How does off-farm work participation of farm couples affect household land transfer choices? An empirical investigation

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Contributed paper prepared for presentation at the 63rd AARES Annual Conference, Melbourne, Vic 12-15 February 2019

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Abstract

Off-farm work plays a significant role in diversifying rural income and reducing risks generated from relying solely on agricultural production. Prior studies have examined the association between off-farm work participation and land use behaviors of rural households, but little attention has been paid to the effects of the joint off-farm work decisions of farm couples on land transfer choices. To bridge this gap, this study investigates the determinants of farm couples' off-farm work participation, using a seemingly unrelated bivariate probit regression model and survey data collected from Hubei province of China. We also estimate the impact of the joint off-farm work decisions of farm couples on land transfer choices by employing a multinomial logit model and controlling for the endogeneity issues of off-farm work variables. The empirical results show that farm couples are jointly making decisions to work off the farm, but their decisions affect household land transfer choices differently. In particular, we show that the husbands participating in the off-farm work are more likely to rent in land, while their wives are less likely to do so. Both the husbands and wives are more likely to rent out land if they work off the farm. Our findings highlight the importance of farm couples' off-farm work decisions in stimulating the development of rural land rental markets.

Keywords: Off-farm work; Farm couples; Land transfer choices; SUBP; MNL; Rural China

JEL codes: C83; R14; R23;

1. Introduction

Off-farm work by farmers has been a persistent phenomenon in both developed and developing countries. For example, in 2010 it was estimated that about 91% of the farm households have at least one family member working off the farm in the United States (Brown and Weber, 2013). In China, there is an overall upward trend towards off-farm work participation by rural labors in the past four decades, and the ratio of off-farm work participants to rural labors has increased from 9.3% in 1978 to 74.9% in 2015 (Zhang et al., 2018).

A large body of literature has analyzed the determinants of off-farm work participation and its impacts on such aspects as farm productivity and efficiency, new technology adoption, household income, poverty reduction, food expenditure and food security (Ma et al., 2018c, 2018b; Mishra et al., 2015; Owusu et al., 2011; Su et al., 2016). Most of them have focused on the off-farm work participation decision of household heads (usually males), due to the belief that they dominate household decision-making. For example, Imai et al. (2015) showed that household heads' participation in off-farm work and occupation choice are affected by wealth, human capital, and social group. In their investigation of rural China, Ma et al. (2018b) found that off-farm work participation of household heads (86% of which were male) significantly increases expenditures on productivity-enhancing inputs such as fertilizers and pesticides.

Several studies have also investigated the joint off-farm work participation decisions of farm couples, and found that the husbands and wives are making off-farm work decisions jointly (Abdulai and Delgado, 1999; Chang et al., 2017; Chang and Yen, 2010; El-Osta et al., 2008; Kimhi and Lee, 1996). For example, Abdulai and Delgado (1999) revealed that off-farm work participation of husbands and wives are nonindependent of one another. Compared with farm work, off-farm work enables the female or the wives to improve their well-being, support their financial leverage in the household and reduce food insecurity (Dzanku, 2019; Van den Broeck and Maertens, 2017). In addition, the female or the wives' participation in off-farm work may generate different consequences compared to that of the male or the husbands. El-Osta et al. (2008) examined the impacts of government payments on off-farm decisions of married farm couples, and found that a $10,000 increase in expected government payments tends to increase the likelihood of the wives working off the farm alone by 9.0% and to decrease such likelihood by 8.6% significantly for the strategy where both the husbands and the wives work concurrently off the farm. Chang et al. (2017) showed that compared to farm families in which solely the husbands engaged in off-farm activities, those in which only the wives participated in off-farm work have a lower propensity to engage in direct marketing in Taiwan.

Some studies have investigated the linkage between off-farm work participation and land transfer choices (Huang et al., 2012; Ji et al., 2018; Kung, 2002; Min et al., 2017; Yan and Huo, 2016). For example, Huang et al. (2012) and Yan and Huo (2016) both examined the nexus between off-farm employment and households' decision of land transfer, and they found that households who engaged in off-farm activities are more likely to rent out land in rural China. Kung (2002) showed that the household heads who spent more time on off-farm activities tend to decrease the amount of land rented in China. This observation is echoed by the study of Ji et al. (2018), who showed that rural labor migration has a significant and negative effect on households renting in land and has a positive impact on households renting out land in rural China. Despite the presence of these findings, it is still not clear whether the off-farm work participation of household husbands and wives generate homogenous or heterogeneous impacts on the land transfer choices.

Land rental market participation is an effective way to enhance allocative efficiency and agricultural productivity by facilitating transfers of land from less productive households to more productive ones (Deininger and Jin, 2005). Lambin and Meyfroidt (2011) emphasized that the pathways leading to a land use transition rely on various degrees and combinations of off-farm work activities. Given the existed interdependence of farm couples' off-farm work decisions (Abdulai and Delgado, 1999; Chang et al., 2017; Chang and Yen, 2010; El-Osta et al., 2008), it is quite likely that land transfer choices within a household are affected not only by the off-farm work participation of the husbands but also by that of the wives. Understanding the linkages between off-farm work participation of farm couples and land transfer choices can provide significant information to policy-makers in their efforts to design policy instruments that help increase off-farm work opportunities and stimulate the development of rural land rental markets. However, to the best of our knowledge, there are no previous studies that have examined how the joint off-farm work participation decisions of the farm couples affect household land transfer choices.

The primary objective of this study is, therefore, to analyze the joint impacts of off-farm work participation decisions of farm couples on household land transfer choices using data collected from rural households in Hubei province of China in 2018. The contribution of this study to the literature on rural migration and land transfer is threefold. First, we analyze the factors that affect husbands and wives' decisions to participate in off-farm work, using a seemingly unrelated bivariate probit model. This model enables us to identify whether the off-farm work decisions of farm couples are jointly made through unobserved factors (e.g., farmers' innate abilities and motivations to work outsides). Second, we estimate the impact of off-farm work participation of farm couples on land transfer choices (i.e. no land transfer, renting-in land, and renting-out land) simultaneously by using a multinomial logit model. Third, we provide a theoretical framework that relates the off-farm work decisions of farm couples to land transfer choices.

The rest of the paper is structured as follows. Section 2 presents the theoretical framework. The empirical strategies are introduced in Section 3. The data and descriptive statistics are presented in Section 4 and the estimated results are discussed in Section 5. Section 6 concludes with policy implications.

