The Influence of Land Titling Policy on the Rural Labor Migration to City: Evidence from China

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Abstract

Land Titling, which aims to increase market transaction of farmland by providing landowners' land property rights in China, may affect the peasant households' labor allocation in on-farm or off-farm activities. We identify homogenous farm households by using the PAM clustering analysis technique and estimate the influences of Land Titling on households' labor allocation decision. To address the endogeneity issue caused by Land Titling, we use a fractional SUR IV model. We use interview data collected in 2015 from nationwide peasant households in China. Results from a cluster level fractional SUR IV analysis show that Land Titling has a significant negative effect on households' off-farm labor allocation if households place greater emphasis to their high-quality farmland. On the contrast, Land Titling has a significant positive effect on households' off-farm ratio and even induce the decrease of part-time ratio if those households have bad quality farmland, do not care about their farmland, and feel comfortable migrating temporarily to the city. We also find that Land Titling has no effect on farmers' labor allocation if farmers have been living in a well-developed land transfer market prior to the implementation of Land Titling.

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1. Introduction

Labor allocations in on-farm or off-farm activities by peasant households depend on several factors such as total farm labor availability, land-holding size, agricultural property rights policy, peasant households' education, and agricultural technology available (Ahearn, et al., 2006, Carson, et al., 2010, Ito and Kurosaki, 2009, Jolliffe, 2004). Stable property rights obtained from the Land Titling process can increase land transfer so that land gets cultivated by farmers who have a comparative advantage in farming. Those farmers who have the land title (hence property right on land) may allocate more household laborers in off-farm activities and rent out the land. On the other hand, strong property rights obtained from Land Titling process helps farmers to feel secure about investing in farmland thereby helping to increase land productivity and profitability. This positive outcome from Land Titling may deter farmers from searching an off-farm job. Therefore, we argue that Land Titling can affect peasant households' labor allocation decision. Moreover, Land Titling may affect differently depending on peasant households' characteristics. Land Titling may increase the proportion of labor allocated to off-farm job or increase the proportion of labor allocated to the on-farm production process. Our objective is to refine identify the cause-effect of Land Titling on the peasant household's labor allocation decision.

This research contributes in three ways to the burgeoning literature in the rural labor migration effect of Land Titling. Previous studies in other country have shown mixed effects of Land Titling on off-farm labor allocation (De Brauw and Mueller, 2012, De Janvry, et al., 2015, Do and Iyer, 2008, Valsecchi, 2014). However, these studies have not considered effects of restrictive migration environment and increasing off-farm

opportunity and causal effect if Land Titling on household labor allocation with the homogenous cluster of population. Even in Chinese studies (Giles and Mu, 2017, Uchida, et al., 2009, Xiaoping, et al., 2007, Yan, et al., 2014, Zhang, et al., 2004), they ignored the heterogeneity effect of policy on different farmers when evaluates labor response of rural households. Thus, the first contribution is that we classify peasant households' migration as part-time work and off-farm work depending on whether they spend considerable off-farm time or not (De Brauw and Harigaya, 2007). The second contribution is that we use clustering methods to identify homogenous groups of peasant households according to their original characteristics before the regression estimation. In this way, we can capture the heterogeneous impacts of Land Titling on peasant households' migration in different situations. The last contribution is that we use an instrumental variable for Land Titling, which helps to avoid endogeneity issue so that we can estimate the coefficient of Land Titling more accurately.

The remainder of this paper is organized as follows. Section 2 provides a literature review and background to the research topic. Section 3 shows the theoretical development and draws out hypotheses about the relationships between the implementation of Land Titling and peasant households' migration. Section 4 introduces data and variables used. Section 5 provides details on clustering method and fractional SUR IV model. Results are presented in section 6. We conclude the paper in section 7.

2. Literature Review and Background

2.1 Literature review

Previous studies (Besley, 1995, Chernina, et al., 2014, De Janvry, et al., 2015) have provided many explanations for the influence of Land Titling on

peasant households' labor migration decisions. However, they are not unanimous on the effect of Land Titling on migration.

The seminal paper by Besley (Besley, 1995) and the recent survey by Besley and Ghatak (Besley and Ghatak, 2010) provide a framework that show property rights unambiguously increase investments by reducing the fear of expropriation (by the state and by other households) and by increasing the gains from trade. Based on these authors, we can deduce that the Land Titling, which strengthens peasant households' ownership of farmland, will enable farmers to return to farming.

Differently, other studies focus on labor migration decision-influencing factors and argue that tenure security can increase off-farm migration. Migration in China has traditionally been limited by the hukou system of household registration, under which individuals who wish to change their place of residence must gain approval from the government authorities (Chan and Buckingham, 2008, Liu, 2005). This system is currently being relaxed in an attempt to reduce inequalities between rural and urban areas. Land Titling that is implemented under this background may increase rural-urban migration. Besides, the most striking characteristic of China's migration outflows from rural areas is a high geographical and temporal mobility since village land ownership remains collective own and land use rights can be periodically reallocated. Idling of farmland resulting from a longer period of adult out-migration may result in premature land reallocation there by depriving households' of their land rights. Land Titling may ease these concerns and encourage the off-farm migration. De La Rupelle et al. (2009) finds that as secured land holding goes up, out-migration also increase. In fact, a percentage increase in the secured land to total land ratio increases off-farm working time by 0.19%. Another broader view is that, stable property rights obtained from the Land Titling process can increase land transfer and ultimately affect the rural migration. There are some empirical evidence that supports this view. Chernina et al.

(2014) proved that titling reform increased land liquidity and actually promoted migration by easing financial constraints and decreasing opportunity costs. Mullan et al. (2011) find that, in where land remains at risk of expropriation, rural households may not allocate labor to migration to the extent that they otherwise would do. There can be a positive relationship between tenure security and migration only in where agricultural land can be rented. Valsecchi (2014) finds that the land certification program increased the eligible households' likelihood of having one or more members abroad by 12%. Using the rollout of the Mexican land certification program from 1993 to 2006, De Janvry, et al. (2015) finds that households obtaining certificates were subsequently 28% more likely to have a migrant member.

In general, Land Titling has different effects on peasant household's labor allocation decision depending on households' characteristic. However, previous studies have not estimated the causal effect of Land Titling on migration by capturing the heterogeneity effect of Land Titling on different population groups.

2.2 Background

Land Titling was announced to be implemented on trial basis to a few selected areas by the Chinese Central Government in the Third Plenary Session of the Seventeenth Party Congress held in October 2008. The government clearly stated to invigorate the rural land registration and titled certification work in eight villages as trial areas. In January 2013, the Central NO.1 document, one of the most important government documents in China, proposed to carry out the nationwide implementation of land title work and clearly put forward the instruction that "the country must achieve the basic completion of rural Land Titling work within 5 years, i.e. by2018"[1].

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[1] Document NO.1 of the Central Government in 2013

In the Land Titling process, the first step is to ascertain each farmer's rights and obligations are clearly defined to each peasant household in a technical level, such as having a uniform measurement of the location and the size of each farmland plot, and a uniform land ownership certificate. The Chinese Government considers "Property Right Certificate" as the physical carrier of farmland rights to strengthen the farmland property for farmers.

