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From survival goals to economic rationality: the determinants of farmer households' dual decision regarding land rental area

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Introduction: Large-scale land rentals are a fundamental way of realizing the moderate-scale operation and transformation of modern agriculture. As the suppliers and main demanders in the land rental market, the decision-making logic of farmer households determines the scale of land rentals. However, land rentals have been plagued by the prominent issues of farmer households' insufficient participation and fragmented rental transactions. It is importance and urgent to promote farmer households' participation in large-scale land rental market.

Methods: Based on a sample of 4,815 farmer households from the China Family Panel Studies (CFPS) database, this study applied Bivariate Tobit (Bi-Tobit) model to investigate the correlation between farmer households' decisions of rented-in and rented-out area, and analyzed the determinants and inherent logics of the decision making. Heterogeneity analysis was made to examine the difference in surplus and indebted farmer households.

Results: The results showed that there was a significantly negative correlation between the household rented-in area and the rented-out area. The land value had significantly positive effect on the rented-in area and the rented-out area. Household social security had a significantly positive effect on the rented-out area, but had no significant effect on the rented-in area. For indebted households, only social security significantly affected their decisions of rented-out area, while for surplus households, land value rather than social security became the significant determinant of rented-in and rented-out area.

Discussion: Farmer households' land rented-in area and rented-out area have comprised a dual decision with a significant negative correlation. Facing the dual functions of creating economic value and providing social security of rural land, farmer households' decision-making logic of rented-in area is dominated by economic rationality, whereas that of rented-out area involves the coexistence of economic rationality and survival rationality. With the improvement of household income level, the dominant logic of the decisions of land rental area transformed from survival rationality to economic rationality. Policies should enhance the rural social security system to increase land rental area, especially by providing adequate social security for farmer households with a lower income level.

KEYWORDS

land rental area, survival rationality, economic rationality, China Family Panel Studies (CFPS), land value, social security

1. Introduction

Agricultural scale operation is the key to promoting the transformation of modern agriculture in transitional countries, which could not only directly optimize the agricultural factor allocation, but also improve the efficiency of agricultural production by affecting farmers' employment and technology choices (Hong et al., 2020; Gao et al., 2021; Yang et al., 2022). In the process of China's agricultural transformation, it is facing the dilemma of land fragmentation and land abandonment. First, under the household contract responsibility system that began in China in the 1980s, the plots contracted by each household were fragmented. It was reported that 76.11%[1] of Chinese farmer households hold <0.67 hectares of arable land. Second, in the process of urbanization a large amount of population migrated from rural areas to cities. According to the Migrant Workers Monitoring Survey Report (2021) of the National Bureau of Statistics of China, the total number of migrant farmers in China exceeded 290 million in 2021, of which more than 24%[2] moved across provinces. A large number of farmers left agriculture to off-farm jobs, resulting in the problem of an increasing amount of abandoned rural land (Zhou et al., 2020; Hou et al., 2021; Wang et al., 2022; Zhang et al., 2022). In such a context, land rentals have become an important institutional innovation, providing a path for agricultural operators to enlarge their farms and achieve scale economy (Cheng et al., 2019). Establishing an orderly land rental market to enlarge the land rental area has becoming particularly important in China. The central government of China had issued a series of policies to encourage land rentals, and promoted to establish a unified land rental market in the mid-1980s (Cheng et al., 2019; Tang et al., 2019). As of 2021, a total of 73.21 million farmer households in China rented 37 million hectares of land, accounting for 33.27% of the total number of farmer households and 40% of the total area of land.[3] Small farmer households played the role of suppliers as well as the main demanders in current land rental market, with 60.14%[4] of rented-out land was rented-in by other small farmer households in 2020. However, evidence showed that land rentals were still plagued by the prominent issues of farmer households' insufficient participation and small-scale fragmented rental transactions at the current stage (Chen and Zhai, 2015; Ma et al., 2015; Gao and He, 2023). Figure 1 displays the national land rental area and its growth rate in the period of 2007–2021. It can be found that the growth rate of land rental area slowed down significantly, from 70.3% in 2008 to 0.2% in 2019–2020. As shown in a survey of farmer households conducted by the Ministry of Agriculture and Rural Affairs of China in 2015, only 25.01% of farmers chose to rent out farmland, with an average area of only 0.61 hectares (Cheng et al., 2019). Ma et al. (2020) found that only 28.5% of the respondents have rented in farmland in Jiangxi and Gansu provinces, with an average area of 0.63

hectares. These findings highlighted the importance and urgency of promoting farmer households' participation in large-scale land rental market.

Numerous studies on development economics and agricultural economics have examined the drivers or constraints of land rentals. At the institutional level, many scholars claimed that factors restraining the effective demand and supply of the land rentals included an inadequate land rental market (Ma et al., 2015; Gao and Chen, 2018), high transaction cost (Wang et al., 2015; Huang and Ding, 2016; Ito et al., 2016; Li and Ito, 2021), incomplete land tenure (Holden et al., 2011; Deininger et al., 2017; Cheng et al., 2019; Zhang et al., 2022), and the scarcity of off-farm employment opportunities (Huang et al., 2023). There were also a large number of studies that empirically examined the determinants of farmer households' willingness to participate in land rentals at the micro individual level, focusing on the characteristics of farmer households, plots, villages, external economic and social environment and other factors (Holden et al., 2011; Macours, 2014; Min et al., 2017; Tan et al., 2017; Cheng et al., 2019; Gebru et al., 2019; Li et al., 2019; Tang et al., 2019; Li and Ito, 2021). Moreover, an issue that cannot be ignored was that rural arable land is not only one of the input factors of agricultural production, but also played the role of providing security and risk barrier for farmer households (Chen et al., 2014; Zhou et al., 2020). In the case of an imperfect rural social security system, land served as an effective alternative to cash-based social security payments and played an important role in providing basic security for living, pension and non-agricultural unemployment (Xu and Lu, 2018; Xu et al., 2018). The dependence of farmer households on land security also determined the decision to participate in the land rental market (You et al., 2013; Li et al., 2019).
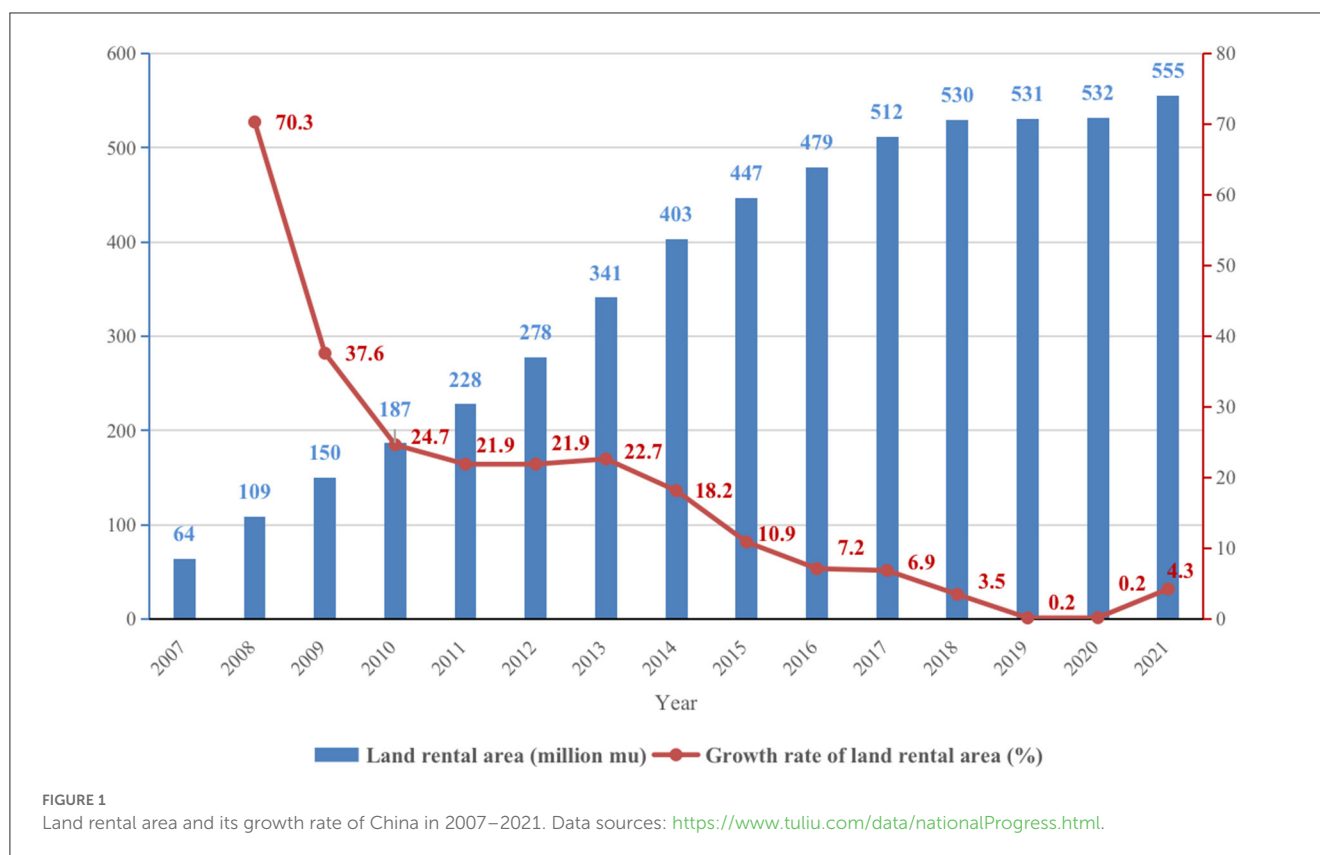
The theoretical basis of these rich and diverse research on farmer households' decision making can be traced to multiple theoretical schools of farmers' rationality. In classic farmer behavior theory, survival rationality and economic rationality were the two mainstream discourse to explain farmers' decision-making logics. Survival rationality of farmers proposed by Chayanov (1996) stressed that the motivation of farmer households' production behavior was to meet their own survival goals. Assuming that in the absence of a labor market, farmers' primary goal of agricultural operation and labor inputs was simply to meet the minimum consumption needs of the entire family. The core decision-making logic was not maximizing profits but rather securing their own livelihood, which was fundamentally different from that of capitalist farmers. They exhibited obvious characteristics of risk aversion (Scott, 1977). Economic rationality of farmers proposed by Schultz's (1983) claimed that farmer households and entrepreneurs had the same decision-making logics. Any economic decision of farmers followed the principle of profit maximization and utility maximization. They made trade-offs between income and cost to optimize the resources allocation and agricultural production. Due to the scenario of "small farmer households in a large country" in China and the rapidly changing rural society during the transition period, the western farmer behavior theories were no longer applicable to analyze the decision making of Chinese farmer households (Ye and Xu, 2021). The Chinese agricultural economist Huang (2000) extracted the characteristics of "comprehensive small farmers" in China. He suggested that Chinese farmers

