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DOES FARMLAND MANAGEMENT SCALE INFLUENCE CREDIT AVAILABILITY? EVIDENCES FROM THREE PROVINCES OF CHINA

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Abstract

Loans are of great importance for new agricultural management entities in China, and loans from formal financial institutions are one of the main sources for them. Using data of 1096 new agricultural management entities from Henan Province, Zhejiang Province, and Heilongjiang Province in China from 2013 to 2015, we examine the effect of farmland management scale on loan availability. Both problems of endogeneity and heterogeneity are solved, in that method of 2SPLS is applied to eliminate endogeneity for the study, and the FMM Tobit model is used to solve heterogeneity that affects the result. The main finding shows that the land scale would affect the loan availability of farmers. For farmers who are less able to obtain loans, a larger land scale brings higher loan availability, while it seems not applied for those who are more able to obtain loans. Besides, it is confirmed that the effect of land scale also depends on the ability to provide high-quality products, farmers' beliefs, and the development of macroeconomic. What's more, it suggested that, for farmers who owned lots of farmlands, changing the decision of management is a common practice after they obtain credit. Finally, suggestions for sustainable farmland use are proposed to promote the development of agriculture in China.

Key words: loans, finite mixture models, scale management, two-stage Probit least squares

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1. Introduction

With the development of farmland circulation, new agricultural management entities have emerged in China in recent years (Chen et al., 2014; Huang and Yang, 2017). Compared to traditional small-scale agricultural management entities, new entities are larger in terms of their management scale, and loans are more important for them. Evidence from developed countries reveals that the development of family farms depends on the good financial policy formulated by the government (Daoudi and Wampfler, 2010; Guan and Lansink, 2006; Kazukauskas et al., 2013; O'Toole et al., 2014). It indicates that finance is certainly the core of the modern agricultural economy, and financial flow is necessary for new agricultural management entities. As a result of subsidies from the Chinese government for large-scale farmers who engage in planting being smaller than those for small-scale farmers, new agricultural management entities, who have large-scale management, tend to apply for loans from banks and other financial institutions to extend the scale of management (Feder et al., 1990). They are suffering from credit constraints (Turvey et al., 2012). Attention should be paid to the loan obtaining by new agricultural management entities, in that they are the guarantee of healthy agricultural development in China.

For new agricultural business entities, financial support from the formal credit sector is of great

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significance. The lack of China's rural financial market has restricted the development of agriculture in the past years, and farmers were restricted by the credit of formal financial institutions. The development of new agricultural management in China attracts attention to the research of financing demand and financing channels. Studies have shown that the development of new agricultural management is the development of large-scale and modern. As the funds of their own are not enough for the inputs of agricultural production, they quietly demand credit. Also, their demand for financial services shows a trend of diversification. Most new agricultural business entities tend to borrow from formal financial institutions, but actually, most of them can only meet their capital needs through informal financial institutions. To ease the restriction of credit constraints on farmers' production and operation, many experts and scholars have analyzed from the perspective of farmers' capital demand and credit availability.

Recent literature has focused on the evaluation of credit rating, and it has been broadly concerned with whether the farmers who have a larger management scale could obtain loans more easily. Previous research has shown that large-scale farmers, who are more eager to finance, are more likely to obtain loans from formal financial institutions (Karlan et al., 2014; Turvey et al., 2012). Moreover, factors including higher family income (Luan and Bauer, 2016), formal organizations (Mojo et al., 2017), better reaction to disaster (Sawada, 2007), and more social capital contribute to the high possibility for large-scale farmers to obtain loans from formal financial institutions. Besides, Petrick (2004) found that large-scale management may not contribute to a reduction in credit constraints, indicating that farmers are suffering considerably from credit constraints regardless of their management scale (Chaudhuri and Cherical, 2012; Petrick, 2004).

The aforementioned studies only considered the one-way relationship between management scale and obtaining loans. However, loans also affect land scale (Kareem, 2018), and the two-way relationship between loans and land scale indicates that the variable is endogenous. The two-stage least squares (2SLS) method is widely used for solving the endogeneity caused by reciprocal causation (Bun and Windmeijer, 2011; Lee, 2007; Nestler, 2015; Poi, 2006), and the two-stage probity least squares (2SPLS), which is an improved method, is applied to research in which the dependent variable is a binary state variable.

