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Smallholder Participation in Land Rental Market in a Mountainous Region of Southern China: Impact of Population Aging, Land Tenure Security and Ethnicity

Shi Min[1], Hermann Waibel[1*], Jikun Huang[2]

1. Institute of Development and Agricultural Economics, Leibniz University Hannover, Germany;
2. Center for Chinese Agricultural Policy, Chinese Academy of Sciences, China

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[*] Corresponding author: waibel@ifgb.uni-hannover.de

Abstract

Rural land rental markets in China play an increasingly important role for the transformation of the agricultural sector. This study focuses on the rural land rental market in Xishuangbanna Dai Autonomous Prefecture in Southern China a mountainous region, where rapid changes in land use have taken place with the transition from traditional agriculture and tropical rainforest to rubber monoculture. Particularly, we assess the impacts of population aging, land tenure security and ethnicity on the participation of smallholders in land rental market. The analysis suggests that the share of older people in a household increases the likelihood of renting out land and reduces the likelihood of renting in land, implying that population aging fosters land rental market development by transferring land from older to younger farmers. We also confirm that the availability of a land tenure certificate increases participation in the land rental market, with a positive coefficient for renting out land but negative for renting in land. However, the participation in land rental market is ethnic sensitive, that is, ethnic minority groups are less likely to rent out land. In addition, specialization in rubber farming, altitude and remoteness of household location also influence the participation in land rental market.

Key Words: Ethnicity, Land rental market, Land tenure security, Population aging

1. Introduction

Rural land rental markets in China play an increasingly important role for the transformation of the agricultural sector in the context of urbanization and societal aging. Better off-farm income possibilities in urban areas are strong incentives especially for the rural youth to take up non-farm employment (Wang *et al.*, 2011), and hence the rural land rental market is gaining momentum (Huang *et al.*, 2012). The rapid process of population aging in rural China makes it necessary to encourage land transactions from households with lack of labor to those with surplus labor. To facilitate land transactions in rural China, the development of a land rental market is important. The study of Deininger and Jin (2005) in China showed that the rural land rental market has a positive impact on land access by redistributing land to those with higher agricultural potential. Since the promulgation of the legislation known as "Rural Land Contract Law" in 2002, rural land reallocation in China has become more complicated[1]. Given this context, land rental markets in rural China are now a more important means of land redistribution as compared to the administrative reallocation processes (Deininger and Jin, 2005).

Although rural land rental markets in China are still in their infancy (Feng *et al.*, 2010), several studies showed that their development can have positive growth and productivity effects without necessarily jeopardizing equity (Tan *et al.*, 2006; Jin and Deininger, 2009; Feng *et al*., 2010). As shown by Deininger and Jin (2005) the emergence of land rental market can be beneficial to poor producers provided they have abundant labor endowments. It can also help to reduce land fragmentation to some extent, one of the major constraints to technological advancement in Chinese agriculture (Tan *et al.*, 2006). By allowing more effective use of unused land, the participation of farmers in land rental markets can also increase agricultural output (Jin and Deininger, 2009). Empirical evidence from southeastern China suggested that land rental markets significantly contribute to higher rice production (Feng *et al*., 2010). Considering the growing food demand and limited land resources in China, a well-functioning rural land rental market is important for enhancing the efficiency of land allocations and thereby contributing to the growth of agricultural output (Kimura *et al.*, 2011).

The advantages of a well-functioning rural land rental market have also gained recognition at the policy level in China. Recently, the Chinese central government encourages the establishment of land markets where farmers can "subcontract, lease, exchange, or swap" land-use rights (Wang *et al.*, 2011). Policy documents also clearly state that farmers should strive to rent land in order to increase farm size, raise efficiency and labor productivity (Huang *et al.*, 2012).

[1] In the past, rural land reallocation was administratively implemented almost every year by the village committees (the local government at village level); while the "Rural Land Contract Law" promulgated in 2002 requires that land reallocation is only to be permitted when the village collectives received approval from two-thirds of the members of the Villagers' conference or two thirds of the Villagers' representatives, as well as the approval of the local governments (Wang *et al.*, 2011).

In order to establish a well-functioning rural land market, an important precondition is to guarantee land tenure security (Deininger and Feder, 2001; Deininger *et al.*, 2003; Lunduka *et al.*, 2009; Holden *et al.*, 2011). In many areas where individual land rights are not yet well specified, the risk of losing the rights of rented-out land can be a major constraint on land rental transactions (Otsuka and Place, 2001). In China, land tenure security has been improved after the Government has introduced a long-term certificate for land tenure under the "Rural Land Contract Law" promulgated in 2002. For instance, the Chinese central government has established a fixed 30-year certificate for farmland tenure (Wang *et al.*, 2011). A new round of forest tenure and institutional reforms has also been undertaken in China, the duration of forestland holding by individual households can last up to 70 years and the certificate of forestland tenure can be renewed upon maturity (Yin *et al.*, 2013).

However, to date there is still a lack of quantitative studies in China that could provide empirical evidence of the impact of land tenure security on the development of rural land rental market, although there are numerous literatures discussing various perspectives of land tenure (Li *et al.*, 1998; Kung, 2000; Liu, 2001; Brandt *et al.*, 2002; Deininger and Jin, 2003; Ma *et al.*, 2013; Qin and Xu, 2013; Robinson *et al.*, 2014), and several studies with regard to the development of rural land rental markets (Yao, 2000; Deininger and Jin, 2005; Huang *et al.*, 2012). An exception is the study of Jin and Deininger (2009), which however found that the possession of land certificates has no significant impact on the participation in land rental markets. Hence, it remains unclear whether improving land tenure security can facilitate farmers' access to land rental market in rural China.

In this study we focus on the rural land rental market in Xishuangbanna Dai Autonomous Prefecture (XSBN) in Southern China. This is an interesting case in several regards. First, XSBN is a mountainous region where rapid changes in land use have taken place with the transition from traditional agriculture and tropical rainforest to rubber monoculture (Zhang *et al.*, 2015), thus land tenure questions are more complex than in ordinary farm lands. Second, it is in a region where until recently extreme poverty was widespread but significant improvements have been achieved with the introduction of rubber among smallholder farmers (Fu *et al.*, 2010) and therefore equity issues involved land use right becoming increasingly important. Third, XSBN is a minority autonomous region with a high degree of cultural diversity including several indigenous ethnic minorities such as Dai, Hani, Bulang, and others. It will be interesting to find out whether there are differences in land rental market participation between ethnic minorities and the Han majority.

In our analysis we aim to investigate the behavior of smallholder rubber farmers to participate in the local land rental market. Particularly we focus on two factors: (1) the effect of land tenure security on farmers' participation in the local land rental market, (2) the role of population aging, i.e. to what extent a farm household's age structure influences its decision to engage in land rental markets. The data used in

this study are from a cross-sectional survey of 612 smallholder rubber farmers in XSBN carried out in 2013. In this comprehensive survey we collected detailed information, including land use history, natural land conditions, current land tenure status, land productivity, farm and off-farm activities as well as demographic characteristics of the individual member of the households.