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FIGURE 1
Land rental area and its growth rate of China in 2007–2021. Data sources: https://www.tuliu.com/data/nationalProgress.html.

made economic decisions based on family units rather than on individuals, and they should would greater consideration to the value of family intergenerational inheritance. To achieve that, survival rationality and economic rationality were two main traits coexisted in comprehensive small farmers. Several research have also noted that Chinese farmer households' production and management decisions may be dominated by multiple rationality, and also, the differentiation of farmer households also led to differences in the decision-making logic (Zhong and Kong, 2013; Fang and Zhou, 2018).

These studies provided crucial viewpoints on the issues of the land rentals in developing countries. However, according to the land rental market undergoing transition in China, there were still research gaps in the existing literature that need to be improved. First, the identification of farmer households' logics of decision making in land rentals lacked the comparative analysis of economic rationality and survival rationality, and also lacked further consideration of the heterogeneity of farmer households. China's small farmers were both profit-seekers and subsistence producers, who had the dual goals of profit maximization and risk minimization (Hou and Huo, 2015). Faced with multiple risks associated with farming and living in the country, farmers regarded land as personalized property and an important risk barrier (Xu et al., 2011; Luo et al., 2015). Especially for farmers who migrated to urban areas, due to the instability of off-farm employment and the inability to be covered by urban social security, rural land was their last guarantee when they lost work and had to return to farming (Qian and Hong, 2016; Xu and Lu, 2018). Farmer households renting in land also equally considered the long cycle and low

income related to agriculture, as well as multiple uncontrollable risks such as policy, nature and market in agricultural production (Chen and Zhang, 2015; Xu et al., 2018). The conflicts among the need for scale operation, limited external support and resource endowment made it more difficult to rent large areas of land (Chen and Zhai, 2015; Huang et al., 2023). Therefore, land rental decisions for farmer households might be a trade-off between economic benefit and risk avoidance. Besides calculating the direct benefits and costs based on economic rationality, farmer households must consider the value of land security to fulfill their survival goals.

Second, previous studies mostly assumed that to rent in or to rent out are independent decisions, and examined their determinants separately (Cheng et al., 2019; Tang et al., 2019; Ma et al., 2020; Zhang et al., 2022). In fact, the land contracted by farmer households was fragmented, and almost every household included multiple plots with different areas, locations and soil fertility. In this case, for the needs of land concentration and scale operation, farmer households may simultaneously rent out some plots as principals and rent in other plots as agents Rahman (2010). It provides the possibility of positively correlated decisions of renting in and renting out. Another possible case is that the two decisions might be negatively correlated. Renting in land means that farmer households have agricultural production as their main income source, while renting out land means that farmers have migrated to off-farm employment and have no need for rural land. Farmer households who rented out land may no longer rent in other land plots. That is, the two decisions will be highly mutually exclusive. Therefore, under the premise of farmer households pursuing optimal scale and maximizing the benefits, decisions

regarding renting in and renting out may be related. The omission of the intrinsic relationship between land rental decisions may lead to bias in empirical analysis.

Furthermore, although a few studies applied joint estimation methods such as Bivariate Probit to estimate renting-in and renting-out decisions (Min et al., 2017; Tan et al., 2017; Li et al., 2019), they only focused on the "participation decision"—that is, the choice of whether to rent in or rent out (He et al., 2023). They did not go further into the "intensity decision" (Teklu and Lemi, 2015), which focused on the rented-in area or rented-out area. For farmer households, it is relatively easy to participate in the land rental market by renting small land plots. However, renting a large area of land or multiple concentrated plots not only means large amounts of income and expenditure changes, but also further determines whether they will mainly make a living from farming. Therefore, the decisions of "Whether to rent" and "How large to rent" may have completely different logics and determinants. Moreover, compared with the probability of land rental market participation, the explanation of land rental area could better serve the policy goal of promoting land concentration and realizing moderate-scale operation (Teklu and Lemi, 2015; Gao and He, 2023).

This study contributed to existing research by firstly assuming that farmer households' decisions of rented-in land area and rented-out land area are correlated. Combining the decision-making logics of economic rationality and survival rationality, this study used the sample of 4,815 farmer households collected by the China Family Panel Studies (CFPS), and applied the joint estimation method of Bivariate Tobit (Bi-Tobit) model to examine the farmer households' decision-making regarding land rentals. CFPS contains representative and random samples covering 25 provinces, including detailed information on household economy, population, land use, etc. To examine the decision of "how large to rent", the Bi-Tobit has the advantage of revealing the real participation intensity as well as the potential participation intensity of farmer households who did not rent land in or out (Teklu and Lemi, 2015). To reveal farmer households' decision-making logics of economic rationality and the survival rationality, we selected land value and social security as the key variables in empirical analysis. Heterogeneity analysis was also conducted for farmer households with different household income levels. The structure of the following text was arranged as follows: Section 2 introduced the data collection and processing process adopted by this study, as well as the measurement model and variable setting; Section 3 discussed the estimation results of the regression models; Section 4 provided discussions of the results; and Section 5 provided the conclusion and policy implications of this study.