Also, heterogeneity is another common problem that has not been solved in this area before. To eliminate the heterogeneity of farmers, methods such as introducing dummy variables are widely used in the study of loans. Farmers display obvious differences in terms of the ability to abate credit constraints, and such ability could not be identified by several control variables. Furthermore, previous studies have noted that the method of introducing dummy variables should be avoided for dealing with the problem of heterogeneity. Grouping analysis is another common method in which farmers are divided into groups without space or time constraints. Different from the two aforementioned methods, a finite mixture model (FMM) is a method that divides farmers into groups mathematically and can eliminate the heterogeneity caused by unobserved factors.

Using the 2SPLS method and based on survey data of 1096 new agricultural management entities, this study examines the effect of management scale on credit constraints in Henan, Zhejiang, and Heilongjiang Provinces in China. A traditional Tobit model was also selected for loan availability, and FMM Tobit regression is further applied to improve the research. The results reveal the status of new agricultural management entities in the agricultural financial market. Moreover, the continuous improvement of the finance policy could be realized through the sustainable development of farmland management.

2. Materials and methods

2.1. Data resource

This study is based on survey data of new agricultural management entities conducted by the Ministry of Agriculture and Rural Affairs in 2016. Henan, Zhejiang, and Heilongjiang provinces were selected for this study. Characteristics including management situation, technological innovation, and financial support for new agricultural management entities are collected in the survey. The survey is based on the sampling method; agroeconomic structure and the level of economic development are considered for the selection of cities, with 10–20 sample cities selected in the aforementioned provinces. A total of 30–40 samples of new agricultural management entities are randomly selected from the sample cities. New agricultural management entities who engage in planting, aquaculture, and marketing are included in the survey. Given that attention is paid to the scale management and land scale of large-scale farmers who engage in the planting industry, 1096 valid samples are selected. Besides, only farmers who own more than 50 mu (≈3.33 ha) land are considered as large-scale management.

2.1.1. Management scale variables

In general, variables of total land scale, total assets, total income, and total labor input can be selected to represent the scale of management (Klerkx et al., 2010; Xu et al., 2020). In our survey, data on the total land scale is comparatively complete among the aforementioned options; it is, therefore, the most suitable as the main independent variable.

Land scale can be increased through land approval, as well as the political parties (Valle et al., 2014). Farmers who have been trained are more knowledgeable, more skilled in technology, and more experienced in management, as a result, they have an

advantage in expanding the scale of management. Furthermore, the management scale depends on the willingness of farmers; hence, the ideal land scale would affect farmers' actual land scale to some extent. Agricultural insurance has the function of reducing risk, that is, farmers who have purchased insurance may seek to purchase additional land than those who have not bought.

2.1.2. Loan variables

Credit constraint (Agur, 2013; Kirschenmann, 2016; Petrick, 2004) and loan availability (Cebenoyan and Strahan, 2004; Melzer, 2011; Ono et al., 2013) are dependent variables that are widely selected in the study of loans. Also, farmers who previously had non-performing loans are more likely to be subject to constraints when applying for a new loan (Ghosh, 2015). Specifically, previous literature shows that "whether the farmer joins in political parties" does not affect obtaining loans. Besides, as the training mentioned in the survey is specific to agricultural technology, undergoing training is not found to affect loans.

2.1.3. Other independent variables

Factors including individual, family, social capital, loan, and regional characteristics affect both land scale and obtaining loans. Individual characteristics include gender, age, and level of education. Family characteristics include the type of crop and farming, loan characteristics include whether loans are borrowed from informal financial institutions except for the independent variables, and social capital character is represented by whether a farmer is native to the region.

2.1.4. Properties of data

Table 1 divides the variables selected into five categories: individual, family, social capital, loan, and regional characteristics. The logarithmic form of the *Total land scale* is selected as the kernel variable to represent the scale of management, while *Credit constraint* and *Loan availability* are dependent variables. Quantity and risk rationing are two types of credit constraints (Boucher et al., 2008). The former represents the situation in which people who apply for loans from financial institutions fail to obtain the full amount requested, while the latter represents the situation in which people who have financial demands stop actively borrowing from financial institutions, indicating that they refuse to apply for loans on their own. Both types of credit constraints are included in the *Credit constraint* variable. Furthermore, the financial institutions in this study are specifically formal financial institutions.