Before Land Titling, the most icon system of rural land in China is to ensure the fairness. Since 1978, the Household Responsibility System, in which the institutional arrangement is based on the principle of equal entitlement (James, 1995), has been initiated in China. From then on, China's agricultural lands are collectively owned. The collective, which contains multiple households, can also be called community. As the consensus of "fairness", each legitimate member of the community is entitled to free to charge to contract an equal share of farmland from the community and shares the income generated from other common properties. Moreover, there is a periodic reassignment of land in response to changing family demographics and changing land quality (Kung, 2002). After the implementation of Land Titling, the collective farmland ownership has been weakened. In this context, the farmland will not be redistributed again because collectives need to follow the policy of protecting the stable property rights of farmland. This farmland system reform entails the weakening of collective ownership and the enhancement of landowners' ownership on the farmland.

3. Theoretical Developments and Hypothesis

3.1 Influence of farmland policy on migration via land transfer process
There are two ways that land-related policies may affect the peasant households' labor allocation decision. First, after the implementation of the policies, peasant households are no longer required to protect their

farmland by guarding the land with permanent on-farm labor allocation. When land ownership remains collective own and land use rights can be periodically reallocated, individual out-migration can result in the deprivation of their land rights by neighboring farmers or village level (Jacoby et al., 2002, Rozelle et al., 2002). Under this situation, peasant household must guard the land to avoid land loss due to encroachment from neighboring farmers. It can result in the decrease of out-migration of rural residents (Giles and Mu, 2017). After the implementation of land-related policy, peasant households may choose to transfer farmland to obtain full benefit. Therefore, peasant households can release the labor that is used to permanently work on farmland.

Second, after the implementation of the policies, peasant households may choose to involve in farmland transfer market to re-match resources and take advantage of their own endowments. The lack of property rights is seen as one of the major reasons for the underdevelopment of the land market in world history. A plethora of studies shows that the policy that can increase farmland property safety for farmers can promote the development of the agricultural land market (Galiani and Schargrodsky, 2010, Kimura, et al., 2011). Under the constraints of the land market, farmers with comparative agricultural advantages cannot expand farmland area. Farmers with non-agricultural comparative advantages are need to assign some amount of labor in the agriculture area as unable to transfer-out farmland. Therefore, after the implementation of the policies, peasant households may reallocate the farmland and labor via transfer farmland market.

Therefore, the key to whether Land Titling can affect peasant households' labor allocation decision is whether the promulgation of Land Titling can have an impact on the farmland market where peasant households are located (Ma, et al., 2016). The more direct manifestation is whether the transfer of farmland is being restricted before Land Titling is

promulgated. If property rights are unstable before the enactment of Land Titling, and this instability manifests itself as a constraint on the development of farmland market, the promulgation of Land Titling may help the formation of farmland transfer markets by stabilizing property rights. At this point, Land Titling will have an impact on the household's labor allocation decisions. On the contrary, if the property rights system before the promulgation of the land policy is functional, and the farmland transfer market has developed to a certain extent, the implementation of Land Titling may not have an effect on households' labor allocation decisions.

3.2 Land Titling's influence on migration depending on households' type

Our next question id If Land Titling has an effect on households' labor allocation decisions, what are the direction and magnitude of this influence?

Land Titling affects farmland transfer which eventually determines labor allocation decision. Those peasant households who are motivated to transfer-in farmland after Land Titling have to allocate a larger fraction of household labor in agriculture. On the contrary, those households who prefer transfer-out farmland after Land Titling may allocate more labor to off-farm activities. We argue that factor determining peasant households' farmland transfer decision are related to farmland and other resources endowment.

The first issue is related to find a job in the urban area. Peasant households who are willing to transfer-out farmland are those who have a higher opportunity cost off-farm and hence decide to allocate more labor off-farm. However, the opportunity for low skill laborers may be limited in urban areas. Even if they find jobs, there is no permanency on employment. For these laborers, the unban employers exert similar kind of behavior like

a monopolistic firm. It means that the rural labors who migrant out for an off-farm job may or may not have stable employment or an opportunity to settle in the city. Therefore, the harder it is for peasant household to find a stable job in the urban area and settle down, the less likely they are to transfer-out farmland or out-migrate.

The second issue is related to the desire of controlling farmland. China's unique agricultural history created an inseparable emotional relationship between landowners and farmland. Landowners express feeling such as "love", "relish" and "occupy" the land and form the concept that farmers must have land. Landowners have a strong psychological ownership of farmland and the sense of control of land, which makes the landowners have an emotional attachment to farmland (Pierce, et al., 2003). The stronger the households' emotional-dependency is on their farmland, the more reluctant they become to transfer-out farmland, and ultimately the fewer household laborers choose to out-migrate.

The third issue is related to households' farmland quality. In agriculture, farmland is the most important place and the most basic resources of agricultural production. Peasant households with high-quality farmland may rely on farmland to survive and regard farmland as a scarce resource because the control of farmland is the most basic means of guaranteeing family income and carrying family labor force. In addition, the productivity of farmland and the earnings of the farmer can increase dramatically if the farmer invests more on infrastructure on higher quality and contiguous farmland under the stable farmland property right (Deininger and Feder, 2009, Deininger and Jin, 2006). Therefore, the more obvious advantages of farmland owned by peasant households, the more likely they transfer-in farmland to expand land holding, and the less likely that household laborers choose to out-migrate.

In general, those peasant households who have a comparative advantage in agriculture, on the face of stable property rights and

functioning farmland market, tend to transfer-in farmland and increase on-farm labor allocation. Peasant households with comparative advantages in farming, on the face of more stable property rights and functioning farmland market, tend to transfer-out farmland and increase off-farm labor allocation.

4. Data and variable selection

4.1 Data

We use data collected using the same set of questionnaires at three different waves. Data contain information about household characteristics, the labor market, the financial market, and land transfer. First, our research group conducted a nationally representative interview survey of 2880 peasant households from 54 counties in Guangdong, Guizhou, Henan, Jiangsu, Jiangxi, Liaoning, Ningxia, Shanxi, and Sichuan provinces[2] (Figure 1) during the Chinese Spring Festival (January) in 2015. Then, we conducted two additional surveys. In September 2015, we conducted an interview survey of 2500 peasant households in Jiangxi. In February 2016, we conducted an interview survey of 1800 peasant households in Guangdong. In total, 7180 peasant households were interviewed, and 6877 questionnaires were collected. The effective rate of questionnaires was 95.78%. Removing the missing data, the final usable number of observations is 4,752.

[Figure 1 should be here]

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2 To ensure a nationwide representative sample, we selected six indicators - including total population, per capita GDP, total cultivated area, the proportion of cultivated land area to total land agricultural population accounting for the proportion of the total population, and the proportion of agricultural output to provincial GDP. Moreover, we took into account the seven major geographical partitions (East China, South China, North China, Central China, Southwest China, Northwest China, and Northeast China) in mainland China. According to the above principles, the final selected provinces were Guangdong, Guizhou, Henan, Jiangsu, Jiangxi, Liaoning, Ningxia, Shanxi, and Sichuan.