2. Materials and methods

2.1. Data sources

This study used data from the CFPS funded by the "985" Program of Peking University and implemented by the China Social Science Research Center of Peking University. Although CFPS has provided tracked survey data in every 2 years, the main objectives and research field as well as the corresponding survey questionnaires will be adjusted by years. The dependent variables rented-in/out area were not included in CFPS database after 2012 anymore. To examine the decision-making regarding land rental area, we could only apply the CPFS data in 2012. The CFPS data in 2012 tracked households in 25 provinces of China and collected individual-, family-, and community-level data, including information on household income and expenditure, land characteristics, agricultural production, demographics, etc. We constructed the sample data by matching the three level variables. Samples were screened based on the following criteria: (1) the category of household was classified by the China Bureau of Statistics is "Rural"; and (2) the land area contracted by the household is not zero. As the "Rural" category in the China Bureau of Statistics may also include suburban villages, some farmer households no longer had contracted land after land expropriation, and completely withdrew from agriculture. This kind of farmer household was not included in the scope of this study. After screening and deleting samples with omissions in key variables, a sample set of 4,815 farmer households covering 24 provinces was finally formed.[5]

The descriptive statistics of the sample are shown in Table 1. Among the total of 4,815 samples, 1,163 farmer households had participated in the land rental market, accounting for about 24% of the total sample. Among the participated households, there were 442 households that only rented out and 701 households that only rented in, accounting for 37.87 and 60.06% of the households who participated in the land rental market, respectively. The average rented-out area and rented-in area of households were 0.29 hectares and 0.68 hectares, respectively. There were 24 farmer households that rented in and rented out simultaneously, accounting for 2.06% of the farmer households involved in the land rental market. The average rented-out area was 0.25 hectare, and the average rented-in area was 1.46 hectares. Although this proportion was small, it was consistent with theoretical assumptions and practical experience that the decisions to rent in and rent out may be interrelated. Comparing the area of rented-in and rented-out land, the average area of rented-in land was more than 2 times that of the average rented-out area among farmer households with one-way renting. For farmer households that with renting in and renting out simultaneously, the average rented-in area was nearly 6 times that of the average rented-out area. The gap suggested that land rentals had a trend toward land concentration and scale operation. Furthermore, the determinants of rented-out area and rented-in area may be different, meriting further empirical examination.

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5 The 24 provinces (including municipalities and autonomous regions) are: Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi Zhuang Autonomous Region, Chongqing, Sichuan, Guizhou, Yunnan, Gansu, Shaanxi, Heilongjiang, Jilin, Liaoning Province.

TABLE 1 Statistics of farmer households' participation in the land rental market.

Total sample	Fre.	%	Participated sample	Fre.	%	Average rented area (hectare)
Participated households	3,648	75.85	Households only rented out	442	37.87	0.29
			Households only rented in	701	60.07	0.68
			Households with rented in and out simultaneously	24	2.06	Renting out: 0.25
						Renting in: 1.46
Not participated households	1,163	24.15				
Total	4,815	100	Total	1,167	100	-

Data sources: CFPS.

TABLE 2 Definitions of variables.

Variables	Definitions and units
Dependent variables	
Rented-in area	Household rented-in land area (mu)
Rented-out area	Household rented-out land area (mu)
Explanatory variables	
Land value	Value of household contracted land (1,000 CNY)
Social security	The proportion of family members who have received pension insurance payments (%)
Control variables	
Household net income	Household net income (1,000 CNY)
Off-farm employment	Share of off-farm income in total income (%)
Household asset	Value of household non-agricultural fixed assets (1,000 CNY)
Land endowment	Area of per capita household contracted land (per capita hectares)
Agricultural subsidies	Amount of received agricultural subsidies (CNY)
Agricultural machinery input	The proportion of agricultural machinery input to total physical capital input (%)
Age of householder	Years
Education of householder	Ordered dummy: 1 = illiterate; 2 = elementary school; 3 = junior high school; 4 = high school/technical school/vocational high school; 5 = college; 6 = undergraduate; 7 = master; 8 = doctor and above
Village location	Travel time from the village central location to nearest commercial center (minutes)
Village topography	Multinominal dummy: hilly area; alpine; plateau; plain; grassland; fishing village; other
Local economic development[a]	Provincial per capita GDP (1,000 CNY)
Local agricultural development[b]	Provincial grain output (10 million tons)
Local land rental market development[c]	Provincial average rents obtained (paid) by renting out (renting in) land (CNY)

[a,b]The data is from National Bureau of Statistics of China (2013).
[c]The average rents obtained from renting out land is used in rented-out equation of Bi-Tobit model, and the average rents paid for renting in land is used in rented-in equation of Bi-Tobit model.

2.2. Variables selection

2.2.1. Dependent variables
2.2.1.1. Land rental area
We applied rented-out area and rented-in area as dependent variables of the Bi-Tobit model. The model assumed that the rented-in area and the rented-out area may be correlated. It provided information on the decision to participate as well as the participation intensity of "How large to rent".

2.2.2. Explanatory variables
We chose *land value* and *social security* as the core explanatory variables to examine the dual logic of economic rationality and survival rationality in farmer households' land rental decision-making. *Land value* reflected the function of land as an agricultural input factor, which was measured by economic benefits and costs based on economic rationality. *Social security* reflected the function of the land of providing social security, which revealed farmer households' dependence on land security and demand for risk aversion based on survival rationality.

2.2.2.1. Land value

The rural land is an important means of production for farmer households, which provides basic income to farmer households engaged in agriculture. Direct benefits and costs based on rational calculation are the logical starting point for small farmer households to make decisions regarding land rentals (Leng and Fu, 2014). According to the technical report of the CFPS database, the land value was calculated according to the estimation method proposed by Mckinley and Griffin (1993), assuming that land provides 25% of the total household agricultural income at a rate of return of 8%. Therefore, the land value could directly reflect the productive income provided by land. If farmer households are significantly affected by land value in land rental decisions, they may take economic rationality as the dominant decision-making logic and use market thinking to measure the direct benefits and costs brought about by land rentals.

2.2.2.2. Social security

The benefits brought about by land security are difficult to measure directly. The welfare directly related to rural land are mainly reflected in pension security for farmers (Xu et al., 2018). It was suggested that a substitution effect existed between the social pension security system and the pension security provided by land (Jin et al., 2009; Lin et al., 2016; Huang et al., 2023). The stronger the social pension security obtained by the family, the weaker the household dependence on land security. Therefore, the level of social security obtained by households can indirectly reflect the value of land security. If farmer households are significantly affected by social security in land rental decision making, it shows that they have a tendency toward risk aversion under survival rationality and may still regard land as an important source of social security. In this study, social security was measured by the proportion of people who get the payment of pension insurance in the total household population. Previous studies mostly used the dummy variable of "whether householder or family members pay pension insurance" as the proxy for pension insurance obtained by farmers (Ardington et al., 2009; Xu et al., 2018). However, paying pension insurance is not equal to obtaining the security provided by pension insurance. It is stipulated in China that individuals over 60 years old can start to benefit from pension insurance payment. Before that, participating in pension insurance is only related to the expenditure of the premium payment. Moreover, the behavior of the householder or other family members is not enough to reflect the household demographic structure, population burden and overall access to pension security. Adopting the variable of the proportion of people who get the payment of pension insurance could make up for this bias.

2.2.3. Control variables

This study selects a series of factors that may affect the decision regarding rented-in and rented-out land: household economics and employment, agricultural input and land endowments, householder's human capital[6] and characteristics of the village and local economic environment.