According to Table 1, the average credit constraint of the sample farmers is 83%, and the loan availability is 23%, indicating that most of the farmers are suffering from the financial constraint of formal financial institutions.

Table 1. Data sources and description of variables

Variables	***Explanations***	***Mean***	***SD***	***Obs***
Individual characteristics				
Gender	male=1; female=0	0.91	0.29	1094
Age	Measured in years	48.61	9.27	1079
Education	Below primary school=1; primary school=2; junior high school=3; senior high school or technical secondary school=4; university and above=5	2.97	0.97	1092
Have ever been a cadre	yes=1; no=0	0.43	0.70	1093
Party number	yes=1; no=0	0.21	0.41	1095
Have join a train	yes=1; no=0	0.68	0.47	1094
Family characteristics				
How long has it been in business	Measured in years	5.10	3.27	326
Types of the agricultural business entity				1082
Professional large-scale farmers or family farms	yes=1; no=0	0.72	0.45	1096
agriculture cooperation	yes=1; no=0	0.23	0.42	1096
agricultural enterprises	yes=1; no=0	0.04	0.19	1096
others	yes=1; no=0	0.00	0.03	1096
Total land scale	Measured in mu (1 mu=0.0667 hectare)	642.20	2073.42	1096
Labour input per mu	Measured in CNY/mu	1584.34	2639.95	427
Average assets from 2013 to 2015	Measured in 10000CNY	533.54	2168.19	329
Average debts from 2013 to 2015	Measured in 10000CNY	231.99	1049.16	205
Average incomes from 2013 to 2015	Measured in CNY/mu	207.12	903.60	873
Average subsidies from 2013 to 2015 per mu	Measured in CNY/mu	241.66	617.10	570
Land approval	All lands have been approved=1; some of the lands have been approved=2; plan to be approved=3; not ready to be approved yet=4	2.09	1.07	1002
Types of crops	food crop=1; economic crop=0	0.29	0.45	716

Plan of land scale for the future	To expand the land=1; no change=2; to reduce the land=3; give up farming=4	1.72	0.76	1029
Ideal land scale	Measured in mu	1109.65	8058.02	981
Loan characteristics				
Length of maturity	Measured in months	39.39	177.58	352
Demand for loan	Measured in 10000 CNY	109.76	489.96	772
Application for loan	Measured in 10000 CNY	86.16	338.40	384
Obtaining for loan	Measured in 10000 CNY	65.93	229.48	267
Loan availability	Obtaining for loan/Demand for the loan, Measured in percent	0.23	0.39	772
Credit constraint	Obtaining for loan/Demand for loan less than 100%=1; equal to 100%=0	0.83	0.38	749
Obtaining for loan/Total land scale	Measured in CNY/mu	1625.48	15978.85	1096
Have non-performing loans	yes=1; no=0	0.01	0.10	1096
Have informal loans	yes=1; no=0	0.63	0.48	865
Regional characteristics				
Sample from Henan Province	yes=1; no=0	0.37	0.48	1096
Sample from Zhejiang Province	yes=1; no=0	0.36	0.48	1096
Sample from Heilongjiang Province	yes=1; no=0	0.27	0.45	1096
Other characteristics				
Native	yes=1; no=0	0.96	0.20	1093
Agricultural insurance	yes=1; no=0	0.61	0.49	964

2.2. Empirical model

2.2.1. Method of 2SPLS

Most of the studies deal with the question of endogenous unclearly, while studies have proven that loans affect land scale, pointing out the two-way relationship between loans and land scale. Method of two-stage least squares (2SLS) is widely used for solving the problem of endogenous that caused by reciprocal causation (Nestler, 2015), and two-stage Probit least squares (2SPLS) is applied in the study given the research object.

In this study, variable Credit constraint is dichotomous, while variable Total land scale is continuous. 2SPLS regressions are applied for research, and we hypothesize that land scale cannot lower credit constraints. Given a simultaneous equations model Eqs. (1-8) (Omar and Kwshk, 2003):

$$lnL = \alpha_1 C^* + \beta_1 X_1 + \varepsilon_1 \quad (1)$$

$$C^* = \alpha_2 lnL + \beta_2 X_2 + \varepsilon_2 \quad (2)$$

where: *lnL* defines the logarithm of the *Total land scale* and it is a continuous endogenous variable. C^* is a dichotomous endogenous variable, and it is observed as 1 if $C^* > 0$, and 0 otherwise. X_1 and X_2 are matrices of exogenous variables. α_1, α_2, β_1, and β_2 are the vector of unknown parameters. ε_1 and ε_1 are the error terms, and they are unobserved factors with zero mean.