To achieve our objectives, we develop three types of econometric models in order to test several hypotheses. First, a bivariate probit regression to test the simultaneity of renting out land and renting in land is developed. Second, a probit regression with endogenous regressors is applied to control for endogeneity of land tenure certificate. Third, an endogenous switching probit model is employed to test for selection bias and to establish a counterfactual analysis. We employ these models to test the hypothesis that households with a higher share of older people are more likely to participate in the land rental market. Furthermore, we assume that the availability of a land certificate is a significant factor in facilitating participation in the land market. We also hypothesize that ethnic minorities are less likely to participate in the land rental market than the Han majority. Finally, results of our econometric models show that all of these hypotheses can be approved. Population aging and issuing land tenure certificate can foster rural land rental market in general. However, it is more difficult to be established in an ethnic minority region because minorities tend to rent out less land. Even though this study is limited to XSBN, the findings can contribute to a better understanding of land rental market development in rural China.

The rest of this paper is organized as follows. Section 2 briefly introduces the study area and the data collection procedure. Descriptive statistics are presented in Section 3. Section 4 describes the empirical models developed for estimating the behaviors of smallholders regarding renting out land and renting in land. In Section 5, we report and discuss the estimated results of established models. The last section presents our summary and conclusions.

2. Data

Xishuangbanna Dai Autonomous Prefecture (XSBN) is located in Southern Yunnan province of China (Figure 1), bordering Laos and Myanmar. XSBN totally covers about 19124.5 km^2, wherein over 95% are mountain regions with altitude between 475 and 2429.5 meters above sea level (MASL). In 1950s, for strategic purposes, nature rubber planting was introduced to XSBN by the new government of China, such that several state-farms were established successively for producing rubber and meeting the domestic demand from late 1950s to early 1980s (Hu *et al.*, 2008). However, since China's agricultural reforms in the 1980s, more and more rubber trees are planted by smallholders (Xu, 2006). Previously forested lands have been largely converted into rubber plantations (Xu *et al.*, 2005); while the unclear land ownership of those lands brings about potential conflicts now. Accordingly, the existence of the

conflicts of land-use right between farmers, villages and local state farms likely slows the progress of issuing land tenure certificate in XSBN.

Furthermore, the expansion of rubber plantations increases the inequity of household income among smallholders in XSBN. In 2012 the per capita net income of rubber farmers has reached over 16000 Yuan, which was almost three times higher than the average household income of rural areas in XSBN (Waibel *et al.*, 2014). The relatively large income gap and inequality between rubber farmers and other farmers is a development that needs more attention. A possible measure to reduce inequality is to advance land rental market of agricultural land in XSBN which can facilitate the transfer of land from rubber farmers to other farmers.

<Figure 1>

Data used in this study are from a comprehensive socioeconomic survey of smallholder rubber farmers carried out in XSBN in March 2013. The survey instrument includes detailed information on socioeconomic characteristics of household members, land use history, natural land conditions, current land tenure status, land productivity, and farm and off-farm activities. To ensure the sample is representative for smallholder rubber farmers in XSBN, we applied a stratified random sampling approach (stratified by rubber planting area per capita) and also took into account the distribution of rubber areas within each county/city. As shown in figure 1, we interviewed a total of 612 households from 42 villages of 8 townships in one city (Jinghong) and two counties (Menghai, Mengla) in XSBN.

3. Descriptive statistics

Based on the collected household survey data, in this section we statistically describe the population structure, ethnicity status, land tenure status, and farmers' participation in land rental market as well their correlations.

3.1. Population aging and ethnicity

China, the world's most populous country, is experiencing dramatic changes in its society due to the significant aging of its population (Min *et al.*, 2015). As shown in figure 2, according to China's national population census in 2010, over 13% of the populations was 60 years old and above. Also, the demographic structure in China is rapidly changing with an increasing proportion of the population being elderly and this aging trend is expected to continue into the future (Min *et al.*, 2015).

< Figure 2>

In XSBN, the process of population aging is also inevitable. At household level, over 42% of households have at least one family member whose age is 60 years old and above. From the perspective of demographic structure, although only 11% of smallholder rubber farmers in XSBN are 60 years old and above, the demographic structure in XSBN actually is in line with the national level (figure 2). It can

be expected that the population aging in XSBN will continue to take place in future. This change likely has potentially important implications concerning future land allocation, land operating and agricultural development, hence it is essential to account for the effects of population aging on farmers' participation in land rental market.

XSBN is a minority autonomous region with a high degree of cultural diversity including several indigenous ethnic minorities. According to the official report (Bureau of Statistics of Xishuangbanna Dai Autonomous Prefecture, 2011), 77.61% of populations living in Xishuangbanna are minorities, including Dai, Hani (called *Akha* in Thailand), Bulang and other upland minorities who are traditional forest dwellers (Fu *et al.*, 2009). While according to our survey results, in rural XSBN 95% of smallholder rubber farmers are minorities, only 5% of households are the Han majority. Generally various ethnicity smallholders have distinct histories, cultures and knowledge, so that their agricultural practices are quite different (Pierce Colfer and Newton, 1989; Brush and Perales, 2007). Thus, the ethnic minorities and the Han majority likely have distinct behaviors toward participation in land rental market. Hence, finding out if there are differences in land rental market participation between ethnic minorities and the Han majority will be interesting and conducive to a better understanding of land rental market in this ethnic minority region.

3.2. Land tenure certificate

Since the "Rural Land Contract Law" was promulgated in China in 2002, a long-term certificate for land tenure has been gradually issued to farmers. While policy documents clearly proposed that over 90% of households in rural China should be issued land tenure certificate by the end of 2007, the real situation didn't reach the objective (Huang and Ji, 2012). The results of a household survey from six provinces (Liaoning, Zhejiang, Hebei, Hubei, Shaanxi, and Sichuan) in China showed that on average only near 70% of households obtained land tenure certificate by 2008 (Huang and Ji, 2012; Deininger *et al.*, 2014).

In XSBN, the issuance of land tenure certificate seems a little bit lagging behind. According to our survey, only 26.6% of smallholder rubber farmers have farmland tenure certificate, 31.2% for forestland tenure certificate; the proportion of households owning both farmland tenure certificate and forestland tenure certificate is only 5%. Although 52.6% of households own either farmland tenure certificate or forestland tenure certificate, this proportion is still lower than the survey results in the other six provinces in 2008 (Huang and Ji, 2012; Deininger *et al.*, 2014). The relatively low issuance rate of land tenure certificate is likely due to the higher costs of verifying land use right (Huang and Ji, 2012). On one hand, the costs of land tenure verification can be increased by the complex geographic situation in this remote mountainous region. On the other hand, the conversions from the public forest lands, which hadn't clear ownership in past, to household rubber plantation normally leads to disputes between farmers, villages, and local state farms; thereby it is quite difficult to confirm land use right for these

lands. Hence, the potential conflicts caused by the uncontrolled expansion of rubber plantations in past is a possible reason for the current lagging issuance of land tenure certificate.

3.3. Participation in land rental markets

Rural land rental market in China is still in its infancy (Feng *et al.*, 2010). Using a nationwide set of household-level data in China, Huang *et al.,* (2012) showed that about 17.2 % and 17.2% of households respectively rented out and rented in cultivated land in 2008. They pointed out that China's cultivated land rental markets are moving land from those with less labor, less capital and more cultivated land to those with more labor, more capital and less cultivated land.