2.2.3.1. Household economic characteristics
2.2.3.1.1. Household net income

Farmer households' land rental decisions were made on a certain economic basis. The surplus of household net income means more freedom of decision making (Shi and Jia, 2002). The increasing of household income may motivate farmers to migrate to urban areas and leave farm away, and may also motivate them to add more agricultural input and rented in land.

2.2.3.1.2. Off-farm employment

The situation of household off-farm employment was represented by the proportion of off-farm income to total income. Compared with the variables such as "whether family members have off-farm jobs" in previous studies, the proportion of off-farm income could reflect the stability and benefit from farmers' off-farm employment (Hu and Ding, 2015). If studies only consider whether famers get an off-farm job but ignore the stability of the work and income, the impact of non-agricultural employment on land rental area may be overestimated (Xu and Lu, 2018). With the increase in the proportion of off-farm income, the dependence of farmers on farming and land may decrease, and the amount of land being rented out may increase.

2.2.3.1.3. Household assets

We adopted the value of durable consumer goods to represent household assets, including common household consumer goods such as cars, televisions, computers and refrigerators.[7] Household asset may increase farmers' ability to resist risks, thus increasing the possibility of renting out land and weakening the willingness to rent land in.

2.2.3.2. Household agricultural inputs
2.2.3.2.1. Land endowment

In rural China, farmer households contracted the land from the village collectives. Land endowment as represented by the per capita contracted land area of households. The resource endowment is closely related to farmer households' willingness of land rental. Generally, the land will flow from farmer households with abundant resource endowment to farmer households with relatively scarce resource endowment (Huang et al., 2012).

2.2.3.2.2. Agricultural subsidies

Agricultural production has the characteristics of high risk, low income and long periodicity, and needs the external support of policies and funds. In the case of low agricultural comparative income, agricultural subsidies may provide the necessary source of funds for farmer households to expand their production area, reduce agricultural production costs, and

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6 This study takes the "core respondent" of the family defined in CFPS2012 as the householder, who is the respondent of the family economic questionnaire, and assumes that the family member knows the family situation best and has the main decision-making power.

7 Source: *China Family Tracking Survey Technical Report on Property Data* of CFPS in 2012.

increase farmer households' demand for land (Chen and Zhai, 2015). In this study, agricultural subsidies were represented by the total monetary amounts of the grain production subsidies, seed subsidies, agricultural materials subsidies and agricultural machinery subsidies.

2.2.3.2.3. Agricultural machinery input

The agricultural machinery input represents the agricultural assets of the farmer. Under the imperfect conditions of the agricultural machinery market, owning more agricultural assets makes it possible for farmer households to rent in more land and achieve scale operation. On the contrary, households owning more agricultural assets will have higher sunk costs in renting land out. Agricultural machinery input was represented by the proportion of the value of agricultural machinery owned by households to the total capital input. In addition to machinery capital, the total capital inputs also included physical capital composed of various direct and indirect costs incurred by intermediate inputs in agricultural production, such as the costs of seeds, pesticides, fertilizers, and irrigation facilities.

2.2.3.3. Householder's characteristics
2.2.3.3.1. Age of householder

There may be a multiple and non-linear correlation between the age of the householder and land rental decisions. On the one hand, with the increase in age, farmer households' labor capacity will decrease and quit from agricultural production. The possibility of renting out will thus increase, and the possibility of renting in land will decrease. On the other hand, older farmers may have more farming experience and skills, and they are more likely to rent in land for business than young farmers, who have a stronger tendency to seek off-farm employment (Shi and Li, 2014). This study adopted the age of the householder and its squared term in the regression model to examine possible non-linear relationships.

2.2.3.3.2. Education of householder

The education level of householder reflects the level of knowledge and skills, and directly determines their ability and experience in agricultural production (Zhu and Cai, 2016), and then affects decisions regarding renting-in area and renting-out area.

2.2.3.4. Characteristics of village and local economic environment

The village and local economic environment could also affect the area of land rentals. The convenient transportation conditions of the village and developed local economy will promote the prosperity of the land rental market, thus increasing the external demand for land. We chose two variables to reveal the characteristics of the rural village where farmer households live. *Village location* denoted the time it takes to travel from the village center to the nearest business center. *Village topography* was a multinomial dummy including categories of hilly area, alpine, plateau, plain, grassland, fishing village and other types.

Three variables are used to represent the local economic environment. *Local economic development* was represented by the provincial per capita GDP. *Local agricultural development* was represented by the food output of the province in that year. *Local*

land rental market development was represented by the provincial average price of renting land in/renting land out. On one hand, the average price of land rental provided reference for farmer households' decisions about the expected price. On the other hand, it could make up for the model estimation bias caused by the fact that the farmer households that do not rent in or rent out cannot be observed in the actual price of land rentals. The definitions of variables are shown in Table 2.

It is worth noting that the analysis of the determinants of land rental decisions with cross-sectional data may have the problem of endogeneity caused by mutual causality. This mainly originated from the variables of agricultural production inputs and household economics, for example, previous studies mostly selected variables such as machinery input level and labor input level to represent agricultural production capacity. Similarly, the change in household income may also be directly affected by the price of land rentals. However, it is not reasonable to exclude these factors in econometric models, which may in turn cause serious variable omissions. In order to avoid the problem of endogeneity as much as possible, in the absence of effective instrumental variables and lag terms for model estimation, this study tried to set appropriate proxy variables to represent agricultural inputs and household economics as far as possible. Firstly, we adopted the variable of *Agricultural machinery input* represented by proportion of agricultural machinery input to total physical capital input. The proportion represented the structure of agricultural capital inputs and is determined by exogenous factors such as agricultural technology and the local machinery supply. Therefore, the proportion of agricultural machinery input could be considered as an exogenous variable. Secondly, we did not adopt variables of income or expenditure directly related to household land rentals. Instead, the income of renting land out and the payments for renting land in were deducted from *Household net income*. Moreover, the provincial average price of rented land other than real payments of household rented land was adopted to represent the local development of the land rental market. This revealed the price expectation that the average land rental price provided to the farmer households. Thirdly, the value of non-agricultural durable consumer goods was selected to represent *Household assets*. The increase or decrease in non-agricultural fixed assets will be less affected by the price of land rentals. It will not fluctuate significantly in the short term, thus reducing the endogenous impact.

2.3. Estimation model

This study applied Bi-Tobit model to examine the determinants of farmer households' decisions regarding land rentals. As the dependent variable, the probability distribution of land rental area had a mixed distribution consisting of a discrete point and a continuous distribution. If a farmer did not participate in the land rental market, the optimal solution of the rented area was the corner solution 0; if a farmer participated in the land rental market, the rented area was a positive value. The Tobit model is an effective method to deal with the problem of restricted dependent variables with a corner solution and make full use of all the samples. In the analysis of land rental area, this method will not omit the

samples of those who have not participated in land rental, reflecting the potential participation intensity of these farmer households (Teklu and Lemi, 2015). The Bi-Tobit model composed of bivariate equations was used to estimate the determinants of rented-in area and rented-out area, and assumed that the random error term of the two equations may be correlated.