2. Theoretical Framework

The theoretical framework employed in the present study assumes that a household consists of one husband and one wife who have fixed time endowments, which can be allocated to leisure, farm production, and off-farm work activities. Given this assumption and following previous studies (Abdulai and Delgado, 1999; Ma et al., 2018b), the simplified utility of the household can be expressed as a function of goods and services consumed and leisure time:

$$U = (C, L_1, L_2; A) \tag{1}$$

where U is a household utility function, which is assumed to be monotone increasing in its arguments, strictly concave, and to possess continuous second partial derivatives; C denotes a set of goods or services purchased for consumption; L_1 and L_2 represent leisure time used by the husband and his wife, respectively; A represents a vector of socio-demographic characteristics (e.g., age, education and household size) that affect household's utility. Utility maximization is subject to a time constraint, income constraint and technology constraint. In particular, the time constraint is expressed as follows:

$$T = T_{i1} + T_{i2} + L_i \quad (i = 1,2) \tag{2}$$

where T is the total time available for either the husband or the wife; T_{i1} and T_{i2} are time allocated by the husband (i=1) and the wife (i =2) to farm work and off-farm work, respectively; and L_i is considered the leisure time used by the husband (i =1) and his wife (i =2). Non-negativity constraints are imposed on farm work and off-farm work of both husbands and wives, i.e. $T_{i1} \geq 0$ and $T_{i2} \geq 0$ for $i = 1, 2$.

Consumption is constrained by household income, which is composed of net farm income, income from off-farm work, and income from other sources (i.e. interest, dividends, private pensions, and remittances). The resulting income constraint is:

$$P_c C = P_Q Q - P_B B - P_X X + \sum_{i=1}^{2} W_{i2} T_{i2} + R \tag{3}$$

where P_c and C denote the prices and quantities of goods and services purchased for consumption, respectively; P_Q and Q represent the price and quantity of farm output, respectively; P_B and B are the price and quantity of farmland, respectively; P_X and X are the prices and quantity vectors of farm inputs besides land such as fertilizers, pesticides and seeds, respectively; W_{12} and W_{22} represent off-farm wage rates received by the husband and his wife, respectively; T_{12} and T_{22} capture the time used for off-farm work by the husband (*i*=1) and his wife (*i*=2), respectively; R is the quantity of non-labor income such as private pension, remittance and government transfers.

The technology constraint can be expressed by a twice differentiable, concave production function:

$$Q = Q(B, X, T_{11}, T_{21}; Z) \tag{4}$$

where Q, B, X, T_{11} and T_{21} are as defined above, and Z is a vector of exogenous factors that shift the production function.

As outlined above, the Lagrangian function of the household's utility-maximization problem can be specified, given the constraints specified in Equations (2), (3) and (4). For analytical purposes, we substitute Equation (4) into Equation (3). Then, the Lagrangian function of the household's utility maximization problem can be expressed as:

$$\begin{aligned} \mathcal{L} = U(C, L_1, L_2; A) + \lambda(2T - T_{11} - T_{12} - L_1 - T_{21} - T_{22} - L_2) + \eta[P_Q Q(B, X, T_{11}, T_{21};\ Z) \\ - P_B B - P_X X + W_{12}T_{12} + W_{22}T_{22} + R - P_C C] \end{aligned} \tag{5}$$

where λ refers to the Lagrangian multiplier associated with the time constraints on the work of the husband and his wife, while η is the Lagrangian multiplier associated with the household income constraint.

Under the Kuhn-Tucker conditions, maximization of this Lagrangian function with respect to Q, T_{i1} and T_{i2} yields the optimal choices by the husband and his wife. In particular, the farm work participation condition of farm couples can be expressed as:

$$\frac{\partial \mathcal{L}}{\partial T_{i1}} = -\lambda + \eta P_Q \frac{\partial Q}{\partial T_{i1}} = 0 \ (i = 1, 2) \tag{6}$$

The off-farm work participation condition of farm couples can be expressed as:

$$\frac{\partial \mathcal{L}}{\partial T_{i2}} = -\lambda + \eta W_{i2} = 0 \ (i = 1, 2) \tag{7}$$

Equations (6) and (7) can be rearranged to obtain the return to labor from the farm and off-farm work:

$$W_{i2} \leq \lambda/\eta = P_Q \partial Q/\partial T_{i1} \ \ (i = 1, 2) \tag{8}$$

where λ/η, with $\lambda = \partial \mathcal{L}/\partial T_i$ and $\eta = \partial \mathcal{L}/\partial C$, represents the marginal rate of substitution between leisure and consumption of goods; $P_Q \partial Q/\partial T_{i1}$ refers to the value of marginal product of farm labor for the husband (i=1) or the wife (i=2). In Equation (8), $W_{i2} < \lambda/\eta \ \ (i = 1, 2)$ (strict inequality) implies that the potential wage rate received by the husband or his wife from off-farm work is less than the marginal value of farm work or leisure (i.e. reservation wage). [1] In this case, the optimal time that farm couples allocated to off-farm work is zero, i.e. $T_{i2} = 0$ (Abdulai and Delgado, 1999; Ma et al., 2017). However, when $W_{i2} = \lambda/\eta$ (interior solution), an individual's off-farm wage rate equals the marginal value of his or her leisure or farm work. In this case, the optimal time that the husband or his wife used for off-farm work may be positive.

Through Lagrangian duality theory, the above derivation of the farm couples' off-farm work participation decisions can be related to the use of agricultural inputs such as land, fertilizers, and pesticides, and the farm household production problem can be specified as a profit-maximizing problem at the optimal solution (Kousar and Abdulai, 2016; Ma et al., 2018b). We specify the household's profit-maximizing problem as follows:

[1] The reservation wage for off-farm work is the marginal value of the individual's time when all of it is allocated to either the farm and leisure (Ma et al., 2018b).

$$\pi = Max\left(P_Q Q - P_B B - P_X X + W_{12}T_{12} + W_{22}T_{22} + R\right) \quad (9)$$

where π is the profit obtained from the farm, off-farm and non-labor activities, and Equation (9) is subject to $Q = Q(B, X, T_{11}, T_{21}; Z)$. From Equation (9), we can specify the maximized profit as a function of inputs and output prices, wages from off-farm work, and household and farm-level characteristics, as:

$$\pi = \pi\left(P_Q, P_B, P_X, W_{12}, W_{22}; Z\right) \quad (10)$$

Direct application of Hotelling's Lemma to Equation (10) yields the reduced form specifications for input demand and output supply functions. Without loss of generality and extrapolating the case only to land use, we can obtain the optimal quantity of land used for cultivation as follows:

$$\frac{d\pi}{dP_B} = -B = B\left(P_Q, P_B, P_X, W_{12}, W_{22}; Z\right) \quad (11)$$

where B represents the land used for agricultural production, and P_B refers to the land price per unit, as defined previously. The specification (11) suggests that the demand for land input is influenced by output price, land price, other inputs prices, off-farm work wage rates received by the husband and his wife, as well as household and farm-level characteristics.