4.2 Variable selection

4.2.1 Dependent variable

As the definition of migration matters to understand the variables affecting migration, our dependent variables are set as the fractions of labor allocated by farm households in off farm activities (leave farm completely to work in urban area or leave farm intermittently). We refer intermittent work off farm as part-time whereas if adults leave farm completely to work in urban area as off-farm. Part time farmers leave farm for a job in the urban area but comes back for farming in agricultural busy season. Off-farm worker is the individual who goes out for a job in urban area all the year. The data shows that the average ratio of households' part-time labor is 25.49%, and the average ratio of households' off-farm labor is 34.35%.

4.2.2 Independent variable

Land Titling is the key explanatory variable. We coded this variable as a binary variable with 1 indicating that a farmer already has land title, or 0 otherwise. Our data show that in total 61.81% of households have land title, whereas the remaining 38.19% of households do not have land title.

4.2.3 Clustering variables

As we want to control the heterogeneous effects of land title on peasant households' labor allocation decision among different groups of farmers, we use following variables to cluster the data:

(1) The variable related to farmland transfer: Peasant households' farmland transfer experience represents the farmland transfer market prevalent in their region. It is the most important variable that determines whether Land Titling affects the farmland allocation decision. We ask households if they are renting or leasing farmland. The fact that the households are already involved in the farmland transfer market means the

farmland transfer market is functional.

(2) The variables related to finding an off-farm job in the urban area. Peasant households' probability of finding an off-farm job influences how land titling impacts off-farm labor allocation decision. We use households' satisfaction level for the following three employment related policy variables: employment support policy; entrepreneurship support policy; and city integration policy. We also capture households' anxiety related to migrating to city by using the following four variables: worry about the housing issue in the city, worry about the employment in the city, worry about the medical and pension security in the city, and worry about children's education in the city.

(3) The variables related to the desire of controlling farmland. Peasant households' desire to own and operate farmland will decrease the possibility of allocating households' labor to the off-farm area. We ask peasant households three different questions to measure their desire to own and operate farmland. First is the crop control, which means that they still care about what crops will be planted on their farmland after they transfer-out farmland. Second is the operation control, which means that they are concerned about farmland physical structure change. The third is the use control, which means farmers are concerned about crop pattern change or the alteration of existing farming system.

(4) The variables related to farmland quality. The quality of farmland represents the productive ability of farmland. Peasant households tend to allocate more labor on farm if they have good quality farmland. We choose "land fertility condition", "land machine use condition", "country traffic condition", "land irrigation condition", "farmland area", and "farmland plots quantity" as indicators of farmland quality.

Variable definitions are provided in Table 2.

[Table 2 should be here]

5. Empirical methodology and identification strategy

5.1 Cluster analysis

Cluster analysis or clustering is the process of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense) to each other than to those in other groups (clusters). Clustering group helps to control for heterogeneity prevalent in the data. After grouping the whole observations by using cluster analysis, we can estimate the different effects of Land Titling on households' rural labor migration in different clusters.

Cluster analysis can be achieved by various algorithms that differ significantly in their notion of what constitutes a cluster and how to efficiently find them. Commonly used clustering methods are hierarchical agglomerative, partition-based, density-based, and model-based. In addition, each kind of the method uses different algorithm. For example, the algorithms of BIRCH belong to the hierarchical agglomerative method; k-means and partitioning about medoids (PAM) algorithm belong to the partition-based method; and Gaussian Mixture algorithm belongs to the model-based method. Different algorithms have their own advantages and disadvantages and use different data scale, features types and demand different calculation accuracy. However, most algorithms are limited to the use of continuous and numerical variables which are not suitable for continuous and categorical variables prevalent in our dataset. PAM algorithm can handle continuous and categorical variables. It can use any distance calculation methods whereas other algorithms generally use Manhattan distance and Euclidean distance. In addition, Partition-based methods can be applied to medium volume datasets.

The steps of PAM algorithm are as follows:

(1) Choose k objects at random (Each object is set to be a medoid point).

(2) Calculate the distance/dissimilarity between observations to each

medoid points.

(3) Assign each observation to the cluster associated with the closest medoid points.

(4) Calculate the sum of the distance of each observation to their medoid points.

(5) Change the medoid points randomly in each cluster.

(6) Re-assign the observations to the new closest medoid points.

(7) Recalculate the sum of distance.

(8) Repeat Steps 5 and 7 until the minimum sum of the distance and the medoids point fixed.

5.2 Identification

Another challenge in estimating the causal impact of Land Titling on peasant households' labor allocation decision is the possibility of unobserved characteristics of households that influence whether they accept Land Titling immediately or not. Since China's agricultural lands are collectively owned, the central government has no ability to directly manipulate the implementation of Land Titling. As collective consists of farmers in the same community, how the collective accomplishes Land Titling is closely linked with peasant households' acceptance or resistance attitude. We argue that peasant households who allocated more labor out-migrant to the city may accept Land Titling quickly in order to protect their ownership. At the same time, Land Titling that can stabilize households' farmland property right and enhances chance of going for an off-farm job (De La Rupelle, et al., 2009). A simple comparison of titled land peasant households and non-titled land peasant households would, in this case, overstate the rural labor migration effect from Land Titling. Alternatively, negative off-farm labor market may both induce acceptance of land title and holding of labor migration to city. Additionally, workers who cannot find off farm

employment opportunities may decide to return to village and rely on farming. Thus, they are quick to accept Land Titling to claim their farmland ownership. Those peasant households experiencing negative off-farm labor market allocate less laborer to the off-farm job thereby reducing off-farm to household labor ratio. These reasons lead to a spurious relationship between Land Titling and labor migration ratio. As such, the direction of any selectivity bias is theoretically uncertain.

To identify the causality of Land Titling to the labor allocation decision, we use the coefficient of variable in the machine using level of farmland with a same village (machine_cv) as the instrumental variable. We choose it as an instrumental variable because "machine_cv" has a close relationship with land policy. We argue that the less "machine_cv" within a village, the easier Land Titling is to be implemented. Small farmers have subsistence goal that entails food security, minimum income, and retain independence as owners and operators of a farm enterprise (Glover and Kusterer, 2016). Also, fairness is one of the manifestations of security and welfare, especially the pursuit of justice for the poor is particularly strong, which believe that the poor have been unfairly treated and are not lazy (Grimes, et al., 2015). As a result, the fairness of the institution can reduce landowners' resistance to institutional change thereby reducing the cost of institutional change (Cheung, 2005). It is easy to understand that "average distribution" reflects the welfare assurance of farmland and has a certain degree of institutional advantages in operation given the history of land ownership in China. Farmland in a village may not be homogeneous as land quality, land topography, and road and other physical infrastructure difference. Land Titling process eliminates future land-adjustment, which exists under the Household Responsibility System. It means that the allocated farmland will no longer be readjusted after Land Titling. If households perceive Land Titling undermines the concept of fairness, especially the one who is allocated with low productivity farmland, he may

feel treated unfairly. If this happens, the conflict is inevitable which slow down the progress of Land Titling. The only way to reduce the unfair effect is to maximize the homogenization of the farmland within a village, which means that the productivity of farmland obtained by each peasant household needs to be relatively similar. The productivity of farmland mainly can be expressed as the machine using level of farmland. The farmland that is flat and with road access has a high machine using level and are more favored by farmland. Therefore, the given village with homogeneous machine using level (small machine_cv) speeds up the progress of Land Titling.

