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ABSTRACT

Land Markets and Labor Productivity: Empirical Evidence from China*

This study investigates the impact of the land rental market (LRM) on labor productivity in rural China. Particular attention is given to farm and non-farm labor productivity. Using 2012 household-level data and a multinomial endogenous switching treatment regression (MESTR) technique, we find that rural households renting-in farmland increased labor productivity in the farm sector by about 55%, while labor productivity in the non-farm sector decreased by about 6%. We also find that rural households renting-out farmland had lower labor productivity in both the farm and non-farm sectors by 13% and 9%, respectively. More family labor transferred from the farm to the non-farm sector after renting-out land.

JEL Classification: C31, J22, Q15, Q18

Keywords: land rental market, labor productivity, farm sector, non-farm sector

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INTRODUCTION

The labor productivity gap between the agricultural and non-agricultural sector is a common occurrence in developing counties (Djido and Shiferaw, 2018; Gollin, Lagakos, and Waugh, 2013; McCullough, 2017). This is because a higher proportion of labor force is employed in the agricultural sector and a larger share of agricultural income in total household income (Djido and Shiferaw, 2018). Low agricultural labor productivity has become a hurdle for farmers, leading to insecure livelihoods and poverty in developing countries. To this end, China is an example where the farming system is characterized by an abundant labor force relative to scarce cultivatable farmland. With the rapid economic growth in recent decades, the contribution of agricultural sector to China's economy has declined. For example, in 2015 the agricultural sector accounted less than 15% of the value added, and the share of agricultural income in total income for rural Chinese households has declined by about 18% (NBSC, 2017).

However, the share of labor employed in the Chinese agricultural sector is significantly large, about 28.3% in 2015 (NBSC, 2017). The higher share of employment in the agricultural sector than the share of value-added implies lower labor productivity in the agricultural than in the non-agricultural sector (Gollin, Lagakos, and Waugh, 2013). Although Chinese farmers may diversify into a set of non-farm strategies to improve labor productivity and household income (Shi, Heerink, and Qu, 2007), not all farmers have the ability to work in the non-farm sector, which prefers more educated and younger workers (Yu and Zhao, 2009). Therefore, comparatively low productivity widens the income gap within the rural areas and between rural and urban residents (Cai and Wang, 2008), leaving 90–95% of all the

poor in the rural areas (Minale, 2018).

Agricultural labor productivity can be improved by either improving land productivity or land-to-labor ratio (Carter, Chen, and Chu, 2003; Fan and Chan-Kang, 2005; McCullough, 2017). China's land productivity has increased continuously in the last decade, mainly due to the adoption and availability of fertilizer, technology, and institutions (Yu and Zhao, 2009). At the same time, the amount of agricultural labor has decreased (e.g., rural labor migration and agricultural modernization) significantly and increasing the land-to-labor ratio (Carter, Chen, and Chu, 2003; Cai and Wang, 2008; Ito, 2010). In their study Carter, Chen and Chu (2003) found that the growth rate of labor productivity lagged growth in the total factor productivity (TFP) in China's agricultural sector, before the 1990s. After 1992, due to the mass movement of labor from the rural areas to the urban areas, labor productivity increased due to labor migration. Additionally, Ito (2010) concluded that the modernization of agricultural production in China improved the land-labor ratio and improved labor productivity.

Although the importance of labor migration on land productivity has been studied in the literature, the impact of the land rental market on rural labor productivity has seldom been studied (Kimura et al., 2011). Considering the current land tenure system in China, where land sale is prohibited, and land is collectively owned by the villagers, land rental is regarded as a way to improving allocative efficiency. In the absence of land rental market, migrating households may return home during the busy farming season instead of leaving the farming sector (Huang and Ding, 2016). Additionally, farming households are unable to expand their farm size to improve the land-labor ratio. Therefore, land rental restrictions may reduce the

labor productivity for both migrating rural households and farming households in rural areas. In recent years, under a series of land tenure reforms and government intervention, land rental markets (LRM) have developed. By the end of 2015, approximately 63 million (or 27%) rural households rented-out their cultivatable farmland, about 33% of the total contracted farmland area, under the household responsibility system (Committee of China Agriculture Yearbook, 2016). The LRM can have profound effect on labor allocation between farm and non-farm sectors.

