit users with better education are more likely to rent out farmland, while non-users with better education are less likely to do so. Credit enables educated farmers to invest in non-farm businesses. Given that land cultivation may take away time from non-farm businesses, they may choose to rent out farmland partially or fully. Rahman (2010) also found that households with high levels of educated members are more likely to rent out farmland in Bangladesh. The coefficient of household size variable is negative and statistically significant, which suggest that households with more family members are less likely to rent out farmland. Our finding is mostly consistent with the result of Huang, Gao, and Rozelle (2012). The estimated coefficient of the asset value variable is positive and statistically significant from zero, suggesting that wealthy households are more likely to rent out farmland. Thus, financially better-off families may choose to run non-farm businesses by renting out farmland. Finally, results in Table 5 shows location-fixed effects in the decisions to rent out farmland. Our results show that relative to farm households in western China (reference group), farm households located in the eastern and central regions of China are more likely to rent out farmland.

5.3. Treatment effects of access to credit on land rental market participation

Table 6 presents estimates for the impact of access to credit on the expected probabilities of renting in and renting out farmland. In particular, the estimates show that farmers with access to credit are about 10% more likely to rent in farmland. The finding is mostly consistent with our first pathway analysis presented in Fig. 1. First, access to credit provides farmers with an opportunity to invest in yield-increasing inputs (e.g., improved seeds, fertilizers, and pesticides). It allows them to expand agricultural production by renting in farmland. Mumuni and Oladele (2016) argued that access to capital enhances farmers' farm management capabilities and improves their agrarian entrepreneurship. Another study on Brazil by de Garcias and Kassouf (2017) shows that rural credit exerts a positive and significant effect on agricultural technology adoption, thus increasing land productivity. Second, access to credit allows rural farmers to invest in the farm business, which increases their demand for farmland. Evidence presented here supports the notion that access to credit increases the probability of renting in farmland and thereby increasing the size of operational farmland.

Column 4 of Table 6 reveals that access to credit increases the likelihood of renting out land by about 20%, a finding that is echoed with our second pathway analysis presented in Fig. 1. Access to credit relaxes farmers' financial constraints and, as a result, they can launch or expand their rewarding non-farm businesses. Previous studies have shown that access to credit is one of the critical factors driving farmers' decisions to operate non-farm household enterprises (Alemu & Adesina, 2017; Nagler & Naudé, 2017). For example, Alemu and Adesina (2017) found that access to credit has contributed positively to farmers' engagement in non-farm household enterprises in Ethiopia. The present study confirms the positive role of access to credit in facilitating farmers' decisions to rent out farmland to better engage in non-farm activities.

For robustness check and comparison, we also estimated the treatment effects of access to credit on farmers' decisions to participate in the farmland rental markets, using the propensity score matching (PSM) approach. Our results (Table A3 in Appendix) show two interesting findings. First, PSM estimates confirm the positive association between access to credit and farmland rental market participation by rural Chinese households. Second, the magnitudes of the estimates obtained from the PSM approach were relatively smaller than the magnitude of estimates derived from the ESP technique. More specifically, the ATT estimates of the PSM approach show that access to credit significantly increases the likelihood of renting in and renting out farmland by 3.6% and 2.9%, respectively. However, smaller estimates observed in the PSM approach are not implausible, given the fact that PSM only includes the observed selection bias (e.g., Ciaian et al., 2012; de Garcias & Kassouf, 2017; Martey et al., 2019). On the other hand, we show a

Table 6
Treatment effects (ATT) of access to credit on farmland rental market participation.

Category	Obs.	Mean outcome	
		Farmland rented in	Farmland rented out
Full sample	4883	0.101 (0.001)***	0.203 (0.001)***

Notes:Standard errors in parentheses;
*** indicates a significance level at 1%.
ATT: Average treatment effect on the treated.

Table 7
Average treatment effects (ATT) of access to credit on farmland rental market participation by household head' ages and survey regions.