In XSBN our survey results show an unbalanced participation of smallholder rubber farmers in land rental market. Although near 32% of smallholder rubber farmers in XSBN rented out land in 2012, only 4% of them rented in land. In terms of land area, as shown in figure 3 averagely only 11% (1.42 mu/ person) of owned lands are rented out. Also, figure 3 further illustrates the unbalance of land areas between renting out and renting in. These results to some extent imply that lands in XSBN are possibly shifting from rubber farmers to those that didn't own rubber plantation.

< Figure 3 >

Table 1 demonstrates the associations between participation in land rental market and land tenure certificate, population aging and ethnicity. Firstly, households with land tenure certificate (either farmland tenure certificate or forestland tenure certificate) have a higher proportion (58%) and more areas (1.63 mu/ person) of renting out land, compared to the households without land tenure certificate. As for renting in land, its association with land tenure certificate seems unclear. Secondly, households with at least one elder seem more likely to rent out land and less likely to rent in land. For the households with at least one elder, around 32% (2%) of them rented out (in) land; while it was 31% (5%) for the households without elder. Finally, as expected, ethnic minorities are reluctant to opt for participating in land rental market including both renting out land and renting in land. Although a less proportion of ethnic minorities rented out land, averagely they rented out more areas of land. This may be because the indigenous minorities normally have more land areas than the Han majority in XSBN.

< Table 1 >

In summary, population aging of smallholder rubber farmers in XSBN, in principle, follows the demographic structure at national level. In this mountainous region, where ethnic minorities dominate the socioeconomic and cultural conditions, the process of land tenure verification is lagging behind other regions in China. Our descriptive statistics show that the development of a land rental market appears to be associated with the age structure of the population, the availability of land tenure certificates and ethnicity.

4. Empirical models

In this section we propose to establish two econometric models that respectively represent farmers' behaviors of renting out land and renting in land. In the second part of this section we focus on discussing our approach of estimating these models.

4.1. Model specification

In order to capture the impacts of population aging, land tenure certificate and ethnicity on farmers' participation in land rental market by controlling for other independent variables, in line with the general model of farmers' participation in land rental market in previous studies e.g. Deininger and Jin (2005) and Huang *et al.* (2012), we specify the following econometric models:

$$y_{i1} = \alpha_1 + \beta_1 D_i + \gamma_1 C_i + \delta_1 E_i + \theta_1 Z_i + \varepsilon_i \quad (1)$$

$$y_{i2} = \alpha_2 + \beta_2 D_i + \gamma_2 C_i + \delta_2 E_i + \theta_2 Z_i + \mu_i \quad (2)$$

where the subscript i represents the i^{th} household. Equations (1) and (2) are respectively specified to identify the determinants of the behaviors of renting out land and renting in land. In equation (1) the dependent variable y_{i1} is a dummy variable; where in $y_{i1} = 1$ represents the i^{th} household rented out land in 2012, otherwise y_{i1} is equal to 0. Likewise, the dependent variable y_{i1} in equation (2) is also a dummy variable. If the i^{th} household rented in land in 2012, y_{i2} is equal to 1; otherwise, y_{i2} is equal to 0.

The independent variables included in equations (1) and (2) are consistent. D_i represents a vector of variables of household demographic structure, which consists of the proportions of family members belonging to different age groups. The proportion of family members aged 60 years and above is defined as the variable of population aging. The independent variable C_i is a dummy variable; it is equal to 1 if the i^{th} household owned land tenure certificate, otherwise it should be equal to 0. E_i denotes the ethnicity of the i^{th} household; wherein $E_i = 1$ if the household belongs to ethnic minorities *i.e.* Dai, Hani, Bulang and so on, while $E_i = 0$ represents the household is the Han majority. Z_i is a vector of control variables that might influence the behaviors of renting out land and renting in land. α_1, β_1, γ_1, δ_1, θ_1,α_2, β_2, γ_2, δ_2, θ_2 are parameters to be estimated; ε_i and μ_i are the disturbance terms.

The detailed definitions and statistical descriptions of all variables used in regression are summarized in table 2. In addition to the explanatory variables of interest in equations (1) and (2), such as demographic structure, land tenure certificate and ethnicity, a vector of control variables Z_i includes five other independent variables to account for their possible impacts on participation in land rental market. As shown in table 2, ***Hhsize*** denotes the size of the household, measured as the number of family members; ***Land*** is defined as the size of household owned land, which excludes the land rented in, so that the variable ***Land*** is exogenous. To detect the possible impacts of rubber farming on land rental behavior,

we include a variable ***Rubber*** which is defined as the percent of rubber planting area in household owned land. Considering the relatively high labor intensive in rubber farming, we expect that the specialization in rubber farming is likely to facilitate renting out land and hinders renting in land. Since XSBN is a mountainous region, we also control for altitude and remoteness of household location, the latter one is defined as the distance from household to the center of county/city. The development of land rental market in a remote mountainous region is likely to lag behind, hence we hypothesize that the variables ***Altitude*** and ***Remoteness*** have negative affect the decision of households to participate in the land rental market.

<Table 2>

4.2. Estimation approach

In order to estimate the models, three potential problems must be considered. First, the equations of renting-out (1) and renting-in (2) may be correlated; hence a test of simultaneity has to be undertaken. Since the issuance of land tenure certificates could be influenced by the land conflicts in the past, the variable of land tenure certificate is likely to be endogenous. Third, we must check for a possible selection bias of the land tenure certificate.

4.2.1. Simultaneity

In order to test the simultaneity between renting out land and renting in land, a bivariate probit regression which allows estimation of two binary dependent variable models together (Tu and Bulte, 2010) is employed. According to the setup of a bivariate probit regression (Greene, 2003), the unobserved error terms ε_i and $\mu_i$are assumed to have the standard bivariate normal distributions with unit variance $var(\varepsilon_i) = var(\mu_i) = 1$and zero mean $E(\varepsilon_i) = E(\mu_i) = 0$. Thus, the correlation coefficient between ε_i and μ_i can be written as $\rho = cov(\varepsilon_i, \mu_i)$, which identifies whether or not unobserved heterogeneities of renting out land and renting in land are correlated. If the correlation coefficient $\rho$is significantly different from zero, estimating equations (1) and (2) jointly by maximum likelihood estimation would be more efficient (Meng and Schmidt, 1985; De Luca, 2008); otherwise, the two equations can be estimated separately.

4.2.2. Endogeneity

To test for the endogeneity of land tenure certificate in land rental behavior model and the validity of instrumental variable, we estimate the equations (1) and (2) using instrumental variable approach. Assume the variable of land tenure certificate can be expressed as a function of the instrumental variable and the other independent variables, as follow:

$$C_i = a + bD_i + cE_i + dZ_i + hCert\_village_i + \varphi_i \quad (3)$$

where$Cert_village_i$is an instrumental variable defined as the proportion of households owning land tenure certificate in the village. In fact, equation (3) also can be treated as the selection equations of gaining land tenure certificate.