Hence, the objective of this study is to investigate the effect of LRM development on labor productivity in the farm and non-farm sectors of rural China. In particular, the study quantifies the impact of participation in LRM on the labor productivity and work time, both in farm and non-farm sectors. Rural Chinese households commonly allocate labor into the farm and non-farm activities (Shi, Heerink, and Qu, 2007). In this study, we distinguish the labor productivity of family members working in the farm and non-farm sectors.[1] We use the 2012 China Family Panel Studies (CFPS) survey, national representative rural household survey, and multinomial endogenous switching treatment regression (MESTR) technique to estimate our empirical model. The advantage of the MESTR technique is that it controls for selection bias caused by observable and unobservable factors.

The study contributes to the literature on several fronts. First, the study focuses on the cross-sector differences in the labor productivity, namely farm and non-farm sectors. This analysis is much needed as China has witnessed faster growth in the non-farm (industrial) sector and the farm (agricultural) sector has been neglected because of labor migration.

[1] Farm work includes cropping and livestock farming. Non-farm work includes unskilled wage, wage employment, and self-employment.

Second, the study enhances the understanding of the changes in and the factors affecting labor productivity in rural China. These changes are important from the perspective of the LRM, under a peculiar land tenure system in rural China. Third, the study considers observed and unobserved heterogeneity by applying the MESTR estimation method. Lastly, using average treatment effect (ATT) the study quantifies the impact of LRM on labor productivity in farm and non-farm sectors; labor supply (work time) in farm and non-farm sectors. The rest of this paper is organized as follows. The next section reviews the literature. Section 3 is the conceptual framework. Section 4 introduces the survey data and descriptive statistics. The empirical model and identification strategy are presented in Section 5. Section 6 reports results and discussions. The last section concludes the study.

LITERATURE REVIEW

Over the last four decades China's economic transformation has led to an open economy. China has undertaken several initiatives to improve the land market and resource efficiency. Among these, the landmark initiative was the establishment of household responsibility system (HRS) in the late1970s. Under HRS, the cultivatable land is jointly owned by village collectives (Feng, Bao and Jiang, 2014). Rural land rights are based on a dual track system that divides ownership from usage. The rights to use and derive income from the land were allocated to rural individuals on an equitable basis (Zhang and Donaldson, 2013). Finally, under the HRS rural household land rights are partially constrained and individuals are forbidden to sell or use land as collateral.

However, the 1988 constitutional amendment granted the permission to transfer of land usage rights among rural households. In 1996, a survey conducted in the Guizhou, Hunan and

Yunnan provinces, found that only 2.3% of rural households rented in land (Deininger and Jin, 2005). In 2003, under the Rural Land Contract Law land rental activity was formalized and guided by officials. Land rental markets (LRM) developed fast and land rental activities have accelerated rapidly in recent years. For instance, figure 1 shows that, between 2009 to 2015, the share of land rental area[2] increased from 12% to 33%; the ratio of rural households renting-out land[3] increased from 13% to 27%. However, the share of land area transferred to small farmers[4] decreased by 13% during 2009-2015 period. This finding suggest that more land was transferred to non-farmers, such as cooperatives, companies and third parties (Huang and Ding, 2016).

The driving force in the development of LRM in China has been widely investigated and generally fall into two categories. The first set of studies investigate the factors, including household head's characteristics, family assets structure, land-to-labor ratio, and off-farm employment, affecting changes in rural households' assets (Kung, 2002; Feng and Heerink, 2008; Huang, Gao and Rozelle, 2012; Liu et al., 2017). The second set of studies have investigated the impact of external social and institutional factors (land tenure system, government intervention, rural labor and capital market, agricultural mechanization) on changes in the relative price of land and labor and rural households' assets values (Kung, 2002; Kimura et al., 2011; Huang and Ding, 2016).