First, as a baseline, we adopted the Tobit model to estimate the determinants of rented-in area and rented-out area, respectively. The Tobit model was specified as:

$$Y_i^* = \beta X_i + \mu_i \tag{1}$$

Here, Y_i^* is the rented-in/rented-out area, X_i is the vector of determinants of farmer households' decisions, β is the coefficient vector underestimate, and μ_i is a random error term. For the farmer households who participated in land rentals, Y_i^* is equal to the real land rental area (Y_i), and $Y_i^{ast} = 0$ represents farmer households who did not participate in the land rental market (shown as Equation 2).

$$Y_i = \begin{cases} Y_i^* \; if \; Y_i^* > 0 \\ 0 \; if \; Y_i^* \leq 0 \end{cases} \tag{2}$$

Furthermore, we assumed that the farmer households' decisions regarding rented in and rented out may be interrelated and adopt the Bi-Tobit model, which was specified as follows:

$$Y_{1i}^* = \alpha_0 + \alpha_1 Value + \alpha_2 Security + \alpha_3 X_{1i} + \mu_{1i} \tag{3}$$

$$Y_{1i} = Max \left(Y_{1i}^*, 0 \right) \tag{4}$$

$$Y_{2i}^* = \beta_0 + \beta_1 Value + \beta_2 Security + \beta_3 X_{2i} + \mu_{2i} \tag{5}$$

$$Y_{2i} = Max \left(Y_{21}^*, 0 \right) \tag{6}$$

$$\mu_{1i}, \mu_{2i} \approx N \left[0, 0, \sigma_1^2, \sigma_2^2, \rho \right], \; covariance \; is \; \sigma_{12} = \rho\sigma_1\sigma_2 \tag{7}$$

Here, $Y_{1i}*$ is the rented-out area and $Y_{2i}*$ is the rented-in area. *Value* denotes to household land value, *Security* denotes to social security, X_{1i} and X_{2i} are vectors of determinants of farmer households' decisions, μ_{1i} and μ_{2i} are a random error terms. ρ represents the correlation of error terms μ_{1i} and μ_{2i}. $\rho \neq 0$ indicates that the error term of the two equations is correlated, suggesting the decisions regarding rented-in area and rented-out area are correlated. On the premise of the normal distribution and homoscedasticity of sample, maximum likelihood estimation (MLE) was used in the estimation.

2.4. Descriptive analysis

Table 3 shows the statistics of variables by groups: (1) households that had no land rental (A); (2) households only rented land out (B); (3) households only rented land in (C). The descriptive

results exhibited that the majority of variables showed significant statistical differences, indicating that farmer households' decisions regarding land rental area may be affected by these factors. Comparing group (A) and (B) (column 5 of Table 3), the proportion of pension insurance for households only rented land out was 10% higher on average, and the value of household fixed assets was significantly higher than that of no rental households. The agricultural subsidies, land value and agricultural machinery input of households only rented out were significantly lower than those of no rental households. Comparing group (A) and (C) (column 6 of Table 3), the household net income, agricultural subsidies and land value of households only rented in were significantly higher, and the land endowment was significantly less than that of no rental households. In addition, the variables of householder's human capital, village and local economic environment also showed significant inter-group differences. On the basis of the descriptive statistical results, the specific effects of these variables on farmer households' decisions of land rental area need further empirical examination.

3. Empirical results and heterogeneity analysis

3.1. Results of Bi-Tobit models

The results of the determinants of land rental area are shown in Table 4. Model (1) is the results of the baseline independent Tobit models. Models (2) and (3) are the results of the Bi-Tobit model assuming that household rented-out area and rented-in area may be interrelated. In model (2), those variables that may cause endogenous problems were not included to check the robustness of the estimation: *Household net income, Household asset,* and *Agricultural machinery input.* Model (3) included all the explanatory and control variables. The direction and significance of the coefficients did not change significantly after adding all variables in model (3), which proved that the model is not affected by endogeneity and the results are robust. Heteroscedasticity-robust standard deviation was applied in the estimation to eliminate regression bias. The results of model (2) and (3) both exhibited that the correlation parameter ρ was significant at the 1% level, indicating the original hypothesis that the error term of the two equations is not correlated ($\rho = 0$) could be rejected. This showed that there was a significantly negative correlation between the household rented-in area and the rented-out area. The Bi-Tobit model is necessary for estimating the dual-decision of land rentals. The Wald χ^2 result of model (3) and the single-equation Sigma significance also proved the validity of the Bi-Tobit model. Therefore, the explanations and discussions of the determinants of rented-in area and rented-out area were mainly based on the results of model (3).

The results showed that land value significantly affected the rented-in area and the rented-out area. The higher the land value, the smaller the rented-out area and the larger the rented-in area will be. Social security had a significantly positive effect on the rented-out area, but had no significant effect on the rented-in area. The greater the pension insurance payment received by family members, the larger the rented-out area. As for the results of

TABLE 3 Statistical analysis by group of no land rental, only rented land out, and only rented land in.

Variables	A: No renting	B: Only rented out[a]	C: Only rented in	T-test: B-A	T-test: C-A
Land value	40.323	24.652	73.513	−15.671***	33.191***
Social security	0.110	0.210	0.067	0.101**	−0.043***
Household net income	4.155	8.403	8.932	4.248	4.778**
Off-farm employment	0.566	0.565	0.524	−0.001	−0.042
Household asset	9.254	12.843	8.005	3.589**	−1.249
Land endowment	0.213	0.186	0.160	−0.027	−0.053*
Agricultural subsidies	344.996	271.552	426.584	73.444***	81.587***
Agricultural machinery input	0.165	0.133	0.210	−0.033**	0.045
Age of householder	49.405	52.998	46.638	3.593***	−2.767***
Education of householder	2.095	2.208	2.178	0.113**	0.083*
Village topography	38.479	29.437	32.834	−9.043***	−5.645**
Local economic development	35.728	40.290	34.616	4.563***	−1.111**
Local economic development	2.492	2.741	2.663	0.249***	0.17**
Local agricultural development	328.622	338.089	336.969	−9.466	/
Local land rental market development	201.648	221.163	229.695	/	−28.047***
Obs	3,648	442	701	-	-

***, **, *Indicate significant at 1%, 5%, and 10% levels, respectively.
[a]In order to show the difference, the statistical analysis does not include the sample of both renting-in and renting-out farmers.

control variables, the regression results showed that household net income had a significantly positive effect on both rented-out area and rented-in area. Agricultural machinery input and agricultural subsidies significantly increased the rented-in area and had no significant effect on the rented-out area. The age and education of householder, local economic development and local land rental market development also showed significant effects on land rental area.

To further reveal the difference in the participation decision of "Whether to rent" and the intensity decision of "How large to rent", we applied Bivariate Probit (Bi-Probit) model to examine the determinants of the "participation decision"—that is, the choice of whether to rent in and whether to rent out. The results are shown in Table 5. Similarly, model (4) did not include the variables *Household net income, Household asset,* and *Agricultural machinery input* that may cause endogenous problems. Model (5) included all the explanatory and control variables. The comparison of model (4) and (5) indicated the estimation was robust. The correlation parameter ρ was significant at the 1% level, indicating the decisions of renting out and renting in were significantly negative related. This was consistent with the results of the dual decision of land rental area. Different from the determinants of land rental area, the decision to rent out was not affected by the land value, but was significantly inhibited by agricultural subsidies and village location. The increasing agricultural subsidies attached to contracted land will motivate farmer households to keep land. The remote village location also results in a lack of demand or the lower rents for the land, so farmers will be unwilling to rent land out. The decision to rent land out was not affected by household income, but was significantly hindered by household assets value. These results verifies that the determinants

of the participation decisions are different with that of intensity decisions, which are reflected both in renting land out and renting land in.

3.2. Results of heterogeneity analysis

In order to examine the heterogeneity of farmer households' land rental decisions, we further investigated the moderate effect of household income on farmer households' decision making by dividing the samples into surplus farmer households (household net income ≥ 0) and indebted farmer households (household net income < 0). The Bi-Tobit model was applied to perform joint estimations on their land rental decisions, respectively. The grouping regression results were shown in Table 6, with model (6) showing the results of surplus households and model (7) showing the results of indebted households. The results of Wald X^2 and the significance of single-equation Sigma proved the validity of the two Bi-Tobit models. The correlation coefficients ρ of model (6) and model (7) were −0.538 and −0.218, respectively, which are significant at the levels of 1 and 5%, respectively. This indicated that for the two groups of farmer households, there were both significant negative correlations between the rented-in area and rented-out area. This was consistent with the model with the total sample. However, the determinants of land rental area of the two groups were significantly different, and were different from the model with the total sample. This indicates that farmer households' decisions of land renting-in and renting-out were both moderated by household net income.