We use two methods to test for the endogeneity of land tenure certificate and check the validity of instrumental variable. A brief way is to test an assumption that $Cert\_village_i$ is significantly correlated with C_i, but insignificantly correlated with y_{i1} and y_{i2} when C_i is equal to 0. This method provides a simple way to check the validity of instrumental variable and has been widely applied in recent studies such as Di Falco *et al.*, (2011), Ayuya *et al.* (2015), Huang *et al.* (2015), and Parvathi and Waibel (2016). If the assumption can be approved, it means the land tenure certificate is indeed endogenous and the instrumental variable is valid. The second method is to estimate the models by the probit regression with endogenous explanatory variables (IV-probit) (Newey, 1987), and then the Wald-test of the exogeneity of the instrumented variable can be an indicator for the test of endogeneity (Rivers and Vuong, 1988). In empirical studies e.g. Brunnschweiler and Bulte (2009) and Voelker and Waibel (2010), this method has also been widely employed. If Wald-test result can significantly reject the null hypothesis, land tenure certificate is endogenous and the instrumental variable is valid, and hence the regression using the instrumental variable is superior to the standard regression. However, IV-probit regression for use with discrete endogenous regressors is not appropriate, and its results will be biased. Hence, here we use IV-probit regression only for additionally checking the robustness of instrumental variables, instead of interpreting the empirical models.

If the proposed instrumental variable i.e. the proportion of households owning land tenure certificate in the village is approved to be valid, a probit regression with discrete endogenous regressors can be estimated by a two-step approach (Greene, 2003). In the first step, the probability of owning land tenure certificate, $\widehat{C_i}$, will be predicted by the estimation results of equation (3) using probit regression. In the second step, land tenure certificate C_i in equations (1) and (2) should be replaced by $\widehat{C_i}$, and then these two equations can be further estimated by probit regression. Thus, the sign and significance of corresponding coefficients for $\widehat{C_i}$ in equations (1) and (2) can reflect the impacts of land tenure certificate on renting out land and renting in land.

4.2.3. Selection bias

Sample selection is one of frequent causes of bias in non-experimental studies (Arendt and Holm, 2006). In line with previous studies (Lokshin and Glinskaya, 2009; Gregory and Coleman-Jensen, 2013; Ayuya *et al.*, 2015), in this study an endogenous switching probit model (ESP) is further employed to test for selection bias of land tenure certificate and to establish a counterfactual analysis.

Following the setup of an endogenous switching probit model (Lokshin and Sajaia, 2011), the equations (1), (2) and (3) can be reconstructed as follows:

$$C_i = 1 \quad \text{if} \quad a + bD_i + cE_i + dZ_i + hCert\_village_i + \varphi_i > 0 \tag{4a}$$

$$C_i = 0 \quad \text{if} \quad a + bD_i + cE_i + dZ_i + hCert\_village_i + \varphi_i \leq 0 \tag{4b}$$

$$y_{1ij}^* = \alpha_{1j} + \beta_{1j}D_{1i} + \delta_{1j}E_{1i} + \theta_{1j}Z_{1i} + \varepsilon_{1i} \quad y_{1ij} = I\,(y_{1ij}^* > 0) \tag{5a}$$

$$y_{0ij}^* = \alpha_{0j} + \beta_{0j}D_{0i} + \delta_{0j}E_{0i} + \theta_{0j}Z_{0i} + \varepsilon_{0i} \quad y_{0ij} = I\,(y_{0ij}^* > 0) \tag{5b}$$

where the subscript j is equal to 1 or 2 , respectively representing renting out land (j=1) and renting in land (j=2). y_{1ij}^* and y_{0ij}^* are latent variables (latent continuous propensity for renting out or renting in land) that determine the observed behaviors of participating in land rental market y_{1j} and y_{0j} (whether the household rented out or rented in land). Observed y_{ij} is defined as $y_{ij} = y_{1j}$ if $C_i = 1$ and $y_{ij} = y_{0j}$ if $C_i = 0$.

Assume that φ_i, ε_{1i}, and ε_{0i} are jointly normally distributed with a mean of zero, thus the correlation matrix can be written as:

$$\Omega_j = \begin{pmatrix} 1 & \rho_{0j} & \rho_{1j} \\ & 1 & \rho_{10j} \\ & & 1 \end{pmatrix} \tag{6}$$

where ρ_{0j} is the correlation between φ_i and ε_{1i}, ρ_{1j} is the correlation between φ_i and ε_{0i}, while ρ_{10j} is the correlation between ε_{1i} and ε_{0i}. Following the procedure of an endogenous switching probit model (Lokshin and Sajaia, 2011), the simultaneous system of equations (4a), (4b), (5a) and (5b) then can be estimated by maximum likelihood estimation. Accordingly, in case either ρ_{0j} or ρ_{1j} is significantly different from zero, it means the existence of selection bias of land tenure certificate. Moreover, the likelihood-ratio test for $\rho_{0j} = \rho_{1j}$ can be used to test the joint independence of equations (5a) and (5b).

Also, the specified endogenous switching probit model provides a possibility of deriving probabilities in counterfactual cases (Ayuya *et al.*, 2015). The treatment effect on the treated (TT) and the treatment effect on the untreated (TU) can be respectively calculated by using the formulas (7) and (8):

$$TT_j = Pr(y_{1j} = 1|C = 1) - Pr(y_{0j} = 1|C = 1) \tag{7}$$

$$TU_j = Pr(y_{1j} = 1|C = 0) - Pr(y_{0j} = 1|C = 0) \tag{8}$$

where TT_j is the expected effect of land tenure certificate on households with observed characteristics which participated in land rental market; while TU_{j} is the expected effect on participation in land rental market if the households without land tenure certificate gained a land tenure certificate.

5. Results

In this section we present the estimation results of farmers' participation in land rental market. First, we show the test results of simultaneity, endogeneity and selection bias. Then, we focus on investigating the impacts of population aging, land tenure certificate and ethnicity on the behaviors of renting out and renting in land.

5.1. Test results of simultaneity, endogeneity, and selection bias

We begin by testing the simultaneity between equation (1) (renting-out) and equation (2) (renting-in). The results for equation (1) and equation (2) that are jointly estimated by the bivariate probit regression are reported in table A.1 of the appendix. The correlated coefficient (ρ) between the residuals of these two models is 0.107; it insignificantly differs from zero according to the results of Wald chi2 test of ρ=0. Hence, the decisions of smallholder rubber farmers to rent out and rent in land are independent so that the two models can be estimated separately.

The instrumental variable "the proportion of households owning land tenure certificate in the village" ($Cert\_village_i$) is approved to be valid. Table A.2 reports the results of validity test of instrumental variables, showing $Cert\_village_i$ has significant and positive impact on the likelihood of gaining land tenure certificate, but insignificantly affects the participation in land rental market for those household which did not have land tenure certificate. This implies the proposed instrumental variable $Cert\_village_i$ is indeed significantly correlated with land tenure certificate, but not directly correlated with participation in land rental market. In table 3 the estimation results in the first step also evidence that even though controlling for the characteristics of households, the instrumental variable still significantly impacts on the land tenure certificate. Moreover, in the results of the IV-probit regressions (table A.3), the Wald-test of the exogeneity of the instrumented variables for renting out land and renting in land respectively is 2.8 and 5.41, which are significant at 10% and 5% level respectively. Consistent with the test result by using the first method, this test result also confirms the endogeneity of land tenure certificate and the validity of the proposed instrumental. Hence, applying $Cert\_village_i$ as an instrumental variable for assessing the impact of land tenure certificate on participating in land rental market is approved to be valid, so that the estimation results using the instrumental variable is supposed to be appropriate.