Off-farm work participation decisions of farm couples may affect the quantity of land use either positively or negatively. On the one hand, the farm couples' off-farm work participation requires the households to re-allocate the labors used for farm work to off-farm work, resulting in so-called lost-labor effect (Taylor et al., 2003). In order to maintain agricultural productivity, farm households may choose to reduce the quantity of cultivated land by renting out some land. On the other hand, in line with the income effects of off-farm work, earnings from off-farm work can release the credit constraints facing farm households and enable them to invest in productivity-enhancing inputs such as fertilisers and pesticides or soil-improving inputs such as organic manure and green manure (Kousar and Abdulai, 2016; Ma et al., 2018b). In this case, farm households may choose to expand farm production by renting in more land. Nevertheless, the existing literature has failed to provide the evidence regarding the nexus between farm couples' off-farm work participation and household land transfer choices, and this study addresses the research gap by applying the econometric approaches discussed in the following section.

3. Empirical strategies

3.1 Modelling the joint off-farm work decisions of farm couples

Following previous studies (Abdulai and Delgado, 1999; Chang et al., 2017), we assume that farm couples are making joint decisions when they choose to work off the farm. The off-farm work decisions of the husbands and wives are expressed as follows, respectively.

$$Y_{1i}^{*} = \beta_1 K_{1i} + \varepsilon_{1i} , \quad Y_{1i} = \begin{cases} 1, if\ Y_{1i}^{*} \geq 0 \\ 0, otherwise \end{cases} \tag{12}$$

$$Y_{2i}^{*} = \beta_2 K_{2i} + \varepsilon_{2i} , \quad Y_{2i} = \begin{cases} 1, if\ Y_{2i}^{*} \geq 0 \\ 0, otherwise \end{cases} \tag{13}$$

where Y_{1i}^{*} and Y_{2i}^{*} are, respectively, latent variables which represent the propensities of the husband and his wife to participate in off-farm work, for farm household i, which cannot be observed. What is observed in the data is the off-farm work participation status of the husband and his wife, which is indexed by Y_{1i} or Y_{2i}, respectively. In particular, a value of one is given to Y_{1i} or Y_{2i} if the husband or his wife worked off the farm, otherwise a zero value is given. As discussed in the theoretical framework, the husband or his wife decides to work off the farm if the off-farm wage rate is higher than his/her reservation wage. K_{1i} and K_{2i} refer to the factors that affect the off-farm work participation decisions of the husband and his wife, respectively. β_1 and β_2 are the corresponding parameters to be estimated. The error terms $(\varepsilon_{1i},\ \varepsilon_{1i})$ follow a standard bivariate normal distribution across individuals with zero mean and unit variance as follows:

$$\begin{pmatrix}\varepsilon_{1i}\\ \varepsilon_{2i}\end{pmatrix} \backsim N\left[\begin{matrix}0\\0\end{matrix}, \begin{pmatrix}1 & \rho_{\varepsilon_{12}}\\ \rho_{\varepsilon_{12}} & 1\end{pmatrix}\right] \quad (14)$$

where $\rho_{\varepsilon_{12}}$ is cross-equation correlation coefficient of the error terms ε_{1i} and ε_{2i}. Given the dichotomous nature of the dependent variables, this study employs a seemingly unrelated bivariate probit (SUBP) model to jointly estimate Equations (12) and (13) and to test the null hypothesis that the husband and his wife are making independent decisions when they choose to work off the farm. The Wald test is implemented under the null hypothesis that the correlation coefficient $\rho_{\varepsilon_{12}}$ between the error terms in Equations (12) and (13) is equal to zero. Statistical significance of $\rho_{\varepsilon_{12}}$ would indicate the rejection of the null hypothesis and suggest that the probability that the husband chose to work off the farm is related to the probability that his wife works off the farm through unobserved effects captured in the model's error terms (Ma et al., 2018a). For the purpose of SUBP model identification, we follow previous studies and include an instrumental variable representing the off-farm work rate of farmers per village as an additional regressor in Equation (12) (Che, 2016; Janvry and Sadoulet, 2001; Ma et al., 2018a).

The SUBP model estimates the Equation (12) and Equation (13) simultaneously, using a full information maximum likelihood (FIML) approach. In particular, the parameters β_1, β_2 and $\rho_{\varepsilon_{12}}$ can be consistently obtained by estimating the following log-likelihood function (Greene, 2018):

$$LnL = \sum_{i=1}^{N} ln\Phi_2[(2Y_{1i} - 1)\beta_1 K_{1i}, (2Y_{2i} - 1)\beta_2 K_{2i}, (2Y_{1i} - 1)(2Y_{2i} - 1)\rho_{\varepsilon_{12}}] \quad (15)$$

where $\Phi_2(\cdot)$ is the cumulative density function of the bivariate normal distribution.

3.2 Modelling the impact of off-farm work on land transfer choices

To examine how off-farm work decisions of farm couples impact on the household land transfer choices including (1) no land transfer; (2) renting-in land; and (3) renting-out land, a multinomial logit (MNL) model is utilized. Following Hong et al. (2018), we define a discrete choice variable m whose value is 0 for households with no land transfer, 1 for households with rented-in land, and 2 for households with rented-out land. Here, an issue that needs to be addressed in estimating the impact of off-farm work participation of farm couples on land transfer choices is the potential endogeneity issues associated with off-farm work participation variables. This is due to the fact that off-farm work is not randomly distributed among farm households, but farm couples decide themselves (self-selection) whether or not to participate in off-farm work (Imai et al., 2015; Kousar and Abdulai, 2016; Ma et al., 2018b). Failing to control for the endogeneity issues of off-farm work variables would result in biased estimates.

To address the endogenous issues of off-farm work variables, a two stage control function method is used (Ma et al., 2018c). In the first stage, we predict the off-farm work variable for the husbands and the variable for the wives after simultaneously estimating the Equations (12) and (13) using the SUBP model. In the second stage, the predicted off-farm work variables are used to estimate the impact of off-farm work decisions of farm couples on land transfer choices. Previous studies have shown that the predicted values from the first stage estimation enable to help control for the potential endogeneity issues (Chang and Mishra, 2012; Ma et al., 2018c; Wooldridge, 2015). After controlling for the endogeneity issues of off-farm work variables, the probability $Pr(\cdot)$ that farm household i choose a particular type of land transfer strategy ($lt_i = m$) can be modelled as follows (see McFadden, 1987):

$$Pr(lt_i = m|\, \hat{y}_{im}^1, \hat{y}_{im}^2; Z_{im}) = \frac{\exp\,(\beta_{m1}\hat{y}_{im}^1 + \beta_{m2}\hat{y}_{im}^2 + \beta_{m3}Z_{im})}{\sum_{j=0}^{2}\exp\,(\beta_{j1}\hat{y}_{ij}^1 + \beta_{j2}\hat{y}_{ij}^2 + \beta_{j3}Z_{ij})}, \qquad m = 0,1,2 \qquad (17)$$

where $\hat{y}_{im}^1$ and $\hat{y}_{im}^2$ are, respectively, the predicted value of off-farm work variable for the husbands and that for the wives; Z_{im} represents household and farm-level characteristics (e.g., age, education, household size, farm size, and soil quality) that affect household land transfer choices; β_{m1}, β_{m2} and β_{m3} are parameters to be estimated.