The second reason is that the "machine_cv" is unrelated to peasant households' labor allocation decision. The "machine_cv" is the calculated data by all the peasant households from the same village. The major determinant of "machine_cv" is natural conditions or public infrastructure organized by collectives. Differently, the labor migration ratio is a decision making process of each peasant household. There is no reason to think that the "machine_cv" is related to households' individual labor migration decision.

5.3 Estimation techniques

Our outcome of interest in this section is the labor allocation choice of peasant households, i.e., the labor ratio of part-time, and the labor ratio of off-farm with respect to total labor availability in households.

Our estimations use a multi-equation mixed system that utilizes a conditional mixed process estimator which fits a Seemingly Unrelated Regressions (SUR) simultaneous equation model whereby endogenous regressors appear on the right side of other equations. Error terms in each equation would be related to each other. Parameters within the SUR system can be consistently estimated and simultaneous estimation takes into

account the full covariance structure, thus, in general, this is more efficient (Roodman 2011). Moreover, not all the regressors appear in all the equations.

We model two interrelated decisions: the proportion of part-time labor (Equation 1a) and the proportion of off-farm labor (Equation 2a) within a household. In addition, as *landtitling* is an endogenous variable in equations (1a) and (2a) and *machine_cv* is the instrument variable, we also model the third interrelated regression about *landtitling* (3a).

$$part - time - ratio = \beta_{pl}\text{landtitling} + \beta_{px}controls_x + \varepsilon_p \quad (1a)$$

$$off - farm - ratio = \beta_{ol}\text{landtitling} + \beta_{ox}controls_x + \varepsilon_o \quad (2a)$$

$$landtitling = \beta_{lm}\text{machine}_{cv} + \beta_{lx}controls_x + \varepsilon_l \quad (3a)$$

where part_time_ratio captures peasant households' labor allocation ratio of part-time, and off_farm_ratio captures peasant households' labor allocation ratio to off-farm. Landtitling captures if peasant households accepted Land Titling already. $Controls_x$ represents a vector of control variables that might also have affected peasant households' labor allocation decision. β is a vector of estimable parameters and ε_p, ε_o, ε_l are the error terms.

We choose the conditional mixed-process (CMP) framework implemented by Roodman's cmp command to complete the estimations (Roodman 2011). The CMP modeling framework is essentially that of seemingly unrelated regressions, but in a much broader sense. The individual equations are no required to be a continuous dependent variable. A single invocation of CMP may specify several equations, each of which may use a different estimation technique. In our case, equations (1a) and (2a) are fractional and those will be estimated by fractional response models. Equation (3a) is binary and will be estimated by using a probit model.

As we have endogenous variable in the two interrelated decisions, the most important advantage by using CMP is that the maximum likelihood approach in CMP to estimate these equations as a system, rather than as a

two-step estimator, has clear benefits and potential efficiency gains. The CMP framework implements the systems approach, not only for traditional Heckman selection models, but for any combination of its supported components.

6. Results

6.1 Results for cluster

Descriptive statistics of all variables in four clusters generated using the PAM method are shown in Table 2. Values for each variables in different clusters are shown in Figure 2.

[Table 2 should be here]

[Figure 2 should be here]

6.1.1 Cluster 1

The peasant households in cluster 1 have the highest degree of desire to control farmland. The average value of "Mindfulness of farm crops" is 2.16, which is much higher than other three clusters. The average value of "Mindfulness of physical change" is 2.666, and the average value of "Mindfulness of system alternation" is 2.793, which is relatively higher.

Second, the peasant households in cluster 1 have the relatively higher quality of farmland. The average values of "Fertility", "Irrigation", "Traffic", and "Machine using" are not that different and peasant households in this cluster do not have the problem of farmland fragmentation. Cluster 1 is the only group that "Farmland area" average value (5.293) is higher than "Plots quantity" average value (5.029). This means that those peasant households in cluster 1 have contiguous farmland area instead of fragmented farmland. The contiguous farmland area determines the high productivity of farmland.

Third, 17.7% of peasant households in cluster 1 are transferring farmland.

6.1.2 Cluster 2

The peasant households in cluster 2 have highest satisfaction degree of the policy about finding an off-farm job. The average value of "Migrant worker policy" is 3.223. The average value of "Entrepreneurship support policy" is 3.252. The average value of "City integration policy" is 3.186. These three the satisfaction degrees to related policies, compared with other three clusters, are the highest in cluster 2,

Second, the peasant households in cluster 2 have the lowest degree of desire to control farmland. The average value of "Mindfulness of farm crops" is 1.13, the average value of "Mindfulness of physical change" is 1.157, and the average value of "Mindfulness of system alternation" is 1.276. All of these three values are much lower than other three clusters.

Third, the peasant households in cluster 2 have the relatively worse quality of farmland. The average value of "Fertility" is 3.191. The average value of "Irrigation" is 2.109. The average value of "Machine using" is 2.302, and the average value of "Traffic" is 3.26. Most of these average values are the lowest among four clusters. Most important is that "Farmland area" average value (4.429) is lower than "Plots quantity" average value (4.86) in cluster 2, and the ratio of "Farmland area" and "Plots quantity" (4.429/4.86=0.911) is the worst among four clusters. This means that those peasant households in this cluster have fragmented farmland.

Fourth, 21.3% of peasant households in cluster 2 are transferring farmland.

6.1.3 Cluster 3

First, similar to the peasant households in cluster 2, the peasant households in cluster 3 have serious problem of farmland fragmentation. Its main performance is that "Farmland area" average value (5.331) is much lower than "Plots quantity" average value (5.781) in this cluster, and the ratio of "Farmland area" and "Plots quantity" (5.331/5.781=0.922) is the

second worst among four clusters.

Second, peasant households in cluster 3 have the lowest satisfaction degree to the policies about finding an off-farm job. The average value of "Migrant worker policy" is 2.951. The average value of "Entrepreneurship support policy" is 2.918. The average value of "City integration policy" is 2.911. These three average values of the satisfaction degree are the lowest among all the clusters.

6.1.4 Cluster 4

The most prominent feature of cluster 4 is peasant households' participation in farmland transfer process. Regardless of whether Land Titling have been implemented or not, 100% of the peasant households in cluster 4 have already participated in the farmland transfer market. It can be said that all of the peasant households in cluster 4 already live in a well-functioning farmland transfer market regardless the Land Titling policy.

6.2 Regression results from the conditional mixed-process model with IV function

Table 3 presents the results of IV SUR method on impact of Land Titling on peasant households' part-time and off-farm labor ratios as well the impacts of "Machine_ cv" on the implementation of Land Titling. Results for each cluster are presented side by side in this table. The Wald χ^2 values in clusters 1, 2, 3, and 4 are 557.22, 617.23, 1130.10, and 376.35, respectively and are significant at a 1% level.