With land scarcity and off-farm opportunities, rural Chinese households have improved labor productivity and household income by engaging in non-farm activities, including

[2] Total land rental area/ Total area of cultivated land contracted by rural households
[3] Number of rural households renting-out their land/ Number of rural households who get land from village collectives
[4] Land area transferred to small farmers/ Total land rental area

unskilled wage work, wage employment (local wage and migration), and self-employment (Zhao, 1999; Zhang et al., 2018). For example, between 2008 and 2016, rural Chinese households' per capita income increased annually by about 11%. During the same period the wage income growth rate was much higher than self-employment income[5] (mainly agricultural income), about 12% and 8%, respectively. The importance of self-employment income (mainly agricultural income) decreased from 51% to 38% (NBSC, 2008; NBSC, 2017). This means that labor productivity in the farm sector has lagged the non-farm sector. Since on-farm work has relatively lower marginal contribution to the family earnings, most family workers have not withdrawn from farming work (Huang and Ding, 2016). Most rural Chinese households participate in on-farm and non-farm work simultaneously. However, younger and more educated family members are more likely to take off-farm employment (Zhang, Huang and Rozelle, 2002; Fan and Chan-Kang, 2005) while older family members are engaged in farm work. Traditional farm work requires farming experience and physical strength (Feng and Heerink, 2008).

Industrialization, rapid urbanization, and continuous rural labor migration from the farm to the non-farm sector has had profound effects on rural Chinese labor productivity. Several studies have investigated the effect of off-farm employment of rural labor on rural Chinese households' agricultural production. Most of these studies (Carter, Chen and Chu, 2003; Su et al., 2016) found that off-farm employment especially labor migration not only reduced the amount of labor input, but also changed the composition (gender and age of farming worker)

[5] Self-employment income includes incomes from small business and agricultural income. Unfortunately, the national statistics in 2016 did not distinguish between small business and agricultural incomes. As a result, the actual proportion of agricultural income may be even lower than the self-employment income.

of labor input in the production agriculture (Su et al., 2016; Long et al., 2016). The empirical evidence on the impact of labor migration on agricultural productivity is conflicting. On the one hand, labor migration may reduce family labor input leading to a negative effect on agricultural output. On the other hand, remittance income from migrating family members relaxes credit constraints thereby increasing investment in production agriculture (Li et al., 2013). During the last few decades, agricultural output and land productivity in China has increased significantly, due to mechanization and capital substitution for family labor input in production agriculture (Carter, Chen and Chu, 2003; Yu and Zhao, 2009; Ito, 2010; Zhang, Yang, and Thomas, 2017).

LRM can also affect labor productivity in rural China. LRM can effectively raise agricultural output, allocative efficiency and household income. For example, Feng et al. (2010), using plot-level data in Northeast Jiangxi Province, found that households renting-in land have higher rice production per unit of land. In another study, Deininger and Jin (2005) and Jin and Deininger (2009)[6] found that by transferring land from less-able to more-able households and from relatively land-rich to land-poor households, LRM has efficiency and equality impacts. Similarly, Carter and Yao (2002) found that LRM help to equalize the marginal product of land across households with different land-labor endowments. More recently, Zhang et al. (2018) found a positive effect of land renting in on rural Chinese households' total income and agricultural income. However, it should be noted that the effects of LRM on family labor productivity, both in the farm and non-farm sectors has neglected in the literature. Lastly, figure 1 shows a mismatch between the share of land renting in and

[6] Jin and Deininger (2009) found that, due to land renting-out, the share of income derived from migration and local off-farm employment increased from 43% to 84%.

renting out, indicating an upward trend of land rental activities between other parties (cooperatives, companies and others) and small farmland operators.