4. Data and descriptive statistics

4.1 Data

The data used in the present study come from a rural household survey that was conducted in April 2018 in Hubei province of China. A multistage random sampling procedure with random selection of counties, villages and households was employed to select 408 farm households. The counties surveyed include Xiantao, Xiaonan, Yingcheng, Hanchuan, Shayang, Jianli and Huangpi. Within each county between 2 and 4 villages and then around 15-20 households within each village were randomly selected. A structured questionnaire was used to collect information from the rural households by well-trained enumerators who spoke the local language. The enumerators were hired from the universities of Hubei Province. The survey covered information about household and farm-level characteristics (e.g., age, gender, education, farm size, and household size), health conditions of household members, off-farm work participation status of both husband and wife, cooperative membership status, rural transportation condition, and household land transfer choices.

In this study we are particularly interested in analyzing the joint off-farm work decisions of farm couples and their effects on household land transfer choices. In particular, the husband's off-farm work participation is defined as a dummy variable that equals to 1 if the husband participated in off-farm work in 2017, and 0 otherwise. The wife's off-farm work participation variable is defined similarly. Our survey shows that around 21.32% of households have only the husbands working off the farm, while 5.39% of them have only the wives working off the farm (Figure 1). Land transfer choice is defined as a discrete variable in the present study, which gives the value of 0 if a household did not participate in the land rental market (i.e. not transferring land), 1 if the household rented in land, and 2 if the household rented out land in 2017. The final dataset includes a record of 215 households having no land transfer, 143 households having rented-in land and 50 households having rented-out land.

4.2 Descriptive statistics

Table 1 presents variable definitions and descriptive statistics. It shows that in 2017, around 27% of husbands in our sample have engaged in the off-farm work, while more than 11% of wives have participated in off-farm work. The mean ages of the husbands and wives are both approximately 60 years, which reflect the aging trend in agricultural production. This is consistent with the observation of Horioka et al. (2018). Interestingly, the mean education of wives is 4.1 years, which is higher than that of husbands (3.6 years). The health variable refers to the self-reported health status of the husband or wife, which is measured by a 5-point ordinal scale (from 1=very unhealthy to 5=very healthy). The mean health status of husbands is 3.6 scores, which is quite familiar to wives' 3.3, suggesting that both husbands' and wives' health status are just better than the average health status reported by them in 2017. On average, more than 57% of households have children less than 15 years, and around 38% of households have a senior member over the age of 65. The average farm is scattered across nine plots and is 15 mu (1 mu=1/15 hectare) in size. On average, the soil quality of about 65% of the cultivated land was identified as being good.

Table 2 presents the mean difference of selected variables across the different land transfer choices of households. The last two columns in Table 2 report F-statistics and the corresponding P-values that examine whether group means of land transfer choices are the same. The high F-statistics and low P-values indicate that the differences in age of the husband, age of the wife, the presence of the senior member, farm size, soil quality, and land fragmentation in Table 2 are statistically significant across households with no land transfer, housheolds with rented-in land, and the households with rented-out land. There appear to be no significant differences in off-farm work particiaption of the husbands and the wives among the households with and without land transfer. Howerve, the findings presented in Table 2 are not conclusive in explaining the nexus between off-farm work particiaption decisions of farm couples and land transfer choices, because the descriptive analysis does not control for confounding factors that may also affect the off-farm work particiaption decisions and land transfer choices of farm couples.

To facilitate our understanding of the relationship between off-farm work participation and the land transfer choices of farm couples, we plotted the distribution of husbands and wives' off-farm work participation among different categories of land transfer choices and presented the results in Figure 2. The figure shows that there is a noticeable difference in terms of land transfer choices and off-farm work participation decisions between husbands and wives. Among households not participating in land rental markets, 24.7% of the husbands and 11.6% of the wives chose to work off the farm. For households participating in land rental markets, the husbands are more likely to work off the farm. The Figure 2 shows that around 30.8% and 26.0% of husbands in households with rented-in and rented-out land participate in off-farm work, respectively, while the same values for the wives are 10.5% and 10.0%.

5. Estimation results

5.1 Determinants of joint off-farm work decisions

The estimates for the factors that affect the decisions of husbands and wives to participate in off-farm work are presented in Table 3. As indicated earlier, the SUBP model is used to jointly estimate Equations (12) and (13). To facilitate interpretation, the estimates for the marginal effects of explanatory variables are also calculated and presented in columns 3 and 5 in Table 3, which are calculated by multiplying the coefficient estimates $\hat{\beta}$ by $\Phi(\hat{\beta}K_i)$ at the mean values of K_i.

It should be noted that maximizing the joint density of the observed dependent variables in the SUBP model does not guarantee a good fit (Ma et al., 2018a). Therefore, we employed Murphy's (2007) score test to check the misspecification of the SUBP model. In particular, the null hypothesis of the Murphy's score test is that the error terms in Equations (12) and (13) are bivariate standard joint normal. The results, which are presented in the lower part of Table 3, show that the P-value of Murphy's score test is not significantly different from zero at 10% level, suggesting that the null hypothesis of normality cannot be rejected. The finding confirms the validity of using the SUBP to jointly estimate the off-farm work participation Equation (11) for the husbands and Equation (12) for the wives.

The results presented in the lower part of Table 3 show that the coefficient of $\rho_{\varepsilon_{12}}$ is significantly different from zero, suggesting the null hypothesis that the husbands and wives are making independent off-farm work decisions can be rejected. To put it in another way, the probability that a husband chooses to work off the farm is related to the probability that a wife chooses to work off the farm through unobserved effects captured in the model's error terms. This evidence justifies the joint estimation of these equations in improving the statistical efficiency of the parameter estimates. The positive sign of $\rho_{\varepsilon_{12}}$ suggests that the husbands and wives are making complementary decisions when they choose to work off the farm (Ma et al., 2018a).