[Table 5. should be here]

In the "landtitling" regression, the estimated coefficient of "Machine_ cv" is significant at a 1% level in cluster 1 (-0.628), cluster 2 (-0.841), and is significant at a 5% level in cluster 3 (0.378). As stated in the empirical

strategy part of our research, maximizing the homogenization of the farmland within a village can help effectively implement Land Titling. Therefore, "Machine_ cv" has a significant negative effect on "landtitling" in clusters 1 and 2. However, "Machine_ cv" has a significant positive effect on "landtitling" in cluster 3. The possible explanation is that, in cluster 3, "Machine_ cv" is the expression of households' individual agricultural investment situation rather than the fairness of allocated farmland's quality. As we see in the clustering results, the peasant households in cluster 3 have the highest level of "Mindfulness of digging pits" and "Mindfulness of changing the use", but have the lowest level of "Mindfulness of farm crops". This means that peasant households in cluster 3 hope their farmland can stay as it is, although they do not care about who crops or what crops are produced. Also, the peasant households in cluster 3 have relatively higher "Machine using" value. These two features reflect that some of the households in cluster 3 may have more private agricultural investments on farmland from another perspective. The private investment situation can also affect farmers' acceptance speed of Land Titling. If there is heterogeneity of investment patterns by farmers within a village, farmers are more willing to apply for Land Titling quickly to protect their own existing investment. Overall, whether it has a positive or negative influence, these results prove that "Machine_ cv" is not a weak instrumental variable.

6.2.1 The regression results of cluster 1

We discuss parameters and marginal effects from the CMP model which are presented in Tables 6. According to the marginal effects, the "landtitling" variable significantly decreases the off-farm labor ratio by 20.1%. For the peasant households with the highest degree of desire to control farmland and contiguous farmland area, the implementation of Land Titling deters farmers from searching for an off-farm job and come back to farmland. First, peasant households in cluster 1 have the highest degree of desire to control

farmland, even want to control the crop varieties in their rent-out farmland. This shows that this kind of farmer can not be assured that the farmland will be planted by others. Second, peasant households in cluster 1 have contiguous, relatively large farmland. In addition, better property rights from Land Titling unambiguously increase investments via a lower fear of farmland expropriation. The productivity of farmland and the earnings of the farmer can rise dramatically if the farmer invest more infrastructure investments on their contiguous farmland. Therefore, they may choose to allocate more labor to return to agriculture after the implementation of Land Titling. Third, Land scarcity remains one of the limiting factors to agricultural production in China. The stable property rights obtained from the Land Titling process can promote the land transfer market. It helps to solve the constraints of agricultural resources for the peasant households who have a comparative advantage in agriculture. Therefore, peasant households may allocated households' labor return to farm after the implementation of Land Titling.

6.2.2 The regression results of cluster 2

According to the marginal effects, the "landtitling" variable significantly decreases the part-farm labor ratio by 21% and increases the off-farm labor ratio by 38.6%. For the peasant households with highest satisfaction to the policies about finding an off-farm job, the lowest degree of desire to control farmland, and relatively worse quality of farmland, the implementation of Land Titling induce farmers to search for an off-farm job and deters farmers from searching for a part-time job. First, peasant households in cluster 2 have highest satisfaction to the policies about finding an off-farm job. It shows that this type of farmer has an outstanding advantage in finding a job in urban area. Second, peasant households in cluster 2 have the lowest degree of desire to control farmland. While stabilizing the property rights and promoting farmland transfer market, peasant households in cluster 2

can transfer-out their farmland comfortably and focus on non-agricultural work. This may be the reason why the implementation can decrease the part-time ratio and increase the off-farm ratio at the same time. Third, unlike the peasant household with contiguous farmland in cluster 1, those households in cluster 1 who have relatively worse quality and fragmented farmland may not be able to gain the significant increase of farmland productivity even if they increase private investments (Rahman and Rahman, 2009). That is the reason why they do not allocate labor return to farmland after Land Titling.

6.2.3 The regression results of cluster 3

According to the marginal effects, the "landtitling" variable significantly increases the off-farm labor ratio by 41.8%. For the peasant households have both the relatively worse quality of farmland and lower satisfaction to the policies about finding an off-farm job, the implementation of Land Titling induce farmers to search for an off-farm job. First, similar to the peasant households in cluster 2, the peasant households in cluster 3 have peasant households with fragmented farmland. It directly leads to low agricultural productivity of their farmland even with private investments. This the reason why peasant households in cluster 3 do not choose to allocate labor return to farmland after Land Titling. Second, peasant households in cluster 3 have the lowest satisfaction degree to the policies about finding an off-farm job. It shows that this type of farmers has no outstanding advantage in finding an off-farm job. Therefore, different to the regression estimation results from cluster 2, the implementation of Land Titling cannot guide households allocate labor from part-time job to off-farm job.

6.2.4 The regression results of cluster 4

According to the marginal effects, the "landtitling" variable has no

significant effect on the part-time labor ratio and the off-farm labor ratio. For the peasant households who have already participated in the farmland transfer market, Land Titling cannot affect peasant households' labor allocation decision. Regardless of whether Land Titling have been implemented, all of the peasant households in cluster 4 have already participated in the farmland transfer market. It can be considered that the farmland transfer market is in place in this cluster. Therefore, the implementation of Land Titling may not able to affect households' labor allocation decision via the channel of farmland transfer market.

7. Conclusion

We developed a conceptual model of labor allocation decision and supplemented it with empirical analyses by using nationally representative interview data collected from peasant households located in nine provinces in China. We use cluster analysis to divide the observations into four groups before estimating the Fractional IV SUR model. Also, to address the endogeneity issue and identify the causality of Land Titling to peasant households' labor allocation decision, we use the coefficient of variation in the machine using level of farmland in the village (machine_ cv) as the instrumental variable. Results indicate that (1) Land Titling decreases the off-farm labor ratio by 20.1% when peasant households have contiguous big farmland and have the highest desire to control their farmland. (2) Land Titling decreases the part-time labor ratio by 21% and increases the off-farm labor ratio by 38.6% when households have the highest degree of satisfaction to the policies about finding an off-farm job, relatively worse quality of farmland, and the lowest desire to control farmland. (3) Land Titling significantly increases the off-farm labor ratio by 41.8% but have no effect on the part-time labor ratio when households have both the relatively worse quality of farmland and the lower satisfaction to the policies about

finding an off-farm job. (4) Land Titling have no effect on peasant households' labor allocation decision when households reside in a functional farmland transfer market regardless of the implementation of Land Titling.

We argue that, under different circumstances, Land Titling can have different effects on households' labor allocation decision. First, whether a land policy has an influence on the farmland transfer market directly determines whether it has an impact on households' labor allocation decision. From this perspective, Land Titling may not affect the labor allocation decision of those peasant households who are already involved in a farmland transfer market. Second, the characteristics of peasant household determine the direction and magnitude of the policy impact. Those peasant households who have a comparative advantage in agriculture, in the face of more stable property right and functional farmland market, tend to transfer-in farmland and put more investment in the agricultural area, and ultimately increase on-farm labor ratio. On the contrary, peasant household with non-agricultural comparative advantages, in the face of functional farmland market, tend to transfer-out farmland and increase off-farm labor ratios.

These results highlight the need to attach importance to the definition of rural labor migration and distinguish farmers with different characteristics to estimate the impact of Land Titling. Land Titling is a practice of stabilizing farmers' property rights in China. It helps farmers to adjust labor allocation decisions to achieve resource use efficiency. In this process, the government needs to take further actions to provide better services in rural area. For rural households with comparative agricultural advantages, it is necessary to reduce the transfer frictions of farmland and help control the non-systematic risk in agricultural product market. For rural households with non-agricultural advantages, urban employment assistance and strategies for integration into the city should be provided.