Unlike household income, family labor productivity is the average output per unit labor input. A higher labor productivity leads to higher household income, but higher income may not necessarily lead to a higher family labor productivity. For example, two households with same land endowment but different amounts of family labor, in the absence of labor and land market, the family labor abundant household may invest excessive labor in farming to increase production and income, but because of the diminishing marginal production of labor input, labor-rich household may have lower family labor productivity than the labor-poor households (Fan and Chan-Kang, 2005). On the other hand, capital-intensive production such as mechanization, hiring labor and buying agricultural services can reduce family labor requirement in agricultural production. Using a simulation model, Van den Berg et al. (2007) found that increasing mechanization in rice production helps farmers to cultivate larger land areas, leading to higher farm income. Recently, Zhang, Yang, and Thomas (2017) found that mechanization services make up for the loss of family labor input in production agriculture. Su et al. (2016) found that expenditures on agricultural services has reduced the family labor input in farm production. Finally, we note regional imbalances in labor migration and rural labor productivity gaps between regions. For instance, Cai, Wang, and Du (2002) found that agricultural–industrial labor productivity gap was lower in the western region of China, compared to the eastern and central regions of China, reflecting a greater misallocation of family labor and capital in the western region of China.

CONCEPTUAL FRAMEWORK

Figure 3 and figure 4 show households' labor allocation and productivity between farm work and non-farm work. The vertical axis on the left depicts the farm sector, and shows an increasing farm labor supply from left to right on the horizontal axis. Note that the maximum amount of farm labor supply is Q^a_{max}. MR_a represents household's farm labor productivity, with the hypothesis that farm labor productivity declines with additional amount of labor.[7] Likewise, the vertical axis (figure 3) on the right depicts the non-farm sector, and shows an increasing non-farm labor supply from right to left on the horizontal axis. In this case the maximum of non-farm labor supply is Q^o_{max}. MR_o represents household's non-farm labor productivity, with the hypothesis that non-farm labor productivity declines with additional amount of labor.[8] However, there is a reservation (minimum) wage for both farm and non-farm work, which means that family labor productivity is always above zero. The minimum wage for farm work is the surviving wage. The minimum wage for non-farm formal work in China, is usually set by the government. However, informal work in rural areas usually has a lower minimum wage than formal work. We also hypothesize that technology and substitution of capital for labor are fixed in the short-run.

We first discuss the impact of land renting in on household's farm labor allocation and productivity (figure 3). Consider that the initial family farm labor input is L_1^* with corresponding family labor productivity of MR^1_a. When a farm household rents in additional land, it needs more farm labor and labor supply increases to L_2^*. At the same time, family farm labor productivity declines to MR^2_a. However, if land productivity improves after

[7] The decreasing of farm labor productivity may be caused by two reasons, first is the declining marginal productivity effect, another reason is that household laborers with relative lower farm labor productivity also involve in farm work, thus lowing the overall farm labor productivity.

[8] With the increment of non-farm labor supply, a household's laborers with relative lower non-farm labor productivity also enter into non-farm sector, thus lowering the overall non-farm family labor productivity.

household's land renting in decision (Deininger and Jin, 2005; Feng et al., 2010), the marginal productivity curve will move upward, and family farm labor productivity increases to MR^3_a. Of course, when the households renting in large scale farmland and because of the existence of the inverse relationship between farm size and land productivity in Chinese agriculture (Li et al., 2013), land productivity would decrease and the marginal productivity curve would shift downward, thereby, reducing family farm labor productivity to MR^4_a.

Similarly, when a household rents out farmland, some of the family labor retreats from farming and farm labor input decreases to L_3^* (figure 3). At the same time, family farm labor productivity increases to MR^5_a. However, Zhang et al. (2016) found that in China land productivity would decline after households rent out land, mainly because farmers reduced investment in production. Under this condition, the marginal productivity curve would shift downward, and family farm labor productivity would shift to MR^6_a.