Since C^* is not observed, the structural equations above can be rewritten as:

$$lnL = \alpha_1 \lambda_0 C^{**} + \beta_1 X_1 + \varepsilon_1 \quad (3)$$

$$C^{**} = \frac{\alpha_2}{\lambda_0} lnL + \frac{\beta_2}{\lambda_0} X_2 + \varepsilon_2 \quad (4)$$

Then the estimation can follow the typical two-stage estimation process. In the first stage, the two models are fitted using all the exogenous variables in (Eq. 3-4):

$$lnL = \prod_1 Y + \mu_1 \quad (5)$$

$$C^{**} = \prod_2 Z + \mu_2 \quad (6)$$

where: Y and Z are matrixes of all the exogenous variables in (Eq. 3-.4), Π_1 and Π_2 are vectors of parameters to be estimated, μ_1 and μ_2 are error terms.

In the second stage, the endogenous variables in Eq. (3-4) are replaced by their respective fitted values:

$$lnL = \alpha_1 \hat{C}^{**} + \beta_1 X_1 + \varepsilon_1 \quad (7)$$

$$C^{**} = \alpha_2 ln\hat{L} + \beta_2 X_2 + \varepsilon_2 \quad (8)$$

where $\hat{C}^{**}$ is the fitted value of the variable C^*, $\ln \hat{L}$ is the fitted value of the variable $\ln L$.

2.2.2. Method of FMM

Methods such as introducing dummy variables are widely used in the study of loans for eliminating the heterogeneity of farmers. Farmers display an obvious difference in the ability to abating credit rationing, and it could not be identified by several control variables. The grouping analysis is another common method, dividing farmers into groups factitiously. Finite Mixture Models (FMM) is one of the methods that divide farmers into groups mathematically, eliminating the heterogeneity caused by unobserved factors.

The potential of farmers is different, indicating that the ability of farmers to obtain loans varies. According to Fei and Lin (2016), there were obvious regional differences, even within a single province.

The frequency of application for a loan may be different among farmers who obtained equivalent loans. An FMM is combined with several distribution models, thereby avoiding errors and the loss of efficiency. FMM has been applied in medical insurance, job loss, disease risk, health economics, and so on (Deb and Trivedi, 2002; Hughes et al., 2000). FMM can be matched with many regression models, such as linear regression, binary-value response, generalized linear, decentralized response, fractional response, and survival models.

To improve the results, Loan availability is selected as the dependent variable for further analysis. It is defined as the ratio of loans obtained and loan demand (Luan and Bauer, 2016), which range from 0 to 1 and are less than 1 if loans were obtained with a discount. The value is set to 1 if a loan was obtained without discount and 0 if they failed to obtain a loan. A Tobit model is suitable for the regression, and we hypothesize that the effect of land scale on loan availability depends on the intrinsic potential of farmers.

The density function in the group K is defined by Eq. (9)

$$f(y|x;\theta_1,\theta_{2,\ldots,}\theta_k;\pi_1,\pi_2,\ldots,\pi_k)=\sum_{j=1}^{k}\pi_j f_i(y|x;\theta_j), \quad (9)$$
$$0<\pi_j<1$$

The maximum likelihood of the density function is Eqs. (10-11) :

$$max\ln ML=\sum_{j=1}^{k}(log\sum_{j=1}^{k}\pi_j f_i(y|x;\theta_j)) \quad (10)$$

$$\pi_j=\frac{exp(\gamma_j)}{exp(\gamma_1)+exp(\gamma_2)+\ldots+exp(\gamma_{k-1})+1} \quad (11)$$

In an FMM model, the overall conditional mean is the linear combination of the conditional mean of each category, as well as the marginal benefit of covariates. The prior probability of y_i in group K is a constant Eq. (12):

$$Pr[y_i\in populationk|x_i,\theta]=\pi_k,k=1,2,\ldots,K \quad (12)$$

while the posterior probability is Eq. (13):

$$Pr[y_i\in populationk|x_i,y_i;\theta]=\frac{\pi_k f_k(y_i|x_i,\theta_k)}{\sum_{j=1}^{K}\pi_j f_j(y_i|x_i,\theta_j)} \quad (13)$$

Loan availability is selected to test the effect of land scale, omitting samples who obtained no loans or full loans. The histogram graph of *Loan availability* is shown in Fig 1. The overall distribution of the variable does not coincide with normal distribution, but its components do, indicating that the distribution of *Loan availability* is composed of a few normal distributions. Therefore, FMM is a suitable approach to determine the real distribution of *Loan availability*.