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Figure 1. Map of China with the study area highlighted in yellow
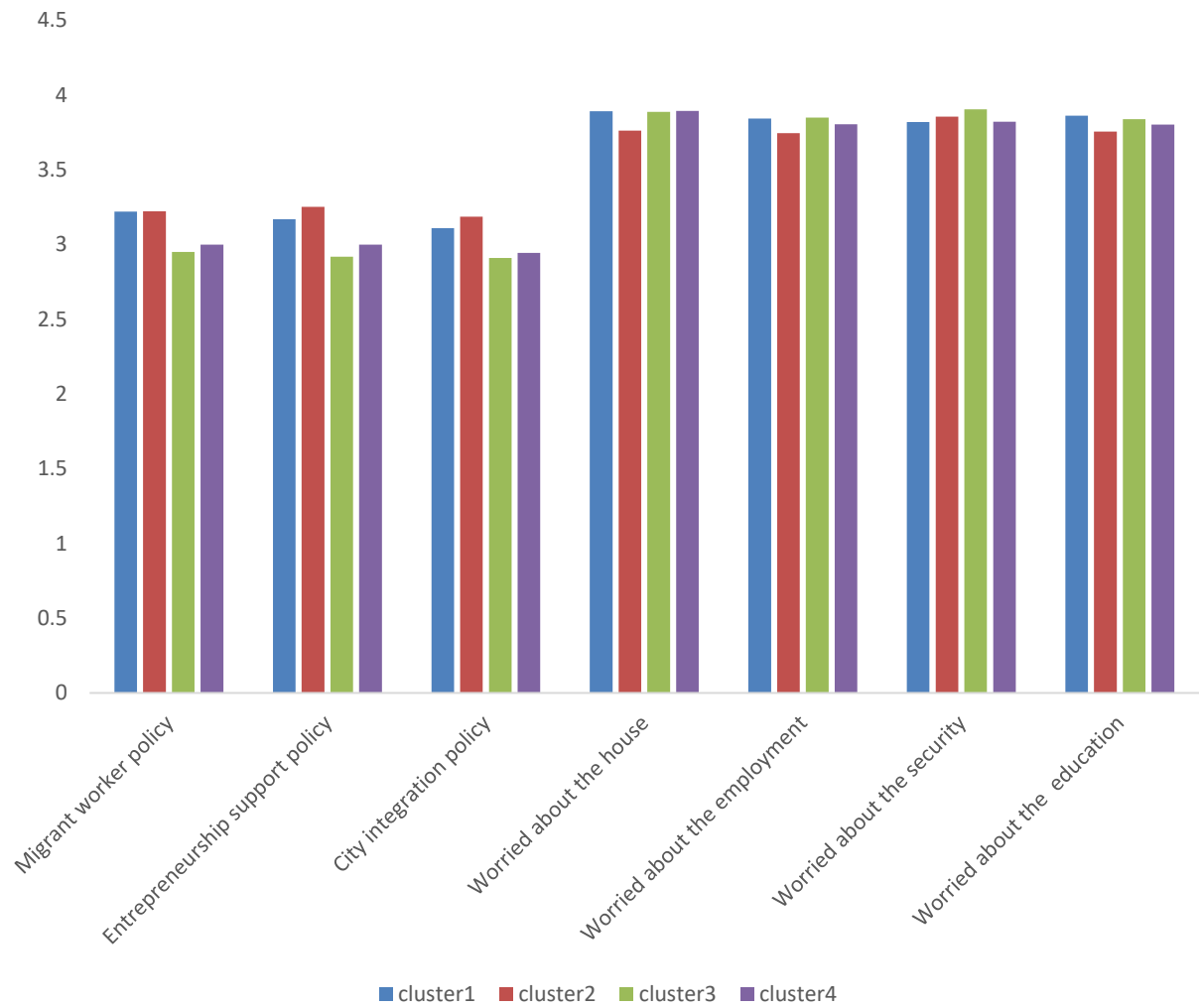
Figure 2. Variables and their values under different clusters
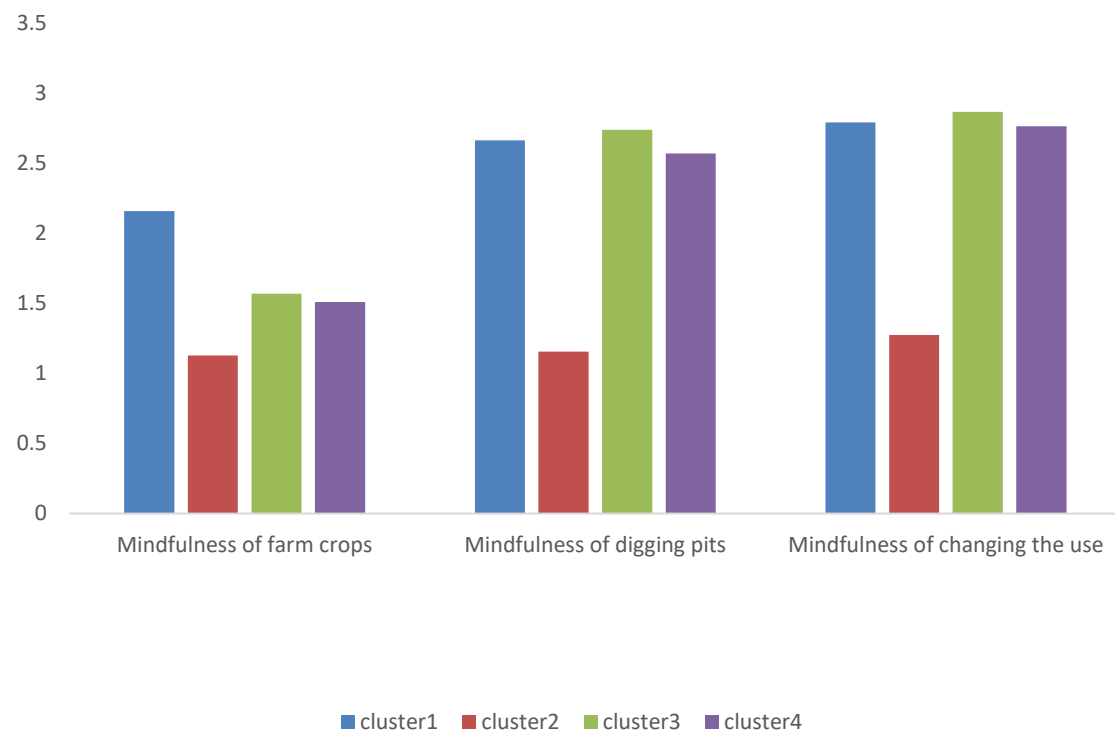
Figure 2 (Cont.). Variables and their values under different clusters
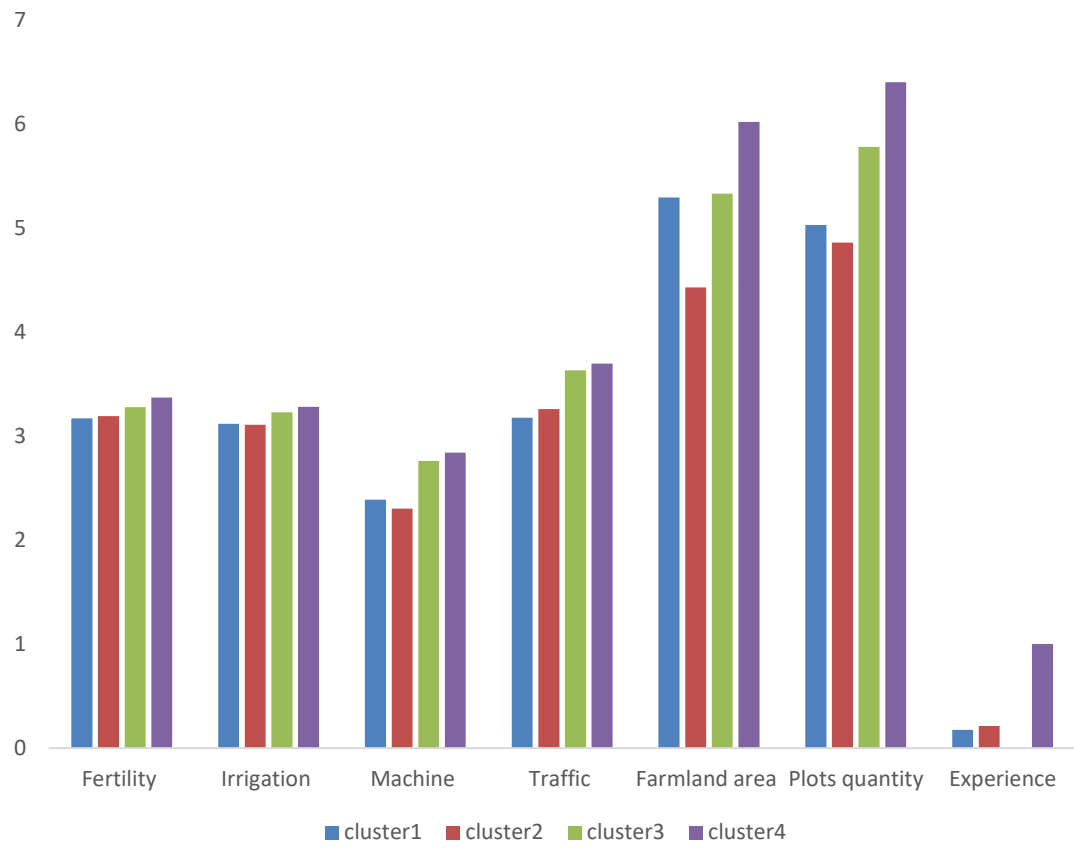
Figure 2 (Cont.). Variables and their values under different clusters