Finally, we test for selection bias of land tenure certificate by further estimating an endogenous switching probit model. The estimation results of equation (5a) and (5b) are presented in tables 4 and 5. According to computing results, $\rho_{11} = -0.348$ and $\rho_{12} = 0.908$ are significantly different from zero, while $\rho_{01} = 0.326$ and $\rho_{02} = 0.372$ are insignificantly different from zero, hence there indeed exists certain selection bias of land tenure certificate. At the same time, this selection bias problem tends to skew the impact of land tenure certificate on renting out land in a negative direction, but for renting in land in a positive direction. This was an indication that among the households possessing land tenure

certificate, households which were more likely to possess land tenure certificate were less likely to rent out land but were more likely to rent in land, due to the unobservable household characteristics. In other words, the selection bias will underestimate the positive impact of land tenure certificate on renting out land, and overestimate the positive impact of land tenure certificate on renting in land. Hence, it is essential to control the selection bias in order to more accurately quantify the impact of land tenure certificate.

5.2. Estimation results for participating in land rental market

To interpret the empirical models of renting out land and renting in land, we adopt two estimation results including: (1) the probit regression with a discrete endogenous regressor (table 3), and (2) the endogenous switching probit regression (tables 4 and 5). The former one, which is estimated by using the instrumental variable and the two-step approach to control for the endogeneity of land tenure certificate, can be used to explicate the impacts of interested variables on farmers' behaviors of participating in land rental market. Through further controlling the selection bias, the second model can identify the interactive effects between land tenure certificate and other independent variables on the likelihood of participating in land rental market. It thus provides a counterfactual analysis by which the impact of possessing a land tenure certificate is more accurately quantified.

5.2.1. Probit regression with a discrete endogenous regressor

As shown in table 3, in the first step, whether household owning land tenure certificate is significantly impacted by the size of household owned land, the percent of rubber planting area in household owned land, the altitude of household location, and the instrumental variable "the proportion of households owning land tenure certificate in the village". As expected, the state of implementation of issuing land tenure certificates in the village has a positive impact on the probability of household obtaining such certificate. Households with more land area are more likely to obtain land tenure certificate. On the one hand, this to some extent implies the inequality of land tenure certificate issuance in XSBN, that is, the households with small land size are falling behind to obtain the official confirmation of land use right. On the other hand, it also might be that households with small land size care less about land tenure security than the households with larger land size. Hence they didn't actively participate in the process of land tenure verification. Moreover, households planting more rubber are less likely to get a land tenure certificate. This result confirms our hypothesis that the expansion of natural rubber leads to conflicts with regard to land use rights in XSBN, and thereby hinders the issuance of land tenure certificates. Finally, altitude has negative impact on the probabilities of getting a land tenure certificate. It shows that the issuance of such certificates in mountainous regions is lagging behind due to the relative high costs of verification.

In the second step, we estimate equations (1) and (2) including the predicted variable from the first step, i.e. the probabilities of possessing a land tenure certificate. As shown in table 3, the results confirm the hypothesis that the share of older people (age ≥ 60 years) in a household increases the likelihood of renting out land, and reduces the likelihood of renting in land. Hence, population aging fosters land rental market development by transferring land from older to younger farmers. Furthermore, the probability of having a land tenure certificate significantly affects the probability of participating in land rental markets, with a positive coefficient for renting out land but negative for renting in land. This confirms that the availability of a land tenure certificate increases participation in land rental market. Interestingly, participation is sensitive to ethnicity whereby, as expected, ethnic minority groups are significantly less likely to rent out land. This underlines the complexity of land transfer procedures in ethnic minority villages which can be different from the conditions existing for the ethnic majority in China.

<Table 3>

Table 3 also shows that several other independent variables e.g. specialization in rubber farming, altitude, and remoteness significantly influence the participation behavior of smallholders in land rental market. In line with our expectation, due to the relatively high labor demand, the specialization in rubber farming positively fosters the behavior of renting out land and negatively impacts on renting in land. This result to some extent implies that land in XSBN was transferring from rubber farmers to those that didn't own (owned less) rubber plantation. Household located in higher altitude and more remoteness is less likely to rent out land, reflecting the constraints of land rental market development in a remote mountainous region.

5.2.2. Endogenous switching probit regression

Table 4 and 5 respectively present the results of endogenous switching probit regression for renting out land and renting in land. The likelihood-ratio tests for the joint independence of the equations shows that equations (5a) and (5b) are not independent in the model of renting out land (table 4), confirming the validity for use of endogenous switching probit regression; but in the model of renting in land (table 5), equations (5a) and (5b) are independent, suggesting that the use of endogenous switching probit regression for renting in land has not remarkable advantage. For the selection equation (3) regarding land tenure certificate, although there are minor differences in magnitudes of the estimated coefficients between tables (3), (4) and (5), the significance and sign of all explanatory variables are always consistent. However, the obvious differences in coefficients of land rental market participation equations between the households with land tenure certificate and those households without illustrate the presence of heterogeneity in the samples (table 4, columns (3) and (4); table 5, columns (3) and (4)).

In the model of renting out land (table 4), explanatory variables such as population aging, ethnicity, specialization in rubber farming, altitude, and remoteness are significantly associated with the probabilities of renting out land by households with land tenure certificate. This illustrates the interactive effects between land tenure certificate and these explanatory variables on the decision to rent out land. Additionally, the proportion of family members aged between 40 and 60 years has also a significant and positive impact on renting out land for households with land tenure certificate. Interestingly, if a household has a land tenure certificate, the size of the household's own land is negatively related with the probability of renting out land. This implies that the issuance of land tenure certificates may be conducive to encourage the formation of large-scale land operations.

<Table 4>

However, for the households without land tenure certificate, only altitude and remoteness are found to have significant impacts on renting out land (table 4). Surprisingly, we find that the variable remoteness has completely different impacts on renting out land compared to the households with land tenure certificate. In other words, in case a household has a land tenure certificate, remoteness reduces the probability of renting out land. For household without land tenure certificate, the effect is opposite. This result on the one hand illustrates the complexity of farmers' participation in land rental market in the remote region of XSBN; on the other hand results reveal the absence of a land tenure certificate negatively affects engagement in agriculture.

<Table 5>

In the model of renting in land (table 5), the determinants between the households that had land tenure certificate and those households that did not have land tenure certificate are also quite different. For instance, the estimated coefficient of population aging is significantly negative only for the household without land tenure certificate; while the negative effect of specialization in rubber farming on renting in land is only significant for the household having land tenure certificate. Moreover, we also find household size and altitude, which are insignificant in table 3, have certain impacts on the behaviors of renting in land. In terms of the households owning land tenure certificate, they having more family members are less likely to rent in land. As for the household without land tenure certificate, they located in higher altitude have larger probabilities of renting in land.

To sum up, the possession of land tenure certificate along with other explanatory variables such as population aging, ethnicity, the area of household land, specialization in rubber farming, altitude, and remoteness play important roles in farmers' participation in land rental market in XSBN. The heterogeneity in the samples and the existence of interactive effects between land tenure certificate and other explanatory variables caused the different influence factors of participation in land rental market between households with land tenure certificate and households without land tenure certificate. The use of

endogenous switching probit model not only controls for the selection bias in land tenure certificate, but also provides more insights and a better understanding of the relations between land tenure security and the development of rural land rental markets.