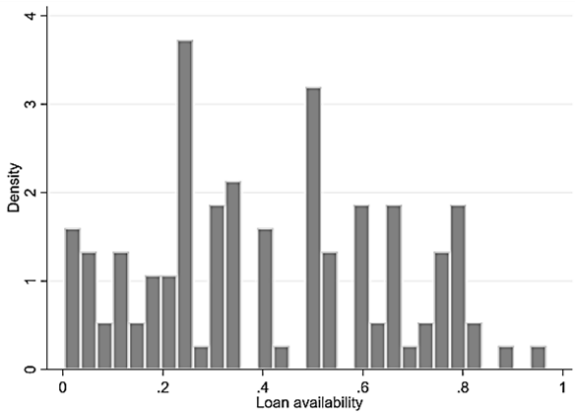

Fig. 1. Histogram graph of Loan availability

The potential category of *Loan availability* is analyzed in Table 2, and the Akaike Information Criterion (AIC) is tested for the selection of FMM Tobit regression.

According to the definition (Eq. 14):

$$AIC=2k-2ln(LM) \quad (14)$$

The model with the minimum AIC is the most suitable. The FMM 3 Tobit model is selected for regression, with three categories. Group 1: "Weak inner ability," Group 2: "Moderate inner ability," and Group 3: "Strong inner ability." The outcome of marginal probability shows that 19.23% of the samples belong to Group 1, 21.82% belong to Group 2, and 58.95% belong to Group 3.

Table 2. Fit index of models

Models	***Log-likelihood (LM)***	***Degree of freedom (k)***	***AIC***
Single category	-2.0906	3	10.1813
Two categories	7.0499	7	-0.0998
Three categories	14.4858	11	-6.9716
Four categories	16.3777	15	-2.7554

3. Results and discussion

3.1. Results

Table 3 presents our main regression results of examining the effects of the total land scale on the likelihood that farmers suffer from credit constraints. Model (1) represents regressions without the instrument, Model (2) represents regressions with the instrument, and Model (3) is improved regressions with corrected standard errors based on Model (2). Probit in Model (3) shows our final result.

According to the probit results in Model (3), the total land scale is positive and statistically significant at the 10% level. It indicates that farmers who own more land are more likely to be constrained by formal financial institutions than those who own less land, confirming the situation that new agricultural management entities are suffering from credit constraints (Turvey et al., 2012). The control variables Native and Have informal loans are positive and statistically significant at the 10% and 1% level, respectively, indicating that farmers who are native to the region, as well as have ever borrowed loans from informal financial institutions, are more likely to suffer from credit constraint.

It can also be inferred from these regressions that Credit constraints do not affect the total land scale. Data selected in our study are all from the same period; Credit constraint is likely to affect the total land scale in the lagged period, but not in the current period. The Wald test (Table 4) proves that the two-way relationship between loans and land scale is insignificant.

The models above ignore the heterogeneity in farmers, and the effect of variable Native is not as expected. Steps should be taken to improve the results. Table 5 reports the results of both Tobit and FMM Tobit regressions, and only significant variables are listed.

Total land scale is not significant in the Tobit regression, while that in all of the three groups in the FMM Tobit regression is significant; it is negative in Groups 1 and 2, statistically significant at the 1% level, and it is positively significant at the 10% level in Group 3. It suggests that farmers who have strong inner abilities are likely to escape the constraint of formal financial institutions. By comparing the results of Table 3 and Table 5, the FMM Tobit regression is found to be more logical than the Tobit regression, confirming that FMM is a perfect mathematical tool for eliminating heterogeneity.

Native in Group 2 is positively statistically significant at the 1% level, while it is negatively statistically significant at the 10% level in Group 3. This indicates that if farmers who do not have strong inner abilities are native to the region, they could have higher loan availability. In the Tobit regression, having informal loans is negatively significant at the 1% level in Group 1 and Group 3, while it is positively significant at the 1% level in Group 2. This suggests that farmers who have ever obtained loans from informal financial institutions have no preference for loans from formal financial institutions.