Table 1. Summary Statistics of Variables Used in the Study

	Variable	Mean	SD	Min	Max
Labor allocation decision	Part-time labor ratio	0.255	0.324	0	1
	Off-farm labor ratio	0.344	0.294	0	1
Policy	Land Titling	0.618	0.485	0	1
	Satisfaction of the migrant worker policy	3.080	1.049	1	5
	Satisfaction of the entrepreneurship support policy	3.061	1.033	1	5
	Satisfaction of the city integration policy	3.018	1.039	1	5
Finding an off-farm job	Worried about the house	3.869	1.073	1	5
	Worried about the employment	3.820	1.070	1	5
	Worried about the medical and old-age security	3.854	1.072	1	5
	Worried about the children's education	3.822	1.127	1	5
Desire to control farmland	Mindfulness of farm crops	1.640	0.803	1	3
	Mindfulness of digging pits	2.414	0.803	1	3
	Mindfulness of changing the use	2.556	0.746	1	3
	Fertility	3.257	0.860	1	5
	Irrigation	3.190	1.000	1	5
Farmland quality	Machine	2.603	1.094	1	5
	Traffic	3.463	0.892	1	5
	Farmland area	5.329	5.614	0	50
	Plots quantity	5.570	4.875	0	89
Farmland transfer	Transfer	0.316	0.465	0	1

Table 2. Variables and their values under different clusters

	Variables	Cluster 1 Mean	Cluster 1 Sd.	Cluster 2 Mean	Cluster 2 Sd.	Cluster 3 Mean	Cluster 3 Sd.	Cluster 4 Mean	Cluster 4 Sd.
Finding an off-farm job	Employment support policy	3.221	1.038	3.223	1.119	2.951	1.031	3	1.002
	Entrepreneurship support policy	3.17	1.005	3.252	1.078	2.918	1.025	2.999	1.007
	City integration policy	3.11	1.008	3.186	1.027	2.911	1.052	2.944	1.042
	Worry about house	3.891	1.014	3.763	1.127	3.887	1.082	3.894	1.082
	Worry about employment	3.842	1.017	3.745	1.102	3.849	1.08	3.805	1.092
	Worry about security	3.82	1.051	3.856	1.054	3.904	1.079	3.822	1.098
	Worry about schooling	3.861	1.092	3.755	1.154	3.839	1.117	3.803	1.16
Desire to control farmland	Mindfulness of crops species	2.16	0.705	1.13	0.388	1.57	0.813	1.51	0.793
	Mindfulness of physical change	2.666	0.512	1.157	0.41	2.74	0.554	2.572	0.723
	Mindfulness of system alteration	2.793	0.419	1.276	0.57	2.868	0.381	2.766	0.56
Farmland quality	Fertility	3.17	0.832	3.191	0.911	3.279	0.821	3.371	0.896
	Irrigation	3.118	0.996	3.109	1.028	3.228	0.946	3.28	1.05
	Machine using level	2.388	0.993	2.302	1.061	2.762	1.056	2.841	1.184
	Country traffic	3.176	0.811	3.26	0.834	3.631	0.913	3.698	0.873
	Farmland area	5.293	6.114	4.429	5.297	5.331	5.512	6.02	5.286
	Farmland plots	5.029	4.543	4.86	4.673	5.781	4.784	6.403	5.349
Farmland transfer	Transfer	0.177	0.382	0.213	0.41	0	0	1	0

Note: The total number of observation in clusters 1, 2, 3, and 4 are 1,269 (cluster1), 801 (cluster2), 1,578 (cluster3), and 1,104 (cluster4).