According to the group regression results of Table 5, it can be found that the effect of explanatory variables, land value and

TABLE 4 Results of Tobit and Bi-Tobit models.

Variables	Model 1: Tobit		Model 2: Bi-Tobit		Model 3: Bi-Tobit	
	Rented-out area	Rented-in area	Rented-out area	Rented-in area	Rented-out area	Rented-in area
Land value	−0.008**	0.100***	−0.007**	0.101***	−0.008***	0.098***
	(0.003)[a]	(0.007)	(0.003)	(0.007)	(0.003)	(0.007)
Social security	2.863***	−0.823	2.486**	−0.857	2.762***	0.054
	(1.028)	(4.996)	(1.009)	(5.035)	(1.012)	(5.033)
Household net income	0.012**	0.049***			0.010**	0.053***
	(0.005)	(0.019)			(0.005)	(0.019)
Off-farm employment	0.048	−2.761*	0.058	−1.167	0.046	−2.027
	(0.147)	(1.638)	(0.142)	(1.578)	(0.145)	(1.642)
Household asset	0.022***	−0.046			0.021***	−0.044
	(0.007)	(0.038)			(0.007)	(0.038)
Land endowment	0.033	−0.442*	0.032	−0.339	0.031	−0.366*
	(0.022)	(0.228)	(0.022)	(0.215)	(0.022)	(0.220)
Agricultural subsidies	−0.001	0.004**	−0.001*	0.004**	−0.001	0.004**
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Agricultural machinery input	−1.384	4.885			−1.298	5.889*
	(0.882)	(2.986)			(0.865)	(3.035)
Age of householder	−0.488***	2.613***	−0.480***	2.807***	−0.471***	2.711***
	(0.107)	(0.512)	(0.106)	(0.522)	(0.106)	(0.520)
Square of age[a]	0.006***	−0.031***	0.006***	−0.033***	0.005***	−0.032***
	(0.001)	(0.005)	(0.001)	(0.006)	(0.001)	(0.005)
Education of householder	0.747***	−1.157	0.783***	−1.023	0.696***	−1.045
	(0.244)	(0.846)	(0.239)	(0.850)	(0.240)	(0.856)
Village location	−0.014*	−0.006	−0.013	−0.006	−0.012	−0.004
	(0.008)	(0.017)	(0.008)	(0.017)	(0.008)	(0.017)
Village topography	Controlled	Controlled	Controlled	Controlled	Controlled	controlled
Local economic development	0.073***	−0.130*	0.082***	−0.171**	0.076***	−0.153**
	(0.018)	(0.069)	(0.018)	(0.069)	(0.018)	(0.069)
Local agricultural development	0.083	0.999	0.092	0.527	0.110	0.338
	(0.177)	(0.614)	(0.175)	(0.581)	(0.175)	(0.582)
Local land rental market development	−0.000	−0.007	−0.001	0.021***	−0.001	0.023***
	(0.002)	(0.006)	(0.002)	(0.006)	(0.002)	(0.007)
Constant	−7.845***	−89.057***	−8.008***	−100.291***	−7.833***	−98.399***
	(2.886)	(12.716)	(2.850)	(12.985)	(2.847)	(12.960)
Sigma	9.426***	36.927***	9.393***	37.363***	9.329***	37.235***
	(0.374)	(1.038)	(0.370)	(1.055)	(0.367)	(1.051)
LR chi^2 (p-value)	207.67	331.84				
	(0.000)	(0.000)				

(Continued)

TABLE 4 (Continued)

Variables	Model 1: Tobit		Model 2: Bi-Tobit		Model 3: Bi-Tobit	
	Rented-out area	Rented-in area	Rented-out area	Rented-in area	Rented-out area	Rented-in area
ρ			−0.375***		−0.356***	
			(0.075)		(0.079)	
Wald chi² (*p*-value)			60.39		160.59	
			(0.000)		(0.000)	
Obs	4,815	4,815	4,815		4,815	

***, **, *Are significant at the levels of 1%, 5%, and 10%, respectively.
[a]Numbers in parentheses represent heteroscedasticity robust standard deviations.

social security had differences in surplus households and indebted households. For surplus households, the land value increased the rented-in area and decreased the rented-out area at a significant level of 1%. The land security had no significant effect on both the rented-in area and rented-out area. For indebted households, the land value increased the rented-in area at a significant level of 1%, and the land security increased the rented-out area at a significant level of 5%. This indicated that the dominant logic of land rental decision making of the two kinds of households had some disparities.

4. Discussions

4.1. Different dominant logics in the decisions of renting-in and renting-out area

The results of this study indicate that rented-out area was affected by the evaluation of land value as well as the consideration of social security. The dual logic of economic rationality and survival rationality in decision making was verified in farmer households' renting out decisions. The rented-in area was only affected by the land value, which is reflected as a market-oriented decision based on economic rationality. Therefore, the decisions of the rented-in area and rented-out area were driven by different factors and inherent rationalities of decision making. The behavior of renting land in and out cannot be considered as a simple "mirror image". When farmer households rent land out as the supplier in the land rental market, the characteristics of comprehensive small farmer households described by Huang (2000) are more prominent.

The effects of land value and social security indicate the different dominant logics in renting-in and renting-out decisions. The economic value of land is the embodiment of land production function and its potential benefits. As the necessary material basis of agricultural production, arable land is the primary source for ensuring the basic income of farmers (Chen and Zhai, 2015). It can also provide a continuous income stream because of the preservation of soil fertilizer. The significant effect of land value on farmer households' decision making suggests that farmer households regard land as a tradable commodity and perform economically rational judgments on the economic value of land. When its value rises, the demand increases and the supply decreases. The farmer households who have a demand for arable

land will have a higher expectation of future income through the current land value, and will rent in more land to gain scale benefits.

The effect of social security suggests that rural land still plays an important role in providing social security for farmer households. In the case of no stable income and the outflow of young labor forces, farmer households have a strong need for pension security. Due to the insufficient coverage of social pension insurance, farmer households still regard land as a source of stable income when they are getting old and lose their working capacity. Their concerns about the risk of losing land will restrict their willingness to rent land out. Only when the security of pension insurance is strong enough to replace the function of land security will farmer households be willing to rent out more land. This finding indicates that survival rationality with the preference for risk avoidance is still one of the most important logics of farmer households' land rental decision making. The impact of household assets also confirms this finding. Farmer households with more assets have higher risk resistance, meaning that they can break away from the dependence on land security and increase rented-out area.

4.2. Transition of the decision-making logic with the variation of household income

The results of heterogeneity analysis indicated that, with the increase in household income, the logic of their land rental decisions transitions from the survival rationality to the economic rationality. Farmer households with lower household net income have a stronger tendency to pursue survival security and avoid risks, and the land security is the main factor restricting large-scale land rentals. In contrast, when farmer households have a higher income level and considerable non-farm income, they may break away from basic survival land security, and economic rationality begins to dominate the land rental decision making. Land value, off-farm employment and agricultural subsidies that affect the direct benefits and costs of land rental become the main determinants.

Given the background of the differentiation of Chinese small farmer households' identification and employment, different types of farmer households may have different objectives (Huang, 2000; Zhong and Kong, 2013). For indebted households, the dependence on the security provided by household-contracted land has significantly restrained the rented-out area. They are dominated by survival rationality in their land rental area decisions.

TABLE 5 Results of the Bi-Probit models.