The second and third columns present the results for the factors that affect husbands' decision to work off the farm. In particular, the marginal effect of the variable representing the husband's health status is positive and statistically significant, suggesting that healthy husbands are 8.0% more likely to participate in off-farm work. Better health conditions make the husbands more competitive in labour market. The wife's education variable is negative and statistically significant, suggesting that an increase in the wife's education decreases the husband's likelihood of working off the farm. In particular, an additional year of the wives' education will decrease the husband's probability of working off the farm by 1.3%. This finding is in line with the finding of Abdulai and Delgado (1999) who found that additional schooling of wives tends to decrease the probability of husbands working off the farm. The marginal effect of membership variable is negative and statistically significant, suggesting the husbands in households having cooperative membership are 14.0% less likely to participate in off-farm work, a finding this is in line with the finding of Ma and Abdulai (2018). Agricultural cooperatives may directly provide information to members through collective actions, while allocating more labour to cooperative activities would result in less time being allocated to off-farm work. Finally, our results show that the marginal effect of the off-farm work rate variable is positive and statistically significant, suggesting the existence of village-level peer effects of off-farm work participation among males and confirming its validity as an instrumental variable.

With respect to the factors that affect wives' decisions to work off the farm, the age variable of husbands has a negative and statistically significant marginal effect. The finding suggests that wives living with an elder husband are 1.3% less likely to participate in off-farm work due to the necessity of caring for the husband. The variable representing husbands' education has a positive and statistically significant marginal effect, suggesting that wives are 1.1% more likely to work off the farm if they live with better-educated husbands. Using data collected from Israeli farm households, Kimhi (1994) also showed that an additional year of schooling of the men tends to increase the likelihood of women to work off the farm. Better education enables the husbands to help their wives identify and process the job vacancy information, which finally increases the probability of the wives to work in the off-farm work.

The negative and statistically significant marginal effect of the children variable suggests the presence of children under 15 years in a household decreases the probability of wives to work off the farm. These findings are consistent with the findings in previous studies (Matshe and Young, 2004; Qiao and Yao, 2015). For example, Qiao et al. (2015) found that women are still the primary care provider for children in rural China, thus having school-aged children decreases the likelihood of wives' working off-farm. Farm size appears to be an important determinant of the wives' off-farm work decision. The negative and statistically significant marginal effect of farm size variable in the last column of Table 3 suggests that increasing farm size reduces the likelihood of working off the farms among wives. The findings are consistent with Abdulai and Delgado (1999) who found that farm size has a negative effect on wives' off-farm labor supply. In rural regions, men are more likely to migrate than women for the sake of better income opportunities, while women are usually left responsible for managing the family farms. Thus, the wives are less likely to work off the farm if they are living in households with large farm size.

Finally, for the purpose of comparison, the farm couples' off-farm work decisions were also estimated by relaxing the "ad hoc" assumption of the joint error terms using a more flexible semi-nonparametric seemingly unrelated bivariate probit (SNP-SUBP) method (Luca, 2010). The results, which are presented in Table A1 in the Appendix, show that the additional parameters of the polynomial order (r) are not statistically significantly different from zero, suggesting that the probability function $F(\cdot)$ degenerates to the standard normal probability function $\Phi(\cdot)$ and thus confirm the validity of using the SUBP model. The results of the likelihood ratio (LR) test under the null hypothesis that the SUBP model is statistically equal to the SNP-SUBP is 15.61. The P-value = 0.926 suggests that we cannot reject the null hypothesis, which further confirms the validity of using the SUBP model to estimate the joint off-farm work decisions of farm couples.

5.2 Impacts of the couple's off-farm work on land transfer choices

The results for the impact of off-farm work participation of both husbands and wives on land transfer choices are presented in Table 4, which are estimated using a MNL model. As discussed previously, the predicted values for off-farm work participation of husbands and off-farm work participation of wives, which account for issues of endogeneity, are used in the estimations. Given that the coefficients estimated by the MNL model are not interpreted directly, we, therefore, calculate the marginal effects of the exoplanetary variables to provide a better understanding of the magnitudes of the coefficients (Greene, 2018).[2]

The results in Table 4 provide evidence that off-farm work decisions of farm couples are two important factors that determine household land transfer choices, but they affect household land transfer choices differently. The statistically significant marginal effects of off-farm work for the husbands and wives in the no transfer specification (second column of Table 4) suggest that husbands working off the farm are 14.4% less likely to maintain the current land area, while the wives working off the farm are 42.1% more likely to do so. With respect to renting in land, our estimates show that husbands working off the farm are 7.5% more likely to rent in land, while off-farm work participation of the wives has a negative and statistically significant impact on the probability of choosing to rent in land. Previous studies have analyzed the impact of off-farm work participation on the choice of renting in land, but the results remain mixed (Che, 2016; Deininger and Jin, 2008; Huang et al., 2012; Min et al., 2017; Yan and Huo, 2016). For example, Yan and Huo (2016) showed that off-farm work participation has a negative and statistically significant impact on the probability of renting in land in China, while Min et al. (2017) found that off-farm work participation has a positive impact on the probability of renting in land in China.

The results presented in the last column of Table 4 show that the households are more likely to rent out land if both husbands and wives work off the farm. The findings suggest that allocating more labor to off-farm work results in less labor being allocated to farm work. In order to maintain or enhance agricultural productivity, households choose to reduce the cultivated land area by renting out land, a finding that is in line with the lost-labor effects of off-farm work and consistent with the findings in previous studies (Che, 2016; Huang et al., 2012; Yan and Huo, 2016). The findings suggest there exists the presence of gender differences in choosing land transfer strategies and confirm the necessity of analyzing the effects of joint

[2] The results of the coefficients estimated by MNL are presented in Table A2 in Appendix.

off-farm work decisions of both husbands and wives on land transfer choices.

Other variables also show significant impacts on household land transfer choices. The positive and statistically significant marginal effect of age for husbands suggests that elder husbands are 2.6% more likely to rent out land. The elder husbands are usually in unfavorable physical conditions and thus have less incentives to engage in agricultural production. Education of husbands appears to be an important determinant of land rental market participation. The positive and significant marginal effect of the education variable for husbands in the rented-in specification and the negative and significant marginal effect of the variable in the rented-out specification suggest that husbands with better education are 4.8% more likely to rent in land but 2.8% less likely to rent out land. Better education enables husbands to identify and process information used for agricultural production and marketing, which finally motivates the husbands to enlarge the cultivated area through use of the rental market.

The age of wives has a positive and statistically significant impact on the probability of renting in land. Age can be seen as a proxy of farmers' experience and managerial ability. It is possible that experienced wives have an advantage in managing agricultural production and thus choose to rent in more land for the sake of scale-of-operation. The presence of children under 15 years has a positive and statistically significant impact on the probability of choosing to maintain the land area but affects the likelihood of renting in land negatively. Households with children usually have to trade-off the time used for child care and agricultural production. More time used for taking care of the children would result in less time used for agricultural production, and in this case, households are less likely to rent in land but choose to maintain the current cultivated land area.