Table 3. Estimation results of 2SPLS

Variables	**(1)**		**(2)**		**(3)**	
	OLS	***Probit***	***OLS***	***Probit***	***OLS***	***Probit***
The logarithm of *total land scale*	-	-	-	0.1772*	-	0.1772*
	-	-	-	(1.88)	-	(1.88)
Credit constraint	-	-	-0.4055	-	-0.4055	-
	-	-	(-0.49)	-	(-0.31)	-
Gender	-0.1230	-0.3713	-0.2736	-0.3119	-0.2736	-0.3119
	(-1.09)	(-1.03)	(-0.82)	(-0.88)	(-0.51)	(-0.89)
Age	-0.0008	-0.0045	-0.0026	-0.0043	-0.0026	-0.0043
	(-0.23)	(-0.48)	(-0.51)	(-0.47)	(-0.31)	(-0.47)
Education (base outcome=below primary school)						
primary school	0.1260	-0.2737	0.0150	-0.3295	0.0150	-0.3295
	(0.86)	(-0.64)	(0.06)	(-0.79)	(0.03)	(-0.79)
junior high school	0.2282*	-0.3100	0.1024	-0.3527	0.1024	-0.3527
	(1.67)	(-0.77)	(0.34)	(-0.89)	(0.21)	(-0.89)
senior high school or technical secondary school	0.4099***	-0.0001	0.4096***	-0.1165	0.4096	-0.1165
	(2.76)	(-0.00)	(2.76)	(-0.27)	(1.60)	(-0.27)
University and above	0.4287**	-0.3985	0.2671	-0.4757	0.2671	-0.4757
	(2.23)	(-0.71)	(0.67)	(-0.85)	(0.42)	(-0.85)
Types of crops	0.2528***	-0.1974	0.1728	-0.2529	0.1728	-0.2529
	(3.29)	(-0.89)	(0.94)	(-1.15)	(0.59)	(-1.15)
Native	-0.1601	0.5731	0.0723	0.6676*	0.0723	0.6676*
	(-1.10)	(1.54)	(0.14)	(1.89)	(0.09)	(1.87)
Have informal loans	-0.1584**	0.6370***	0.0999	0.6534***	0.0999	0.6534***
	(-2.36)	(3.54)	(0.19)	(3.68)	(0.12)	(3.71)
Region (base outcome= Heilongjiang Province)						
Henan Province	-0.3989***	0.3843*	-0.2430	0.4219*	-0.2430	0.4219*
	(-4.88)	(1.66)	(-0.72)	(1.95)	(-0.46)	(1.95)
Zhejiang Province	-0.2242	-0.2760	-0.3362	-0.1555	-0.3362	-0.1555
	(-0.86)	(-0.47)	(-0.99)	(-0.27)	(-0.64)	(-0.28)
Have ever been a cadre	0.1348	0.0356	0.1492	-	0.1492	-
	(1.48)	(0.14)	(1.52)	-	(0.90)	-
Party number	0.2679***	0.0134	0.2733***	-	0.2733*	-
	(3.10)	(0.05)	(3.13)	-	(1.83)	-
Have join a train	0.2378***	0.0766	0.2689***	-	0.2689	-

	(3.04)	(0.36)	(2.65)	-	(1.63)	-
Land approval (base outcome= not ready to be approved yet)						
All lands have been approved	0.0391	0.2892	0.1564	-	0.1564	-
	(0.45)	(1.16)	(0.60)	-	(0.38)	-
some of the lands have been approved	0.0858	-0.1317	0.0324	-	0.0324	-
	(0.87)	(-0.50)	(0.23)	-	(0.14)	-
plan to be approved	0.1931*	-0.1398	0.1364	-	0.1364	-
	(1.91)	(-0.51)	(0.90)	-	(0.56)	-
The logarithm of *ideal land size*	0.7135***	0.1310*	0.7667***	-	0.7666***	-
	(27.58)	(1.66)	(6.87)	-	(4.38)	-
Insurance	-0.0737	-0.0167	-0.0804	-	-0.0804	-
	(-1.13)	(-0.09)	(-1.02)	-	(-0.72)	-
Have non-performing loans	0.1300	-0.3207	-	-0.2573	-	-0.2572
	(0.49)	(-0.51)	-	(-0.41)	-	(-0.43)
_cons	1.4232***	0.1362	1.4785***	-0.1089	1.4785***	-0.1089
	(4.76)	(0.16)	(4.62)	(-0.12)	(2.73)	(-0.13)
LR chi2	-	31.12	-	25.65	-	-
Prob>F/ Prob>chi	0.0000	0.0537	0.0000	0.0189	-	-
Log-likelihood	-	139.5557	-	142.2875	-	-