Turning to the non-farm sector, Figure 4 shows a household's non-farm labor allocation and productivity. The initial family non-farm labor input is L_1^*, with corresponding average family labor productivity as MR^1_o. When a household rents out part of or all the farmland, it requires less farm labor in production. The labor force released from agriculture may be idle or seek non-farm work. If the labor is idle, family non-farm labor productivity remains at MR^1_o. If the additional labor seeks employment in the non-farm sector, it may lower the overall family non-farm labor productivity to MR^2_o, because the labor has relative lower non-farm labor productivity.[9] Non-farm family labor productivity may increase to MR^3_o because some laborers move from part-time jobs to specialized non-farm jobs after renting out

[9] Recall that family labor employed in non-farm sector usually has higher non-farm labor productivity than those employed in farm sector in the initial stage (absence of land and labor markets).

farmland, and increasing labor efficiency.[10]

If households' renting in decision impacts their non-farm labor allocation decision, renting in farmland would have an effect on family non-farm labor productivity. In empirical work, using Chinese rural household sample, Feng and Heerink (2008) found a negative relationship between rural households' land renting in decision and migration decision. Indeed, for those labor-rich households who have surplus farm labor, renting in land may fail to distort households' non-farm labor allocation because the surplus labor in farming system is enough to cultivate the additional rented in farmland. If the rented in farmland requires part of the non-farm labor to do the farm work, non-farm family labor supply decreases to L_3^*, and non-farm family labor productivity increases to MR^4_o. However, if the non-farm labor has lower farm labor productivity or the specialized labor has to take part-time job, it decreases the overall non-farm family labor productivity to MR^5_o, with the downward shift in the marginal productivity curve of the non-farm family.

Therefore, based on the above analysis we form the following hypothesis. First, family farm labor productivity may improve after renting in farmland because of the improvement of land productivity. However, the increment of farm labor after renting in farmland may lower family farm labor productivity. Similarly, family farm labor productivity may decrease after renting out land because of the decline of land productivity. However, the reduction of farm labor after renting out farmland may improve family farm labor productivity.

Second, non-farm family labor productivity may improve after renting out farmland because of the specialized labor force. However, the increment of family labor with lower

[10] Remember that labor force with part-time job (maybe for labor migration) may return home during the busy farming season (Huang and Ding, 2016).

non-farm labor productivity may lower overall non-farm family labor productivity. Similarly, non-farm family labor productivity may decrease after renting in farmland because of the loss of labor efficiency. However, renting in land may have no effect on non-farm family labor productivity when it does not distort family non-farm labor allocation. In the empirical framework describes the estimation method used to analyze the above hypotheses.

DATA AND DESCRIPTION

Data used in this study comes from rural household survey that was conducted by the China Family Panel Studies (CFPS). The CFPS is a four-wave survey (2010, 2012, 2014, and 2016) collected by the Institute of Social Science Survey (ISSS) at the Peking University. The survey provides a high-quality data for academic research and public policy analysis by collecting information on social, economic, cultural and educational changes for individuals, households, and communities. The CFPS adopts a multistage probability proportional to size sampling (PPS) approach and mainly operates face-to-face interviews aided by computer-assisted personal interviewing (CAPI) technology (Xie and Hu, 2014). We used only the 2012 CFPS (CFPS2012) survey because the survey collected detailed information on households' labor supply in farm and non-farm work. Additionally, since only rural households can be allocated farmland from village collectives in China, we only use data from the rural Chinese households. We use data from 8,130 rural Chinese households from 520 villages, covering 25 provinces, municipalities and autonomous regions. Among the total rural households, 1,110 rented-in farmland, 991 rented-out land, and 44 rented-in and rented-out farmland, accounting for about 14%, 12% and 0.5%, respectively. Lastly, due to the small sample-size the latter category of rural households was deleted from our dataset, making our

final sample size to 8,086.