<Table 6>

Based on the estimation results of the endogenous switching probit models, we further conducted a counterfactual analysis to quantify the impacts of land tenure certificate on the probabilities of participating in land rental markets. As shown in table 6, the results of average treatment effect on the treated (ATT) show that households possessing a land tenure certificate have a 39.3% higher probability of renting out land, and a 2.6% lower probability of renting in land. Moreover, the results of average treatment effect on the untreated (ATU) suggest that if farmers would possess a land tenure certificate this would increase a 63.7% likelihood of renting out land, and decrease a 2.9% likelihood of renting in land. Clearly, improving land tenure security encourages farmers to rent out land, and hence issuing a land tenure certificate can contribute to the advancement of rural land rental markets.

6. Summary and Conclusions

In this study we explored the rural land rental market in Xishuangbanna Dai Autonomous Prefecture in Southern China a mountainous region, where rapid changes in land use have taken place with the transitions from tropical rainforest to rubber monoculture. Our results show the complexity of land use rights and land rental market in this remote mountainous region dominated by ethnic minorities where conditions are not always compatible with modern rural land legislation. Due to the conflicts between traditional land use right and official land tenure legislation, augmented by the expansion of rubber farming, the process of land tenure certificate issuance in this region is lagging behind other regions in China. At the same time, we also find an unbalanced development of land rental market among smallholder rubber farmers. A much higher proportion of smallholders rent out land than renting in. This implies that land is possibly transferred from rubber farmers to households without own rubber plantation. Hence the land rental market seems to be an instrument to reduce the inequality between rubber- and non-rubber farmers in this region.

We assessed the determinants of farmers' participation in land rental market, particularly focusing on the impacts of population aging, land tenure certificate and ethnicity. To ensure the validity and robustness of results, we tested the simultaneity between renting out land and renting in land, and the endogeneity and selection bias of land tenure certificate. Results indicate that the equations of renting out land and renting in land can be estimated separately; the variable of land tenure certificate was indeed endogenous and existed selection bias. Through using a two-step approach, the results of the probit regression with a discrete endogenous regressor confirm our three main hypotheses, namely: 1)

population aging fosters the advancements of rural land rental market by transferring land from older to younger farmers, 2) the availability of a land tenure certificate increases farmers' participation in land rental market by improving the land tenure security, and 3) participation in land rental market is sensitive to ethnicity, i.e. ethnic minority groups are significantly less likely to rent out land. We also find specialization in rubber farming, altitude, and remoteness may play certain roles in farmers' behaviors of participating in land rental market. Moreover, the results of the endogenous switching probit model and the counterfactual analysis suggest that the influence factors of participating in land rental market for the households that had land tenure certificate obviously are different with those for the households without land tenure certificate; if farmers would possess a land tenure certificate this would put 64% higher likelihood of renting out land.

Finally, while our study is limited to the study region, it provides an interesting case which helps to better understand rural land rental market in China. Overall, we confirm our hypotheses that population aging and land tenure certificates facilitate the advancements of rural land rental markets. However, in a remote mountainous and ethnically diverse area the establishment of well-functioning land rental markets is more difficult and will take more time. We recommend that respective government agencies more effectively implement the issuance of land tenure certificates, while giving due considerations to ethnic minority groups and the farmers located in remote mountainous area.

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Tables

Table 1: Participation in land rental markets and its association with land tenure certificate, population aging and ethnicity

Categories	Rent out		Rent in	
	Household (%)	Average area (mu/person)	Household (%)	Average area (mu/person)
Land tenure certificate				
Yes	53.11	1.63	4.35	0.36
No	7.93	1.18	3.10	0.59
Elder in household				
Yes	32.43	1.74	2.32	0.15
No	31.16	1.19	4.82	0.69
Ethnicity				
Han	35.71	1.04	7.14	2.12
Minority	31.51	1.44	3.60	0.39

Data sources: Authors' survey

Table 2: Summary statistics of dependent and independent variables

Variable	Definition and description	Mean	Std. Dev.	Min	Max
Dependent variables					
y1	Rent out land (1=Yes; 0= No)	0.32	0.47	0	1
y2	Rent in land (1=Yes; 0= No)	0.04	0.19	0	1
Independent variables					
Hhsize	Household size	5.12	1.46	2	11
Demographic structure					
Age16	% of family members (age<16)	0.18	0.15	0	0.6
Age16-40	% of family members (16≤age<40)	0.41	0.15	0	1
Age40-60	% of family members (40≤age<60)	0.30	0.18	0	1
Age60	% of family members (age≥60)	0.11	0.16	0	1
Certificate	Land tenure certificate (1=Possess; 0= No)	0.53	0.50	0	1
Ethnic	Ethnicity (1=Minority; 0=Han)	0.95	0.21	0	1
Land	Household owned land size (mu/person)	12.89	12.33	0	145.8
Rubber	Percent of rubber planting area	0.87	0.16	0.06	1
Altitude	Altitude of household location (MASL)	756.11	160.27	541	1468
Remoteness	Distance to the center of county(km)	79.31	46.54	25	190

Data sources: Authors' survey

Table 3: Results of probit regression estimated by a two-step approach

Variables	First step (land tenure certificate)			Second step (Rent out)			Second step (Rent in)		
	Coef.		R. Std. Err.	Coef.		R. Std. Err.	Coef.		R. Std. Err.
Hhsize	0.006		0.046	-0.057		0.041	-0.070		0.070
Age16	0.027		0.563	0.039		0.521	-0.293		0.954
Age40-60	-0.456		0.487	0.684		0.429	-1.067		0.700
Age60	-0.326		0.499	0.892	**	0.450	-1.970	**	0.890
$\widehat{C_i}$				1.800	***	0.202	-0.655	**	0.316
Ethnic	0.056		0.254	-0.590	**	0.271	-0.133		0.378
Land	0.011	**	0.005	-0.002		0.005	0.001		0.009
Rubber	-1.587	***	0.476	0.756	*	0.441	-1.326	**	0.601
Altitude	-0.001	**	0.0005	-0.001	*	0.001	0.000		0.001
Remoteness	-0.0004		0.002	-0.007	***	0.002	-0.002		0.002
Certificate_village	3.401	***	0.220						
Constant	0.401		0.754	-0.396		0.774	1.037		1.042
Number of observations	612			612			612		
Wald chi2 (Joint significance)	249.60***			99.31***			20.11**		
Log pseudo likelihood	-275.36			-318.20			-89.84		
Pseudo R2	0.3496			0.1676			0.0836		

Notes: *.**.and *** indicate significance at the 1%.5%.and 10% level. respectively

Table 4: Estimation results of endogenous switching probit regression for renting out land