Variables	Model 4:		Model 5:	
	Rented out	Rented in	Rented out	Rented in
Land value	−0.001	0.002***	−0.001	0.002***
	(0.001)[a]	(0.000)	(0.001)	(0.000)
Social security	0.312***	−0.003	0.345***	0.001
	(0.112)	(0.132)	(0.112)	(0.132)
Household net income			0.001**	0.001
			(0.001)	(0.000)
Off-farm employment	0.008	−0.026	0.007	−0.039
	(0.012)	(0.043)	(0.012)	(0.046)
Household asset			0.002***	−0.002*
			(0.001)	(0.001)
Land endowment	0.001	−0.022**	0.001	−0.024**
	(0.002)	(0.009)	(0.002)	(0.010)
Agricultural subsidies	−0.000***	0.000***	−0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Agricultural machinery input			−0.081	0.239***
			(0.105)	(0.081)
Age of householder	−0.059***	0.080***	−0.059***	0.077***
	(0.011)	(0.015)	(0.011)	(0.015)
Square of age	0.001***	−0.001***	0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Education of householder	0.081***	−0.010	0.073***	−0.008
	(0.026)	(0.022)	(0.026)	(0.023)
Village location	−0.002**	−0.001	−0.002**	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Village topography	Controlled	Controlled	Controlled	Controlled
Local economic development	0.009***	−0.006***	0.008***	−0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Local agricultural development	0.009	−0.001	0.010	−0.007
	(0.020)	(0.016)	(0.020)	(0.016)
Local land rental market development	0.000	0.001***	0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	−0.670**	−2.595***	−0.655**	−2.578***
	(0.301)	(0.361)	(0.302)	(0.361)
ρ	−0.288***		−0.285***	
	(0.048)		(0.048)	
Observations	4,815		4,815	

***, **, * Are significant at the levels of 1%, 5%, and 10%, respectively.
[a]Numbers in parentheses represent heteroscedasticity robust standard deviations.

TABLE 6 Results of the Bi-Tobit models for heterogeneous analysis.

Variables	Model 6: Bi-Tobit of surplus households		Model 7: Bi-Tobit of indebted households	
	Rented-out area	Rented-in area	Rented-out area	Rented-in area
Land value	−0.015***	0.120***	−0.002	0.080***
	(0.005)[a]	(0.009)	(0.004)	(0.012)
Social security	2.566	3.762	2.849**	−5.637
	(1.576)	(6.462)	(1.363)	(7.970)
Household income structure	1.540*	−1.826	0.005	−2.457
	(0.932)	(2.695)	(0.166)	(2.266)
Land endowment	0.061	0.101	0.029	−1.042**
	(0.058)	(0.225)	(0.026)	(0.436)
Agricultural subsidies	−0.001*	0.004*	0.000	0.002
	(0.001)	(0.002)	(0.001)	(0.003)
Agricultural machinery input	−0.672	1.604	−2.085	10.154**
	(1.090)	(3.700)	(1.370)	(5.031)
Household asset	0.009	−0.013	0.024***	−0.055
	(0.016)	(0.061)	(0.008)	(0.050)
Age of householder	−0.608***	1.717***	−0.340**	4.252***
	(0.143)	(0.611)	(0.155)	(0.911)
Square of age	0.007***	−0.021***	0.004***	−0.047***
	(0.001)	(0.006)	(0.002)	(0.010)
Education of householder	0.724**	−0.100	0.678*	−1.961
	(0.310)	(1.027)	(0.365)	(1.441)
Village location	−0.029**	−0.010	−0.005	−0.004
	(0.013)	(0.022)	(0.008)	(0.025)
Village topography	Controlled	Controlled	Controlled	Controlled
Local economic development	0.073***	−0.171*	0.072***	−0.150
	(0.025)	(0.088)	(0.026)	(0.111)
Local agriculture development	0.106	1.512**	0.113	−1.385
	(0.231)	(0.693)	(0.262)	(1.018)
Local land rental market development	−0.003	0.006	0.001	0.037***
	(0.002)	(0.009)	(0.003)	(0.010)
Constant	−2.076	−68.132***	−13.731***	−141.727***
	(3.796)	(15.427)	(4.294)	(22.420)
Sigma	8.612***	33.166***	9.782***	41.140***
	(0.487)	(1.215)	(0.536)	(1.814)
ρ	−0.538***		−0.218**	
	(0.122)		(0.110)	
Obs	2,412		2,403	

***, **, * Are significant at the levels of 1%, 5%, and 10%, respectively.
[a] Numbers in parentheses represent heteroscedasticity robust standard deviations.

Especially, indebted elderly and female farmers with fewer off-farm work opportunities will be more likely to lack stable income sources and social security. They still attach great importance to the land as the "final barrier against risk" to obtain pension and unemployment security. Moreover, in the reality of frequent defaults in the current land rental market, renting land out may also cause farmer households fall into the risk of rent loss or even land loss. Only when the pension insurance is sufficient enough to substitute the land security will farmer households be likely to rent more land out.

By contrast, surplus households' land rental area was only determined by land value, which indicates the dominance of economic rationality in their decision making. Since they already have basic survival security, the economic value of land and the potential benefits and costs are the major factors that determine whether they rent in or rent out more land. The finding is in line with Yahui et al. (2020) who verified that with the increase in farmer households' income and assets, farmland had gradually lost its function of pension security. Surplus farmer households' economic rationality was also reflected in two other effects. The first was the effect of non-farm employment on land rental area. In the group regression results, the share of income from off-farm employment significantly increased the rented-out area of surplus farmer households [model (6) in Table 6]. This effect was not significant in the model with the total sample [model (3) in Table 4]. Farmer households with economic rationality will regard the income of off-farm work as the opportunity cost of farming, and compare it with the income from land cultivation. Otherwise, when the survival rationality with risk aversion surpasses economic rationality to become the dominant logic of land rental decision making, farmers will still have a tendency to undertake part-time farming or even return to farming because of the instability of off-farm employment. Thus, the promotion effect of non-farm employment on renting land out does not appear to be significant. As emphasized by Hu and Ding (2015), the positive impact of off-farm employment on land rentals will be weakened by farmers' part-time farming. The second effect was the impact of agricultural subsidies. Agricultural subsidies significantly increased surplus farmer households rented-in area and reduced the rented-out area. For the indebted households, there is no significant motivation from agriculture subsidies to hold more land. This finding indicates that the agricultural subsidies have a "one-way effect" on land rental decisions. For surplus farmer households with economic rationality, agricultural subsidies can provide direct compensation for production costs to motivate them to rent in more land and be engaged in agricultural operation. However, for indebted households seeking survival, the small agricultural subsidies are not enough to change their indebted situation and cannot cause a significant change to farmer households' decisions regarding land rentals.

4.3. Other effects of household and individual characteristics on land rental area

Firstly, the household net income promotes the increase in land rental area. The effect of household net income indicates that a higher income provides a prerequisite for farmer households to participate in the land rental market with large-scale renting out or renting in. As a result, the increase in demand and supply will stimulate the prosperity of the land rental market and promote the formation of scale operation. This finding is in line with the research of Yang and Gao (2012), who found that the availability of agricultural credit could promote the probability of renting land in and renting land out at the same time by increasing the cash income of farmer households, thereby promoting the land rental transactions. For farmer households only rented land out, since the agricultural income within the fixed area of land is unlikely to fluctuate significantly, the increase in income means that the proportion of the land income is reduced. Therefore, the increase in household income is mainly caused by off-farm work (as shown in Table 3, the share of non-farm income for farmer households only rented land out is higher). This means that farmers are more likely to switch from farming to off-farm jobs, which may reduce the dependence on land for the income level and the security level, thus increasing the rented-out area. For farmer households only rented land in, the increase in household income makes it possible to compensate for the increasing cost of renting land in, which may come from the rental payments for rented plots and increasing production inputs. As previous studies suggested, the relatively "rich" farmer households rather than the "poor" who were more likely to participate in land rental markets (Leng et al., 2015). This study further proves that rented-in area and rented-out area will be increased in "rich" households. That is, the intensity of participation in land rentals will be increased by a high level of household income.