Category	Obs.	Mean outcome	
		Farmland rented in	Farmland rented out
Disaggregated analyses by ages			
Younger (Age < 40)	1686	0.069 (0.003)***	0.199 (0.004)***
Middle-aged (40≤ Age < 60)	1739	0.065 (0.003)***	0.212 (0.004)***
Older (Age ≥ 60)	1458	0.064 (0.003)***	0.235 (0.004)***
Disaggregated analyses by survey regions			
Eastern	1721	0.055 (0.003)***	0.258 (0.004)***
Central	1416	0.089 (0.003)***	0.229 (0.004)***
Western	1746	0.057 (0.003)***	0.161 (0.003)***

Notes: Standard errors in parentheses.
*** indicates a significance level at 1%.

negative selection bias arising from unobservable factors in the results obtained from the ESP approach.

5.4. Heterogeneous effects of access to credit on farmland rentals

Results reported in Table 7 show that the ATT of access to credit on participation in farmland rental market. Table 7 reveals that even within different age groups, access to credit maintains its positive impact on two farmland rental market participation decisions. Still, the effect of access to credit is heterogeneous. For example, results reveal that among younger, middle-aged and older farmers, with access to credit, younger farmers have a higher probability of renting in farmland, but their older counterparts have a higher likelihood of renting out farmland. Specifically, access to credit increases the probability of renting in farmland among younger farmers by 6.9% while it increases the likelihood of renting out farmland among older farmers by 23.5%.

Access to credit also has regional-fixed heterogeneous effects on farmers' decisions to participate in the farmland rental markets. Results in Table 7 show that, with access to credit, farmers living in central China are more likely to rent in farmland relative to farmers living in the eastern and western region of China. In particular, access to credit increases the probability of renting in farmland among rural households in the eastern, central and western China by about 5.5%, 8.9% and 5.7%, respectively. For those living in the eastern region of China, they are more likely to rent out farmland (about 25.8%).

6. Conclusions and policy implications

This paper examined the impact of access to credit on rural farmers' decisions to participate in farmland rental markets in China. The study used an open-access data collected for the project of China Family Panel Studies by Peking University. The comparisons of mean percentages of renting in and renting out land between credit users and non-users showed some significant differences. The findings of the ESP model estimations confirmed the presence of selection bias arising from unobserved factors. After addressing the bias, the results showed that access to credit positively and significantly affects farmers' decisions to participate in farmland rental markets. In particular, our ATT estimates revealed that access to credit increases the likelihoods of renting in and renting out farmland by about 10% and 20%, respectively. The positive effects of access to credit were also confirmed by the estimation of the PSM model. The results of the disaggregated analyses suggested that younder farmers are more likely to rent in farmland while older farmers are more likely to rent out farmland. In addition, farmers residing in central China are more likely to rent in farmland, while those living in eastern China are more likely to rent out farmland.

In addition to access to credit, our results indicated that farmers' decision to rent in farmland is affected by household heads' age, household size non-farm work and deposit, while their decision to rent out farmland is influenced by age, education, household size and asset value. Regarding the factors that influence access to credit, we showed that age, marital status, education, non-farm work, asset value, social network, deposit and insurance are main factors that positively and significantly affect rural farmers' decision to access to credit.

The findings from this study lead to several important policy implications. The finding that access to credit facilitates farmers' decision to participate in farmland rental markets underscores the importance of government efforts to help rural households obtain credit from formal financial institutions such as banks and credit cooperatives at lower interest rates, which can actually boost both

farm and non-farm investments and consequently promote farmers' participation in farmland rental markets. Farmland transfer in rural areas can increase agricultural productivity and farmland use efficiency (Deininger et al., 2013; Liu, Yan, Wang, & Zhou, 2019; Lu, Jiang, & Gong, 2020). The finding that farmers' participation in non-farm work tends to increase credit accessibility indicates that government should make further efforts in creating more non-farm employment opportunities for farmers. In addition to affecting farmers' decision to participate in farmland rental markets, access to credit may also affect the areas of farmland transacted. Unfortunately, we do not have the data to support such an extension of the analysis, but we believe it is a promising future avenue for research.

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Appendix A. Appendix

Table A1
Probit model estimates for the validity of the instrumental variable.