The positive and statistically significant marginal effect of the transportation variable in the rented-in specification suggests that the probability of renting in land by households increases if the transportation from the village to the train/bus station is convenient. Convenient transportation enables farm households to transport the productivity-enhancing inputs (e.g., fertilizers and pesticides) or agricultural products from or to the markets, which reduces the transaction costs of agricultural production and marketing. The marginal effect of the membership variable is positive and statistically significant in the rented-in specification. Agricultural cooperatives are widely regarded as an important institutional innovation that can help overcome the constraints that impede smallholder farmers' access to inputs and output markets, as well as enhance farm economic performance (Ma et al., 2018a; Ma and Abdulai, 2018). As a result, households with cooperative membership are more likely to enlarge the farm size by renting in more land in order to benefit from agricultural production with the help of cooperatives.

Soil quality also appears to be an important factor determining land rental market participation of rural households. Our results show that households cultivating fertile land are 8.1% more likely to rent out land but 11.4% less likely to rent in land. The plausible reason is that fertile land is more preferred in land rental markets, and the land with fertile soil can usually be rented out at a reasonably high price. The marginal effects of land fragmentation variable in the no transfer and rented-in specifications (second and third columns of Table 4) are -0.026 and 0.028, respectively, which are statistically significant at the 1% level. The findings suggest that fragmentation increases the probability of renting in land. Tan et al. (2008) showed that farmers with more and smaller plots tend to use more labor and fewer modern technologies as compared to farmers with fewer and larger plots. Thus, it is likely that households choose to rent in land with larger plots in order to adopt modern technologies (e.g., farm machines) and save farm labor.

Finally, we predicted the probabilities of land transfer choices by grouping off-farm work decisions of farm couples, including (1) both the husbands and the wives working off the farm;

(2) only the husbands working off the farm; (3) only the wives working off the farm; and (4) neither the husbands nor the wives working off the farm. The results, which are presented in Table 5, show that households with only the wives working off the farm have the highest probability (0.58) of not participating in the land rental market. In comparison, the households with only the husbands working off the farm have the highest probability (0.39) of renting in land, while households with both the husbands and wives working off the farm have the highest probability (0.16) of renting out land.

6. Conclusions

Off-farm work has important implications for diversifying rural incomes and enhancing sustainable rural development in many developing and emerging countries. Although previous studies have widely investigated the determinants and wide impacts of the off-farm work participation decision of household heads, there has so far been no attempt to examine the nexus between farm couples' off-farm work participation and land transfer choices. To bridge this gap, we used farm-level data collected from Hubei province of China and analyzed the factors that affect farm couples' decisions to work off-farm, using a seemingly unrelated bivariate probit model. We also estimated the impacts of the joint off-farm work decisions of the farm couples on household land transfer choices, using a multinomial logit model.

The empirical results showed that rural husbands and wives are jointly making decisions to work off the farm. In particular, we found that health status of the husband, education of the wife and cooperative membership are main factors that determine a husband's decision to work off the farm, while the wife's off-farm work participation decision is mainly affected by the husband's age and education, the presence of children and farm size.

Given the existence of interdependence the decision to work off-farm of the husband and the wife, we estimated the impact of the joint decisions of off-farm work participation of the farm couples on household land transfer choices. The results showed that off-farm work participation of farm couples affects land transfer choices differently. In particular, the husbands working off the farm were more likely to participate in land rental markets by either renting in or renting out land relative to their counterparts who did not work off the farm. The wives working off the farm were more likely to rent out land but less likely to rent in land compared with their counterparts who did not work off the farm. In addition, we found that the households' decision to rent in land is positively affected by the education of the husband, the presence of a senior member in the household, transportation, and cooperative membership, while their decision to rent out land is positively influenced by the age of the husband, farm size and soil quality.

Our findings have important policy implications for enhancing off-farm work participation of rural households and fostering land rental markets. The significant impacts of farm couples' off-farm work participation on land transfer choices highlight the importance of public policies in reducing the constraints that restrict off-farm work participation of rural households and increasing off-farm work opportunities, with the aim of stimulating the development of rural land rental markets. The results that transportation and cooperative membership have a positive and statistically significant impact on land renting-in decision suggest that improving the rural infrastructure such as road and encouraging farmers to join agricultural cooperatives may facilitate rural households to enlarge cultivation area by renting in land and benefit from the increasing economies of scale.

A limitation of this study is that we only focus on rural households in Hubei province of China, without taking into account farm couples' off-farm work decisions and land transfer choices of farm households in other regions. Given the importance of off-farm work participation in improving rural household welfare and enhancing sustainable rural development, further research on other regions may improve our understanding of the nexus between off-farm work decisions of farm couples and land transfer choices in a broader context.

Given we only focus on land transfer choices of rural households, it could be a promising area for future work to investigate how farm couples' off-farm work decisions affect land transfer intensity (i.e. the amount of land transferred) in rural regions.

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Figures and tables

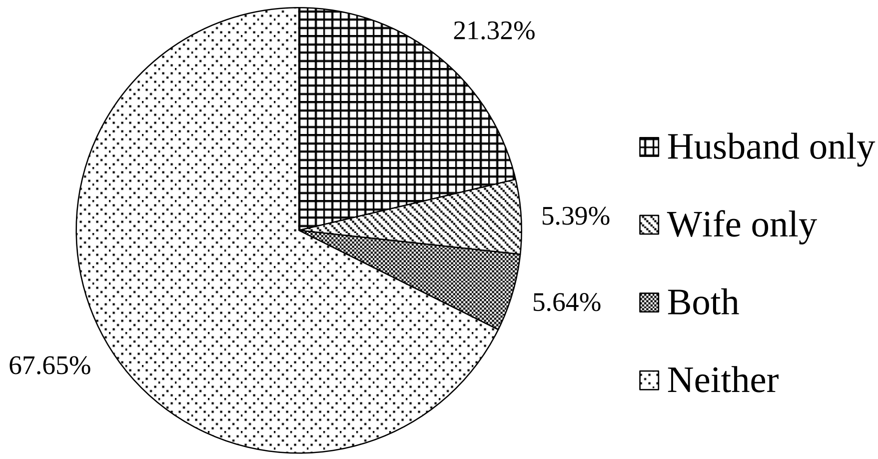

Figure 1 Distribution of farm households couples' off-farm work participation decisions