Secondly, the path dependence of agricultural production increases the renting-in area, which was reflected by the effects of agricultural machinery input and agricultural subsidies. The effect of agricultural machinery input indicates that the "hold-up" effect brought by specific assets is not reflected in the renting out decisions. For farmer households only rented land in, the increase in agricultural machinery investment will improve their agricultural production efficiency and help them to achieve scale benefits. Farmer households tend to rent in more land to share the cost of the agricultural machinery input. Moreover, agricultural subsidies reflect the policy support encouraging agricultural production. By providing subsidies for the direct and indirect costs in agricultural production, the government stimulates farmer households to rent more land for agricultural operations. As confirmed by the research of Ji et al. (2015), paying agricultural subsidies to the actual agricultural operators would increase the ratio of land rental area.

Thirdly, household resource endowments and householders' human capital significantly affect land rental area. The age of householder showed a non-linear relationship with the land rental area. With the increase in the age of the householder, the rented-out area decreased first and then increased (with 47 years as the boundary), and the rented-in area increased first and then decreased (with 42 years as the boundary). The variation of land rental decisions is in line with the change process of farmers' human capital. Generally, the progression from youth to middle age is a process of accumulating physical strength and working experience. The ability and experience of farmers to engage in agricultural production are gradually enhanced, and they have the ability to

rent in land to achieve scale operation, while the rented-out area decreased accordingly. The transition from middle age to old age is a process of declines in the ability and physical strength of farmers, and thus the area of rented in land decreases and the area of rented-out land increases. The education level of the householders had a significantly positive effect on the rented-out area. The level of education reflects the level of human capital more intuitively. Currently, the type of off-farm jobs has gradually shifted from labor-intensive to technical and service industries, which requires higher education and skill levels of workers. Therefore, farmers with a higher education level are more likely to obtain off-farm employment opportunities and higher income, and the rented-out area increases accordingly. Farmer households with smaller per capita contracted land area tend to rent in more land, which is consistent with the existing research—that is, land resources will flow from farmers with more endowment to farmers with less endowment.

4.4. General discussion

The empirical results showed that the household income is an important moderating variable of farmer households' land rental decisions. It makes sense to discuss the implications of household income in analyzing the issue of farmland rentals in China. In the study of development economics, the absolute or relative income was claimed as an important indicator of household viability (Wang, 2016; Chi et al., 2022). The concept of viability was first proposed by Lin (2002), meaning the expected profitability of a normally operating enterprise in a competitive market. In the absence of external policy support, if an enterprise can obtain a profit level not lower than the socially acceptable expected profits through normal operation, it may have the viability. Otherwise, enterprises that can only survive by relying on government support do not have the viability (Lin and Liu, 2001). Extending this finding to rural studies, farmer households' viability could be defined by regarding them as enterprises engaged in self-employment activities such as agricultural operation. Given the existing rural institutions, whether farmer households can obtain socially acceptable expected profits through their own efforts in normal agricultural production and exchange activities represents whether they have the ability to survive. In empirical studies, the "socially acceptable expected profits" were represented by household income level or asset value (Wang, 2016). Schultz's description on farmer households in *Transforming Traditional Agriculture (1983)* verified that farmer households were actually like entrepreneurs in the competitive agricultural market. They engaged in agricultural production activities with the goal of maximizing profits, could also fully collect information, such as market prices and demands, and made sensitive responses. Therefore, farmer households could efficiently allocate their accessible resources to invest in production.

Consequently, farmer households with viability will be mainly based on the economic rationality of calculating benefits and cost in the decision making. Otherwise, the land rental decisions are more likely to be dominated by survival rationality. However,

in the land rental market, farmer households who lack viability not only struggle to obtain an acceptable minimum income level by their own efforts, but also face the uncertainty of external policy systems. This further exacerbates their risk aversion and dependence on land. On the one hand, the land rental market in China is distorted, segmented or even missing due to incomplete and asymmetric information, which results in considerable natural risks and market risks for farmer households who rented out or rented in land (Ma et al., 2015). On the other hand, the ambiguity of rural land tenure and the imperfection of land rental institutional arrangements aggravate the risk of land rentals (Gao and Chen, 2018). The uncertain market environment and imperfect institutional system lead to the lack of a reasonable risk sharing mechanism of land rentals, which inevitably reduces farmer households' willingness to participate in land rentals. Therefore, the viability of farmer households should be a more complex concept than the viability of enterprises. Not only the farmers' own ability but also the imperfections of the external institutional system should be considered in analyzing the effect of viability on their decision making. This study used the surplus of household net income to represent whether farmer households have viability, which could primarily reflect the logical difference of farmer households' decisions. Further research should consider the external farmland system and rural informal norms, provide a more detailed definition of farmer households' viability, and further explore the decision-making differences of farmer households with different levels of viability.

5. Conclusions and policy implications

Based on a nationwide sample of 4,815 farmer households from the CFPS database in 2012, this study used the Bi-Tobit model to analyze the determinants of the rented-in and rented-out areas. Heterogeneity analysis was also conducted according to the difference in household net income level. The results showed that household rented-in area and rented-out area were significantly negatively related. Rented-out area as significantly affected by both land value and social security, which reflected a dual logic of farmer households' economic rationality and survival rationality. By contrast, rented-in area was only significantly affected by land value, and it was more likely a market-oriented decision based on farmer households' economic rationality. With the improvement of household income level, the logic of the land rental decision transformed from survival rationality with strong risk aversion to economic rationality. Both the decisions of surplus farmer households to rent in and rent out were significantly affected by land value, while the decisions of indebted farmer households were only significantly promoted by the accessibility of social security.

This study reflected the intensity of farmer households' land rental market participation and to serve the policy objectives of scale operation. The results may provide implications for policies to improve the land rental market in China. Firstly, the government should take the realization of moderate-scale operation as the ultimate goal of the land rental market, and promote farmer households' participation in the land rental market by means of

large-scale renting in and renting out. The policy support for large-scale circulation is necessary. Secondly, with farmer households as the core subjects in the land rental market, providing policy guidance to match the demand and supply is also important in policy making. From the supply side, in order to increase rented-out area, policies should improve the rural social security system and expand the coverage of social security. Establishing a multi-level and diversified pension security system is helpful to release farmers from land security. It is also necessary to improve the human capital of the rural labor force and provide off-farm employment opportunities with higher comparative benefits. From the demand side, policies should increase agricultural subsidies and guarantee reasonable income from agricultural production. It is important to ensure that subsidies are granted to the actual operators of rented-in land, and provide them with support for agricultural mechanization. Third, the local government should identify the rational behavior of heterogeneous farmer households and provide targeted policy guidance. For low-income farmer households, improving the social security system is the primary goal, and reducing their dependence on land security can promote renting land out. For farmer households with a relatively high income, providing stable and beneficial off-farm employment opportunities will increase the land rental area of farmer households that only rent land out. At the same time, using various means to increase farmer households' income will help guide their decision making from survival goals to economic rationality, and provide a basis for better operation of the land rental market mechanism. Raising the income level of farmer households in various ways will help to promote the transition of the basis of farmer households' decisions from survival goals to economic rationality, and reduce the constraints of land rentals due to the lack of basic survival security.

There are still several limitations in this study. Due to the limitations of the CFPS database, we could only apply the survey data in 2012, since the data in CFPS after 2014 did not have the key variable of land rental area. Although we tried to avoid the endogenous problem in proxy variable setting, the cross-sectional data may still lead to the omission of information. Future studies can be updated by using other tracked surveys with panel data, and more econometric methods could also be applied to deal with endogeneity problems. In addition, this study only examined the heterogeneity of farmer households' land rental decisions with different income levels, and performed an in-depth discussion of the decision-making logic from the perspective of farmer households' viability. Further research can be carried out from the perspective of land security to examine the heterogeneity of the farmer households' land rental decisions with different risk-sharing capabilities and different risk attitudes.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: http://www.isss.pku.edu.cn/cfps/ China Family Panel Studies (CFPS).

Author contributions

Conceptualization, investigation, and funding acquisition: HL and WP. Methodology, software, data curation, and writing—original draft preparation: HL and JF. Validation: HL, WP, and JF. Formal analysis: HL. Writing—review and editing and supervision: WP. Visualization: JF. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1176332/full#supplementary-material

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