*Note: ***, **, and * respectively indicate that the estimated coefficients are significant at levels 1%, 5%, and 10%. The values in brackets are t values*

Table 4. Result of the Wald test

Variables	***Wald test***		***Prob > chi2***
	chi2 (1)	***P***	
Instruments of Probit			
Have ever been a cadre	0.21	0.6495	0.1076
Party number	0.40	0.5272	0.1064
Have join a train	0.02	0.8770	0.0812*
Land approval	2.09	0.1487	0.0000***
The logarithm of Ideal land size	0.06	0.8124	0.0298**
Insurance	0.18	0.6745	0.0000***
Instruments of OLS			
Have non-performing loans	0.04	0.8324	0.0000***

*Note: ***, **, and * represent that the estimated coefficients are significant at levels 1%, 5%, and 10% respectively.*

Table 5. Estimation results of Tobit and FMM Tobit

Variables	***Tobit***	***FMM Tobit***		
		Group 1	***Group 2***	***Group 3***
The logarithm of total land scale	-0.0011	-0.0191***	-0.0562***	0.0276*
	(-0.06)	(-3.75)	(-6.77)	(1.74)
Native	0.0272	0.0337	0.3364***	-0.2024*
	(0.22)	(0.97)	(8.82)	(-1.69)
Have informal loans	-0.1331***	-0.2474***	0.4549	-0.3139***
	(-2.61)	(-14.38)	(27.47)	(-6.14)
Region (base outcome= Heilongjiang Province)				
Henan Province	0.0262	0.0345*	0.2059***	0.0309
	(0.46)	(1.73)	(4.74)	(0.52)
Zhejiang Province	0.0402	0.0391*	0.0689	0.0452
	(0.54)	(1.70)	(1.36)	(0.57)
_cons	0.4492**	0.3610***	-0.026	0.6994***
	(2.57)	(7.21)	(-0.27)	(4.16)
LR chi2 (5)	9.55	-	-	-
Prob>chi2	0.089	-	-	-
Log-likelihood	4.4928	35.6436		

*Note: ***, **, and * respectively indicate that the estimated coefficients are significant at levels 1%, 5%, and 10%.*

3.2. Discussion

3.2.1. Reasons for the heterogeneity between farmers

The study shows that the effect of land scale on obtaining credit depends on farmers' personal potential to obtain credit. Previous literature has demonstrated that farmers are heterogeneous in their ability to produce products of high quality (Merel et al., 2015) and beliefs (Lapple and Kelley, 2013).

The question of whether farmers can provide high-quality products depends on complex factors. Blandon et al. (2009) found that small-scale farmers are limited in the scale of management due to the absence of ability in both production and

management, indicating that farmers who are skilled in producing high-quality products are more likely to realize scale management (Blandon et al., 2009). Farmers who are gifted in learning new skills, as well as those who have skilled workers on their farms are more likely to provide high-quality products. Besides, the mode of operation in the industrial chain affects the quality of products. It is hard to estimate which is better between the integrated production and division of labor since both have their advantages and disadvantages, but it can be confirmed that the difference in efficiency between them may bring the heterogeneity of providing high-quality products.

Also, the heterogeneity of the objectives of agricultural management can lead to different behaviors between farmers. Previous research revealed that farmers are heterogeneous in behavior (Abay et al., 2018), resulting from different attitudes and objectives among farmers (Karali et al., 2013). Moreover, attitudes toward agricultural management are likely to be affected by risk propensity (Chiappori et al., 2014), preference for a specified scheme (Villanueva et al., 2017), and so on. Contrary to farmers who prefer risk, those who tend to evade risk are more inactive in investment. In this case, they would obtain less profit than those who input abundant investment. Similarly, when a scheme is put forward, interested farmers are likely to be active in responding. Farmers who are meant to maintain the current scale of management would like to grow food crops, which have a more stable market than economic crops. On the contrary, farmers who are aimed at expanding the scale of management would like to grow economic crops as they can bring more profit than food crops. Taking the heterogeneity in farmers' attitudes and objectives into consideration, farmers behave differently, especially in terms of investment. Besides, the heterogeneity in behavior leads to slow but continuous change in potential ability.