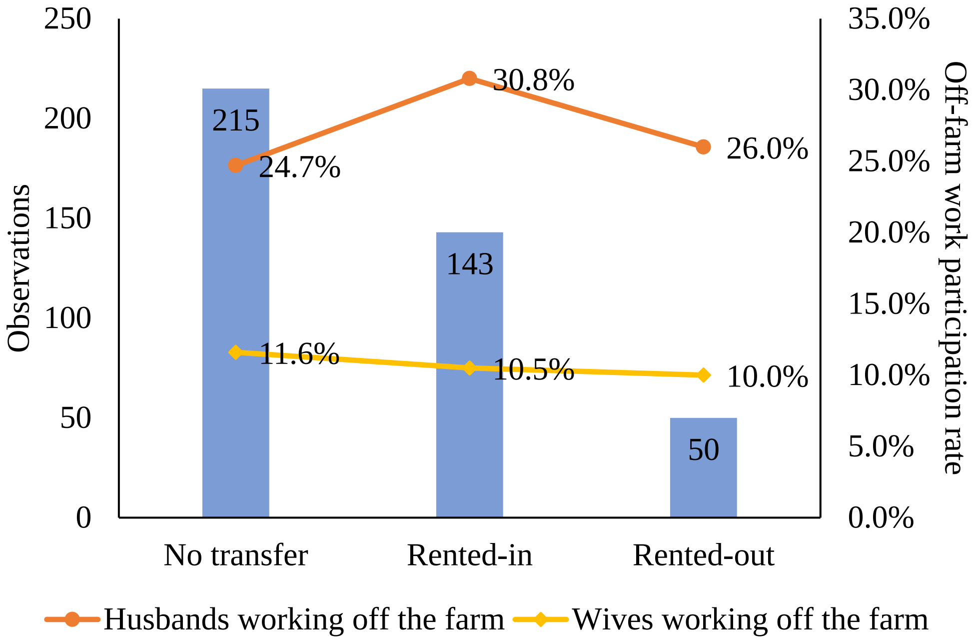

Figure 2 Relationship between off-farm work decisions of farm couples and land transfer choices

Table 1 The descriptive statistics of the variables

Variables	Definition	Mean	Std. Dev.[b]
Land transfer choices	0 if has no land transfer; 1 if household rented in the land; 2 if household rented out the land.	0.60	0.70
Off-farm work (Husband)	1 if husband participated in off-farm in 2017, 0 otherwise	0.27	0.44
Off-farm work (Wife)	1 if wife participated in off-farm in 2017, 0 otherwise	0.11	0.31
Age (Husband)	Age of husband (years)	60.68	8.99
Education (Husbands)	Years of schooling of husband (years)	3.62	2.47
Health (Husband)	Self-reported health status of the husband (from 1=very unhealthy to 5=very healthy)	3.47	1.01
Age (Wife)	Age of wife in years	59.02	9.08
Education (Wife)	Years of schooling of wife (years)	4.06	3.49
Health (Wife)	Self-reported health status of the wife (from 1=very unhealthy to 5=very healthy)	3.29	0.99
Household size	Number of members residency in a household	5.42	2.39
Children	1 if household has children under age 15, 0 otherwise	0.57	0.50
Senior member	1 if household has member above age 65, 0 otherwise	0.38	0.49
Transportation	1 if transportation from the village to the train/ bus station is convenient, 0 otherwise	0.78	0.42
Membership	1 if household has cooperative membership, 0 otherwise	0.10	0.29
Farm size	Total farm size (mu)[a]	14.93	12.70
Soil quality	1 if soil is fertile, 0 otherwise	0.65	0.48
Fragmentation	The number of land plots	8.72	7.99

Note: [a] 1 mu = 0.067 hectare;

[b] Std. Dev. =standard deviation.

Table 2 The descriptive statistics of the variables by land transfer choices

Variables	No transfer	Rented-in	Rented-out	*F*-value	Prob>*F*
Off-farm work (Husband)	0.25	0.31	0.26	0.83	0.44
Off-farm work (Wife)	0.12	0.11	0.10	0.09	0.92
Age (Husband)	61.32	58.88	63.10	5.33	0.01
Education (Husband)	3.63	3.71	3.28	0.56	0.57
Health (Husband)	3.47	3.52	3.34	0.58	0.56
Age (Wife)	59.28	57.66	61.76	4.04	0.02
Education (Wife)	4.14	3.91	4.16	0.21	0.81
Health (Wife)	3.27	3.32	3.30	0.12	0.89
Household size	5.53	5.36	5.14	0.59	0.55
Children	0.60	0.56	0.48	1.25	0.29
Senior member	0.42	0.29	0.44	3.93	0.02
Transportation	0.77	0.77	0.84	0.61	0.55
Membership	0.09	0.10	0.12	0.24	0.79
Farm size	10.75	20.99	15.63	32.30	0.00
Soil quality	0.68	0.52	0.82	8.89	0.00
Fragmentation	6.49	12.43	7.70	27.27	0.00

Table 3 Modeling the joint decision of farm couples in off-farm work participation: SUBP model estimation

Variables	Husbands		Wives	
	Coefficients	Marginal effects	Coefficients	Marginal effects
Age (Husbands)	-0.032 (0.033)	-0.008 (0.009)	-0.091 (0.046)**	-0.013 (0.006)**
Education (Husbands)	0.041 (0.038)	0.011 (0.010)	0.075 (0.047)*	0.011 (0.007)*
Health (Husbands)	0.307 (0.091)***	0.080 (0.022)***	0.006 (0.097)	0.001 (0.014)
Age (Wives)	-0.009 (0.032)	-0.002 (0.008)	0.027 (0.045)	0.004 (0.007)
Education (Wives)	-0.051 (0.026)**	-0.013 (0.007)**	0.033 (0.034)	0.005 (0.005)
Health (Wives)	0.012 (0.083)	0.003 (0.022)	-0.072 (0.112)	-0.011 (0.016)
Household size	0.034 (0.031)	0.009 (0.008)	-0.012 (0.049)	-0.002 (0.007)
Children	-0.030 (0.157)	-0.008 (0.041)	-0.647 (0.222)***	-0.096 (0.033)***
Senior member	0.011 (0.216)	0.003 (0.056)	0.328 (0.269)	0.049 (0.040)
Transportation	0.041 (0.177)	0.011 (0.046)	0.151 (0.316)	0.022 (0.046)
Membership	-0.535 (0.197)***	-0.140 (0.051)***	0.218 (0.243)	0.032 (0.036)
Farm size	0.000 (0.007)	0.000 (0.002)	-0.028 (0.010)***	-0.004 (0.001)***
Soil quality	0.092 (0.163)	0.024 (0.043)	-0.098 (0.299)	-0.014 (0.044)
Fragmentation	-0.003 (0.010)	-0.001 (0.003)	0.019 (0.018)	0.003 (0.003)
Husbands' off-farm work rate (per village)	3.115 (0.510)***	0.812 (0.117)***		
Constant	-0.206 (0.672)		3.105 (1.167)***	
Regional effects	YES			
Cluster effects	YES			
Log pseudolikelihood ratio	-294.379			
$\rho_{\varepsilon_{12}}$	0.447 (0.139) ***			
Wald test	Chi2 (1) =12.020 $P = 0.001$			
Murphy's score test	Chi2 (9) =9.59 $P = 0.3847$			
Observations	408			