Table 3. Results of the influence of Land Titling on households' labor allocate

decision from Fractional IV model by using CMP:

	Cluster 1		Cluster2		cluster 3		cluster 4	
	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx	Coef.	dy/dx
				Part time labor ratio				
Landtitling	-0.754	-0.229	-0.633**	-0.210***	-0.203	-0.062	-0.559	-0.167
Migrant worker policy	0.090**	0.027**	-0.033	-0.011	0.151***	0.046***	0.001	0.000
Entrepreneurship support policy	-0.064	-0.019	0.017	0.006	-0.124**	-0.038**	0.065	0.019
City integration policy	-0.037	-0.011	0.007	0.002	0.074**	0.023**	0.072*	0.021*
Worried about the house	-0.073*	-0.022*	0.013	0.004	0.002	0.001	0.067	0.020
Worried about the employment	-0.014	-0.004	-0.009	-0.003	-0.058	-0.018	-0.098**	-0.029**
Worried about the security	0.102**	0.031**	0.004	0.001	0.027	0.008	0.032	0.010
Worried about the education	0.026	0.008	0.017	0.006	-0.022	-0.007	-0.036	-0.011
Mindfulness of farm crops	-0.084**	-0.026**	0.136	0.045	0.065*	0.020	-0.121***	-0.036***
Mindfulness of physical change	-0.018	-0.006	-0.223**	-0.074**	-0.130***	-0.040***	0.140**	0.042**
Mindfulness of system alteration	0.029	0.009	-0.046	-0.015	-0.040	-0.012	0.021	0.006
Fertility	0.000	0.000	0.051	0.017	0.060	0.018	-0.027	-0.008
Irrigation	-0.062*	-0.019*	-0.099**	-0.033**	-0.030	-0.009	0.066*	0.020*
Machine	0.097***	0.029***	0.125***	0.042***	-0.011	-0.003	0.047	0.014
Traffic	0.120**	0.037**	0.064	0.021	0.001	0.000	0.064	0.019
Transfer	-0.156**	-0.048**	-0.179**	-0.059**				
Farmland area	-0.002	-0.001	-0.013	-0.004	-0.011*	-0.003*	-0.005	-0.002
Plots quantity	-0.011	-0.003	0.000	0.000	-0.010	-0.003	0.005	0.001
Province_2	0.216	0.066	-0.190	-0.063	-0.228	-0.070	-0.055	-0.016
Province _3	-0.159	-0.048	-0.243	-0.080	-0.346	-0.106	0.100	0.030
Province _4	-0.088	-0.027	0.218	0.072	-0.366*	-0.112*	0.251	0.075
Province _5	Omit		0.034	0.011	-0.445***	-0.136***	-0.172	-0.051
Province _6	0.569***	0.173***	0.204	0.068	-0.560**	-0.172**	0.396*	0.118*
Province _8	-0.337	-0.103	-0.116	-0.039	-0.686***	-0.211***	-0.160	-0.048
Province _9	0.258**	0.079**	0.249	0.083	-0.282	-0.087	-0.216	-0.065
_cons	-0.609		-0.357		0.174		-1.241	
				Off farm labor ratio				
landtitling	-0.572	-0.201*	1.159***	0.386***	1.251***	0.418***	-0.193	-0.069
Migrant worker policy	-0.067*	-0.023*	-0.051	-0.017	-0.052	-0.017	0.066	0.024
Entrepreneurship support policy	0.059	0.021	0.018	0.006	0.021	0.007	0.000	0.000
City integration policy	-0.006	-0.002	0.034	0.011	0.026	0.009	-0.099***	-0.035***
Worried about the house	0.010	0.003	-0.069**	-0.023**	-0.058	-0.019	-0.043	-0.015
Worried about the employment	0.007	0.003	0.087*	0.029*	0.053	0.018	0.021	0.007
Worried about the security	-0.072**	-0.025**	-0.027	-0.009	-0.058	-0.019	0.020	0.007
Worried about the education	0.021	0.007	-0.038	-0.013	0.104***	0.035***	0.005	0.002
Mindfulness of farm crops	-0.039	-0.014	-0.092	-0.031	0.006	0.002	0.002	0.001
Mindfulness of physical change	0.042	0.015	0.041	0.014	0.048	0.016	-0.035	-0.012
Mindfulness of system alteration	-0.037	-0.013	-0.106*	-0.035*	-0.312***	-0.104***	0.065	0.023

Fertility	0.027	0.009	0.056	0.019	0.037	0.012	0.059*	0.021*
Irrigation	0.077***	0.027***	0.059	0.020	-0.044	-0.015	-0.024	-0.008
Machine	-0.130***	-0.046***	-0.069**	-0.023**	-0.006	-0.002	-0.110***	-0.039***
Traffic	0.032	0.011	-0.074*	-0.025*	-0.012	-0.004	0.036	0.013
Transfer	0.021	0.007	0.167**	0.055**				
Farmland area	-0.017***	-0.006***	-0.010	-0.003	0.015***	0.005***	-0.005	-0.002
Plots quantity	0.025***	0.009***	-0.008	-0.003	-0.004	-0.001	0.005	0.002
Province_2	0.021	0.007	-0.473***	-0.157***	0.252	0.084	0.051	0.018
Province _3	0.246	0.086	0.061	0.020	0.963***	0.322***	-0.416**	-0.148**
Province _4	0.292**	0.103**	-0.419**	-0.139**	0.665***	0.222***	0.157	0.056
Province _5			-0.488***	-0.162***	0.365**	0.122**	0.030	0.011
Province _6	-0.131	-0.046	-0.322**	-0.107**	0.199	0.066	-0.263	-0.093
Province _8	-0.718***	-0.252***	-0.323*	-0.107*	0.432*	0.144*	-0.053	-0.019
Province _9	0.004	0.001	-0.629***	-0.209***	0.525*	0.176*	-0.004	-0.002
_cons	0.039		-0.235		-0.943		-0.266	

Landtitling				
Machine_cv	-0.628***	-0.841***	0.378**	0.164
Migrant worker policy	-0.015	0.120	-0.022	0.068
Entrepreneurship support policy	0.095	-0.016	0.096	0.012
City integration policy	-0.127***	-0.017	-0.107**	0.034
Worried about the house	-0.086	0.147***	0.140***	0.089
Worried about the employment	0.081	-0.328***	-0.102*	-0.016
Worried about the security	0.019	0.112*	0.021	0.041
Worried about the education	0.038	0.051	-0.065	-0.107**
Mindfulness of farm crops	-0.047	0.102	-0.069	-0.032***
Mindfulness of physical change	0.153**	0.137	0.038	0.131
Mindfulness of system alteration	-0.204**	0.052	0.218**	0.069
Fertility	-0.066	-0.048	-0.029	-0.030
Irrigation	0.024	0.024	0.072	0.067
Machine	-0.082**	-0.005	-0.006	0.085**
Traffic	0.219***	0.199***	-0.050	-0.114**
Transfer	-0.166*	-0.107		
Farmland area	0.007	-0.030***	-0.015**	0.007
Plots quantity	0.031***	0.033**	0.005	0.003
Province_2	0.584**	0.712***	-0.364	-0.515
Province _3	-0.213	-0.363	-1.261***	-0.551**
Province _4	0.248	0.512**	-0.330	0.795***
Province _5	Omit	0.928***	0.295	0.736***
Province _6	1.076***	0.632**	0.153	0.086
Province _8	-0.536**	0.686**	0.151	0.162
Province _9	0.338**	0.670***	-0.961***	-0.244
_cons	-0.113	-1.107**	-0.239	-0.948**
/atanhrho_12	-0.232*	-0.515***	-0.366***	-0.323***
/atanhrho_13	0.324	0.390**	0.128	0.278

/atanhrho_23	0.438	-1.019***	-1.285***	0.125
rho_12	-0.228	-0.474	-0.351	-0.313
rho_13	0.313	0.372	0.127	0.271
rho_23	0.412	-0.770	-0.858	0.124
Number of obs	1,269	801	1,578	1,104
Log pseudolikelihood	-2284.487	1436.206	-2728.292	-1886.752
Wald chi2(72)	557.22***	617.23***	1130.1***	376.35***