Variables	Access to credit	Farmland rented in	Farmland rented out
Insurance (IV)	0.042 (0.008)***	0.005 (0.005)	0.003 (0.005)
Age	0.005 (0.001)***	−0.009 (0.001)	0.001 (0.001)
Gender	−0.029 (0.035)	0.009 (0.041)	−0.023 (0.035)
Marital status	0.086 (0.037)**	0.050 (0.044)	−0.059 (0.037)
Primary school	2.445 (0.047)***	0.662 (0.077)***	0.745 (0.063)***
Junior school	0.436 (0.059)***	0.458 (0.087)***	1.196 (0.069)***
High school	0.360 (0.072)***	1.482 (0.089)***	0.385 (0.086)***
College	0.149 (0.091)***	0.780 (0.116)***	0.858 (0.099)***
Household size	0.007 (0.009)	0.057 (0.011) ***	−0.113 (0.010)***
Non-farm work	0.581 (0.036) ***	0.031 (0.041)	0.093 (0.036)***
Asset value	0.004 (0.001)***	0.002 (0.001)***	0.002 (0.001)***
Social network	0.032 (0.004)***	0.011 (0.003)***	0.009 (0.003)***
Deposit	0.203 (0.035)***	0.290 (0.042)***	−0.013 (0.036)
Eastern	−0.002 (0.042)	−0.028 (0.049)	0.364 (0.043)***
Central	−0.001 (0.044)	0.011 (0.051)	0.306 (0.045)***
Constant	−0.425 (0.083)**	−2.262 (0.114)***	−1.344 (0.093)***
Prob. > chi2	0.000	0.000	0.000
Obs.	6581	6581	6581

Notes: Standard errors in parentheses.
*, ** and *** indicate significance levels at 10%, 5% and 1%, respectively.
The reference region is western China and the reference education level is illiteracy.

Table A2
Pearson correlation test of the explanatory variables.

	Age	Gender	Marital status	Illiteracy	Primary school	Junior school	High school	College	Household size	Non-farm work	Asset value	Social network	Deposit	Eastern	Central	Western
Age	1.000															
Gender	−0.018	1.000														
Marital status	0.219	−0.008	1.000													
Illiteracy	−0.029	−0.010	−0.033	1.000												
Primary school	0.012	0.008	0.017	−0.448	1.000											
Junior school	0.002	0.000	0.004	−0.214	−0.498	1.000										
High school	0.002	0.001	0.008	−0.142	−0.327	−0.157	1.000									
College	0.017	−0.004	−0.002	−0.093	−0.216	−0.103	−0.068	1.000								
Household size	0.024	0.005	0.010	0.026	−0.027	−0.021	0.023	0.028	1.000							
Non-farm work	0.010	−0.002	0.025	−0.041	0.008	0.018	0.014	−0.002	0.018	1.000						
Asset value	0.012	−0.025	0.007	−0.027	−0.004	0.015	0.001	0.028	0.034	0.042	1.000					
Social network	0.014	−0.013	0.018	−0.029	−0.014	0.022	0.039	−0.012	0.066	0.069	0.123	1.000				
Deposit	−0.020	0.003	0.020	−0.003	−0.004	0.034	−0.014	−0.031	0.011	0.014	−0.001	0.027	1.000			
Eastern	0.005	0.010	−0.007	−0.041	−0.032	0.055	0.011	0.031	−0.109	−0.020	0.031	0.012	−0.063	1.000		
Central	−0.011	−0.012	−0.021	−0.020	0.037	−0.002	−0.011	−0.037	−0.007	0.025	−0.013	0.012	0.001	−0.470	1.000	
Western	0.005	0.002	0.027	0.060	−0.003	−0.053	−0.001	0.003	0.116	−0.004	−0.018	−0.023	0.062	−0.552	−0.476	1.000

Table A3
Robustness check: PSM model estimates.

Variables	Credit users	Non-users	ATT	*t*-statistics
Farmland rented in	0.146 (0.005)	0.110 (0.013)	0.036 (0.014) ***	2.63
Farmland rented out	0.257 (0.006)	0.228 (0.016)	0.029 (0.017)*	1.72

Notes: ATT refers to the average treatment effect on the treated, which is estimated using the propensity-score nearest-neighbour matching estimator and STATA commands "kmatch ps".
Standard errors in parentheses.
* and ** indicate significance levels at 10%, 5% and 1%, respectively.

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