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4 Margin impacts of off-farm work on household land use strategies

Variables	No transfer	Rented-in	Rented-out
	Margin effects	Margin effects	Margin effects
Off-farm work (Husband)	-0.144 (0.041)***	0.075 (0.044)*	0.069 (0.038)*
Off-farm work (Wife)	0.421 (0.183)**	-0.703 (0.102)***	0.281 (0.169)*
Age (Husband)	0.051 (0.019)***	-0.077 (0.011)***	0.026 (0.015)*
Education (Husband)	-0.020 (0.018)	0.048 (0.010)***	-0.028 (0.016)*
Health (Husband)	0.098 (0.029)***	-0.065 (0.023)***	-0.034 (0.022)
Age (Wife)	-0.032 (0.011)***	0.031 (0.008)***	0.001 (0.008)
Education (Wife)	-0.013 (0.013)	0.013 (0.009)	0.000 (0.010)
Health (Wife)	0.014 (0.034)	-0.054 (0.030)*	0.040 (0.030)
Household size	0.012 (0.011)	-0.006 (0.010)	-0.006 (0.005)
Children	0.335 (0.130)**	-0.499 (0.087)***	0.163 (0.112)
Senior member	-0.050 (0.086)	0.152 (0.055)***	-0.102 (0.080)
Transportation	-0.071 (0.050)	0.094 (0.047)**	-0.023 (0.050)
Membership	-0.194 (0.087)**	0.219 (0.071)***	-0.025 (0.065)
Farm size	-0.006 (0.008)	-0.006 (0.005)	0.011 (0.005)**
Soil quality	0.033 (0.055)	-0.114 (0.040)***	0.081 (0.043)*
Fragmentation	-0.026 (0.008)***	0.028 (0.005)***	-0.003 (0.005)
McFadden R^2		0.263	
Log-likelihood ration		-289.295	
Observations		408	

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5 The average probability of land transfer choices by farm couples' off-farm work status

Land transfer choices	No transfer	Rented-in	Rented-out
Husband only	0.53 (0.26)	0.39 (0.28)	0.09 (0.09)
Wife only	0.58 (0.27)	0.30 (0.28)	0.13 (0.11)
Both	0.49 (0.24)	0.35 (0.27)	0.16 (0.14)
Neither	0.53 (0.26)	0.34 (0.28)	0.13 (0.14)

Standard deviations in parentheses.

Appendix

Table A1 Modeling the joint decision of farm couples in off-farm work participation: SNP-SUBP model estimation

Variables	Husbands		Wives	
	Coefficients	z-value	Coefficients	z-value
Age (Husband)	-0.038 (0.041)	-0.920	-0.064 (0.040)	-1.617
Education (Husband)	0.086 (0.042)**	2.060	0.079 (0.035)**	2.249
Health (Husband)	0.565 (0.147)***	3.835	0.027 (0.104)	0.258
Age (Wife)	-0.028 (0.041)	-0.677	0.023 (0.039)	0.594
Education (Wife)	-0.099 (0.033)***	-3.054	0.041 (0.028)	1.466
Health (Wife)	0.022 (0.159)	0.138	-0.039 (0.107)	-0.364
Household size	0.093 (0.062)	1.494	-0.001 (0.056)	-0.014
Children	-0.741 (0.280)***	-2.644	-0.596 (0.236)**	-2.522
Senior member	-0.105 (0.254)	-0.412	0.259 (0.198)	1.314
Transportation	0.209 (0.250)	0.833	0.166 (0.206)	0.808
Membership	-0.770 (0.408)*	-1.888	0.167 (0.308)	0.544
Farm size	0.003 (0.010)	0.333	-0.024 (0.011)**	-2.306
Soil quality	0.230 (0.231)	0.994	-0.029 (0.203)	-0.143
Fragmentation	-0.007 (0.015)	-0.466	0.018 (0.016)	1.128
Husbands off-farm work rate (per village)	5.806 (0.984)***	5.902		
Regional effects	YES			
r^{11}	137,715.651 (5,421,722.578)			
r^{12}	597,83.645 (2,353,845.298)			
r^{13}	-8,572.285 (338,114.153)			
r^{21}	33,692.095 (1,326,531.548)			
r^{22}	14,701.358 (579,410.075)			
r^{23}	-1,247.987 (49,643.684)			
r^{31}	-46,712.425 (1,838,975.789)			
r^{32}	-12,744.815 (501,999.796)			
r^{33}	6,044.767 (238,010.598)			
Log pseudolikelihood	-286.311			
$\rho_{\varepsilon_{12}}$	0.217			
Observations	408			

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A2 The impacts of off-farm work on household land transfer choices

Variables	Rented-in		Rented-out	
	Coefficients	z-value	Coefficients	z-value
Off-farm work (Husband)	0.685 (0.278)**	2.463	0.968 (0.410)**	2.363
Off-farm work (Wife)	-4.377 (0.686)***	-6.385	1.713 (1.939)	0.884
Age (Husband)	-0.491 (0.080)***	-6.161	0.127 (0.180)	0.709
Education (Husband)	0.279 (0.077)***	3.600	-0.218 (0.180)	-1.211
Health (Husband)	-0.534 (0.164)***	-3.253	-0.535 (0.253)**	-2.115
Age (Wife)	0.222 (0.055)***	4.031	0.081 (0.096)	0.846
Education (Wife)	0.093 (0.065)	1.428	0.034 (0.120)	0.282
Health (Wife)	-0.293 (0.196)	-1.494	0.345 (0.318)	1.082
Household size	-0.054 (0.074)	-0.729	-0.086 (0.066)	-1.308
Children	-3.186 (0.580)***	-5.497	0.791 (1.289)	0.613
Senior member	0.855 (0.388)**	2.202	-0.849 (0.930)	-0.913
Transportation	0.617 (0.292)**	2.117	-0.059 (0.540)	-0.110
Membership	1.503 (0.480)***	3.130	0.197 (0.755)	0.261
Farm size	-0.017 (0.040)	-0.417	0.120 (0.064)*	1.867
Soil quality	-0.634 (0.281)**	-2.259	0.691 (0.533)	1.297
Fragmentation	0.196 (0.042)***	4.646	0.029 (0.060)	0.491
Constant	12.273 (2.191)***	5.601	-12.345 (5.660)**	-2.181
Regional effects	YES			
Cluster effects	YES			
McFadden R^2	0.263			
Log-likelihood ration	-289.295			
Observations	408			

The reference group is no rent; Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.