Variables	Land tenure certificate			Rent out (Certificate=1)			Rent out (Certificate=0)		
	Coef.		R. Std. Err.	Coef.		R. Std. Err.	Coef.		R. Std. Err.
Hhsize	0.004		0.046	-0.034		0.056	-0.086		0.074
Age16	0.002		0.557	0.820		0.654	-1.244		1.210
Age40-60	-0.500		0.482	1.206	**	0.566	-0.038		0.695
Age60	-0.387		0.503	1.313	**	0.649	0.268		0.786
Ethnic	0.053		0.254	-0.818	**	0.389	-0.185		0.528
Land	0.011	**	0.005	-0.014	*	0.008	0.011		0.007
Rubber	-1.601	***	0.488	1.110	*	0.588	-0.672		0.812
Altitude	-0.001	**	0.0005	-0.002	**	0.001	-0.002	***	0.001
Remoteness	-0.0005		0.002	-0.011	***	0.002	0.005	**	0.002
Cert_village	3.359	***	0.215						
Constant	0.473		0.786	1.865	*	1.119	1.243		1.411
ρ_{11}/ρ_{01}				-0.348	**	0.161	0.326		0.249
Number of observations	612								
Wald chi2 (Joint significance)	257.04***								
Log pseudo likelihood	-523.67								
Wald chi2 (Wald test of independent eqns.)	5.34*								

Notes: *,**, and *** indicate significance at the 1%,5%, and 10% level, respectively

Table 5: Estimation results of endogenous switching probit regression for renting in land

Variables	Land tenure certificate		Rent in (Certificate=1)		Rent in (Certificate=0)	
	Coef.	R. Std. Err.	Coef.	R. Std. Err.	Coef.	R. Std. Err.
Hhsize	0.011	0.046	-0.139 *	0.077	0.020	0.120
Age16	-0.029	0.554	0.456	1.116	-1.623	1.423
Age40-60	-0.382	0.474	-0.877	0.764	-1.398	1.183
Age60	-0.296	0.490	-1.199	0.936	-3.107 **	1.548
Ethnic#						
Land	0.012 **	0.005	0.010	0.014	-0.042	0.026
Rubber	-1.631 ***	0.483	-1.653 **	0.697	-0.719	0.932
Altitude	-0.001 **	0.000	-0.001	0.001	0.002 **	0.001
Remoteness	0.000	0.002	-0.003	0.003	-0.006	0.005
Cert_village	3.427 ***	0.221				
Constant	0.466	0.746	1.300	1.281	-0.736	1.533
ρ_{12}/ρ_{02}			0.908 ***	0.194	0.372	0.314
Number of observations			612			
Wald chi2 (Joint significance)			251.48***			
Log pseudo likelihood			-358.89			
Wald chi2 (Wald test of independent eqns.)			3.12			

Notes: *,**, and *** indicate significance at the 1%,5%, and 10% level, respectively; # Due to the small sample size of households renting in land, the endogenous switching probit regression for the originally specified empirical model couldn't be concave. By trade-off, hence here we drop the ethnic variable, which actually has insignificant impact on renting in land.

Table 6: Treatment effects of land tenure certificate

Categories	Observations	Mean	
		Rent out	Rent in
ATT	322	0.393 ***	-0.026 ***
ATU	290	0.637 ***	-0.029 ***

Data sources: Authors' calculations

Figures

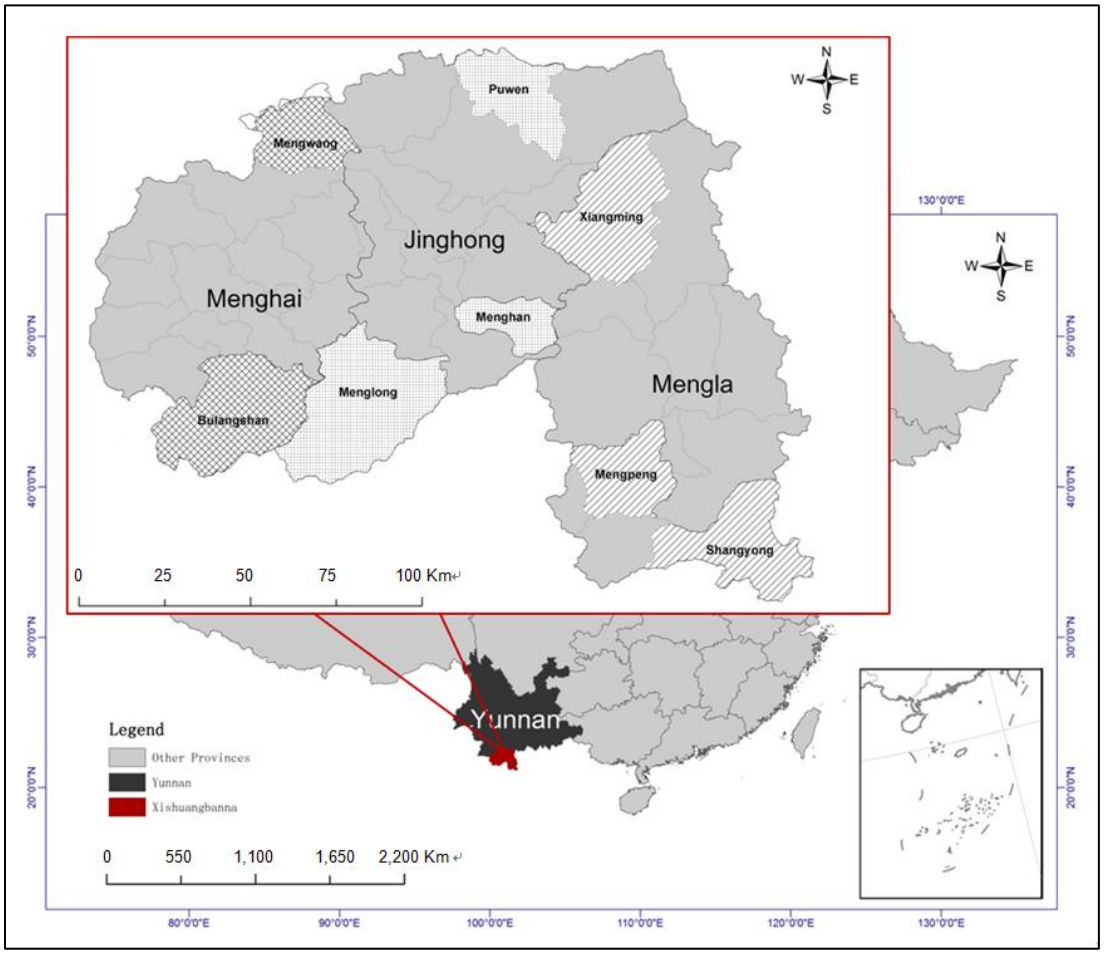
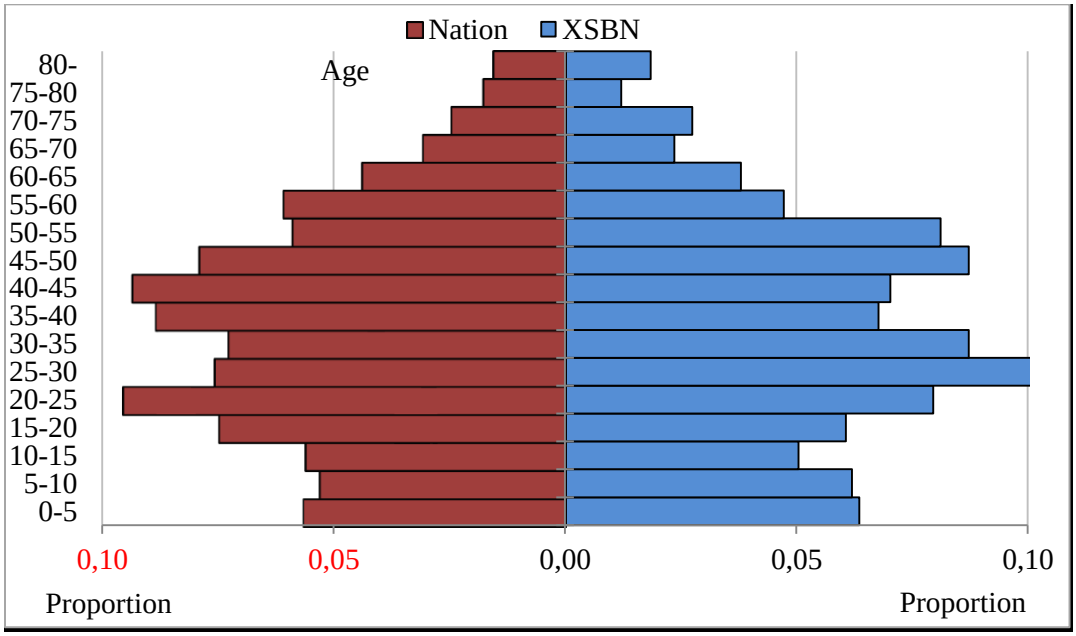
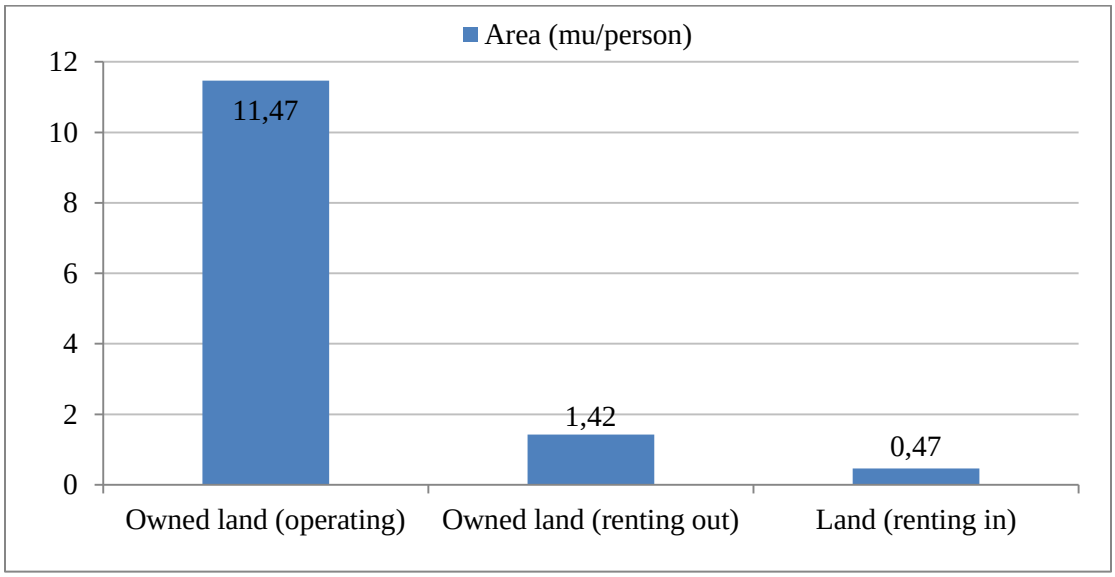