Except for the heterogeneity of farmers in the ability to provide high-quality products and beliefs, heterogeneity between macroeconomic developments may also be one of the possible factors. Regional variables for provinces are selected in the models, but heterogeneity in cities is unobserved. Previous studies show that farmers are influenced by spatial heterogeneity (Lankoski et al., 2008; Useche et al., 2009), which is similar to the influence of regional heterogeneity. Differences in economic development and industrial structure among regions may be responsible for the heterogeneity.

3.2.2. Results of the heterogeneity between farmers

The participation of external capital such as credit will affect the activities of agricultural production, including both the organization of production factors and the adjustment of planting decisions. On one hand, the expansion of farmland management scale is conducive to the realization of the economy of scale, and the reduction of per-unit cost of production (Pokharel and Featherstone, 2019). On the other hand, farmers' income may not consistent with the farmland management scale because of the increased cost of capital, land rent, and employment. As a result, depending only on expanding the farmland management scale could not realize the target of increasing farmers' income (Barbier, 2020).

Adjusting the decisions of management is a common method of increasing income for farmers, including changing the crop they grow and changing the efficiency of per unit of farmland.

As for the former case, farmers would grow the economic crop in their farmland rather than grain, which is contrary to the behavior before they expanding the management scale. As the method of changing the crop they grow is of high risk, assuming that there is no constraint of labor, the more farmland management scale expanding, the higher possibility of increasing the area of economic crop. On the contrary, for farmers who expand only a few farmlands, they were likely to escape from the heavy interest expense and farmland rent, and they don't have to increase the area of economic crop.

As for the latter case, farmers may increase the use of pesticides and fertilizers to produce more products than before. The benefits of the use of pesticide, as well as fertilizers, is at the cost of the ecosystem and environment (Fenner et al., 2013). On one hand, the use of pesticides and fertilizers simultaneously promotes the stability and enhancement of agricultural efficiency (Wang et al., 2019). On the other hand, the pesticide residues and their metabolites are harmful to human health and other living creature (Samsidar et al., 2018), and a significant portion loss of fertilizers would increase the agricultural cost (Chen et al., 2018).

The discussion above presents the challenges for the sustainability of modern agriculture. Suggestions such as growing legume crops (Stagnari et al., 2017), reducing the reliance on nitrogen fertilizer (Hawkesford, 2014), and integrating cropping with livestock systems (Lemaire et al., 2014) had been proposing in the past. To realize the sustainable growth of productivity, adequate investment, as well as effective technologies and innovative institutions, will be required to promote the adoption of environmentally friendly measures in farmers.

4. Conclusions

As the main force of agriculture in China, new agricultural management entities require financial support but are suffering from credit constraints. This study applied the 2SPLS method to examine the effect of land scale on credit constraint, and the FMM method is applied to assess the effect of land scale on loan availability.

The results show that: (1) For farmers who have a strong inner ability, the more land they own, the higher the loan availability. Otherwise, for farmers who do not have a strong inner ability, the more land they own, the lower the loan availability. (2) For farmers who have a strong inner ability, non-local

farmers have higher loan availability. Otherwise, for those who have a moderate inner ability, local farmers have higher loan availability. (3) Regardless of the farmers' inner ability, those who have ever obtained loans from informal financial institutions have lower loan availability.

Attention should be paid to the financial support for new agricultural management entities, especially for those who are less able to obtain loans from formal financial institutions. The development of agriculture in China is currently mainly supported by new agricultural management entities, and policies should be established to guarantee financial resources for these. What's more, attention should be paid to the sustainability of modern agriculture, and the coordinated development of productivity and the environment would be the direction of innovation.

Here are some suggestions for policy improvement in Chinese agriculture. Firstly, in the process of agricultural management, the promotion and subsidy of agricultural new machinery should be increased, and the input of labor costs should be reduced. Secondly, relevant departments should further improve the mortgage guarantee system of financial institutions to relax financial market access standards, and gradually improve the possibility of farmers obtaining sufficient funds, preventing the lack of funds and difficulty in getting funds. Lastly, the government should take measures appropriately to ensure the sustainable and stable development of agricultural management.

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