Figure 1: The map of study area and sample distribution



Data sources: National Bureau of Statistics of China (2011); Authors' survey

Figure 2: Demographic structure respectively at national level and in XSBN



Data sources: Authors' survey

Figure 3: Per capita land area of smallholder rubber farmers in XSBN

Appendix:

Table A.1: Estimation results of bivariate probit regression

Variables	Rent out			Rent in		
	Coef.		Robust Std. Err.	Coef.		Robust Std. Err.
Hhsize	-0.049		0.043	-0.077		0.070
Age16	0.011		0.563	-0.309		0.909
Age40-60	0.823	*	0.440	-1.014		0.694
Age60	1.008	*	0.537	-1.778	**	0.819
Certificate	1.761	***	0.159	0.093		0.193
Ethnic	-0.623	**	0.307	-0.176		0.367
Land	0.001		0.006	-0.002		0.012
Rubber	0.714		0.471	-0.901		0.595
Altitude	-0.001	**	0.001	0.000		0.001
Remoteness	-0.008	***	0.002	-0.002		0.002
Constant	-0.241		0.854	0.294		1.051
ρ	0.107		0.137			
Number of observations	612					
Wald chi2	157.38 ***					
Log pseudo likelihood	-360.980					
Wald chi2 test of ρ=0	0.604					

Notes: *,**, and *** indicate significance at the 1%,5%, and 10% level, respectively

Table A.2: Validity test of instrumental variables

Variables	Land tenure certificate			Rent out (Certificate=0)			Rent in (Certificate=0)		
	Coef.		R. Std. Err.	Coef.		R. Std. Err.	Coef.		R. Std. Err.
Cert_village	3.418	***	0.216	-0.850		0.563	0.409		0.627
Constant	-1.716	***	0.126	-1.165	***	0.180	1.743	***	0.231
Number of observations	612			290			290		
Wald chi2	250.73***			2.280			0.42		
Log pseudo likelihood	-284.688			-78.336			-39.874		
Pseudo R2	0.328			0.025			0.006		

Notes: *,**, and *** indicate significance at the 1%,5%, and 10% level, respectively

Table A.3: Estimation results of IV-probit regression

Variables	Land tenure certificate			Rent out			Rent in		
	Coef.		R. Std. Err.	Coef.		R. Std. Err.	Coef.		R. Std. Err.
Hhsize	-0.00004		0.012	-0.056		0.043	-0.060		0.067
Age16	-0.006		0.143	0.035		0.556	-0.312		0.919
Age40-60	-0.103		0.125	0.843	*	0.433	-0.994		0.670
Age60	-0.065		0.133	1.032	*	0.529	-1.849	**	0.832
Certificate				2.009	***	0.201	-0.520	*	0.279
Ethnic	0.026		0.084	-0.647	**	0.291	-0.099		0.368
Land	0.003	**	0.001	-0.001		0.006	0.001		0.010
Rubber	-0.454	***	0.112	0.865	*	0.480	-1.265	**	0.581
Altitude	-0.0003	**	0.0001	-0.001	**	0.001	0.000		0.001
Remoteness	-0.0002		0.0004	-0.008	***	0.002	-0.002		0.002
Cert_village	0.979	***	0.036						
Constant	0.605	***	0.196	-0.465		0.879	0.927		0.993
Rho				-0.174	*	0.102	0.357	**	0.140
Sigma				0.386	***	0.010	0.386	***	0.010
Number of observations				612			612		
Wald chi2 (Joint significance)				133.25***			21.53**		
Log pseudo likelihood				-553.24			-374.00		
Wald chi2 (Wald test of exogeneity)				2.80*			5.41**		

Notes: *,**, and *** indicate significance at the 1%,5%, and 10% level, respectively