The advantage of using CFPS2012 is that it has detailed information on the composition of household and individual-level income sources. In addition, the survey also collected individual's time allocated to farm (crop planting and livestock farming) and non-farm (local wage work, migration and self-employment) activities monthly. In the survey, each family member was asked how many types of work (farm work, local wage work, migration and self-employment) did they engage in and the exact working time (monthly basis) and net returns from that work. Net farm income was answered by household member who was in charge of the financial condition. Through the aggregation of individual levels, we can get total family labor input in the farm and non-farm sector, as well as net income from non-farm activities (local wage work, migration and self-employment). Like Djido and Shiferaw (2018), family labor productivity across sectors (farm and non-farm) is measured by the ratio of net income to total family labor input (months worked/family worker). For example, farm labor productivity is measured by the ratio of net agricultural income (value of farm production minus costs) to the total family labor input in the farm sector. Similarly, non-farm labor productivity is measured by the ratio of net incomes from wages and profits (operating a small business) to the total family labor input in the non-farm sector. Labor productivity is calculated as follows:

$$LP_{si} = \frac{NR_{si}}{LI_{si}} \tag{1}$$

where *k* denotes activity sectors of farm (crop planting and livestock farming) and non-farm (local wage work, migration and self-employment) activities. *i* index households. LP_{si} denotes household's labor productivity from sector *k*. NR_{si} is net return from farm or non-

farm activities. LI_{si} is total family labor input expressed in terms of months worked per family worker.

Table 1 reports income sources and composition for rural Chinese households engaged in LRMs (those renting in and renting out) and those not engaging in LRM. It is obvious that households participating in LRMs have considerable higher total household income, compared to rural households that did not participate in LRMs. For the three types of rural households, non-farm income comprised more than 60% of the total income, and rural households renting out farmland had the highest share of non-farm income (81%) in total household income. For farm households renting in farmland, farm income accounted for about 32% of the total household income, nearly double, compared to rural households that did not participate in LRMs (16%). Finally, Table 1 reveals that crop income was the main source of farm income, and wage income was an important source of non-farm income, compared to income from wages of unskilled employee and self-employment income. Table 2 reports family labor allocation and labor productivity in farm and non-farm sectors for households engaged in LRM (those renting in and renting out farmland) and rural households that did participate in LRMs. Households renting in farmland, on average, had significantly more family workers and time spent on farm work, compared to rural households that did not participate in LRMs. Finally, households renting out land had less farm workers and time spent working on the farm, they had significantly more non-farm workers and non-farm working time, compared to rural households that did not participate in LRMs.

Table 2 also shows that rural households renting in farmland, on average, had significantly higher farm labor productivity (1,794 Yuan/family worker) compared to rural

households that did not participate in LRMs (1,049 Yuan/family worker). It is worth noting that there was still a huge labor productivity gap between the farm sector and non-farm sector for rural Chinese households[11], however, the gap was the smallest for the rural households that rented in farmland. Table 3 shows the socio-economic characteristics of rural Chinese households. Some key differences related to age, education, and assets are highlighted for households renting in, renting out and rural households that did not participate in LRMs. Table reveals that land renting in activities were more likely to happen in rural households with younger, more educated heads, and large family size with less dependency ratio (share of members with >65 years and below 15), while land renting out activities were more likely to occur in households with older, more educated heads, small family size, and larger dependency ratio. Renting in households had more agricultural fixed asset and less non-agricultural fixed assets.

On the other hand, rural households renting out farmland had less agricultural fixed asset and more non-agricultural fixed assets. Finally, rural households living near business centers and in villages with active labor and mechanization services market are more likely to engage in renting-in activities. Along with attributes of the head of household and household characteristics, we also controlled for regional differences. Figure 2 depicts the distribution of land rental activities across western, central and eastern regions of rural China. Figure reveals that central region of China has the most active LRM, with significant high participation rate in both land renting in and renting out. The western region has higher share of land renting in,

[11] Recall that labor productivity gap between farm sector and non-farm sector may be sensitive to the measurement definition. Several empirical studies related in Africa have found that the agricultural and non-agricultural labor productivity gap may have reduced if it was calculated on the day or hour basis instead of per worker basis (McCullough, 2017; Djido and Shiferaw, 2018). However, due data unavailability we can only use month to calculate labor productivity.

reflecting region's dependence on production agriculture. Finally, consistent with economic theory and theory of labor markets (Cai, Wang, and Du, 2002; Huang, Gao and Rozelle, 2012), the eastern region of China, which has the fastest growing industrial and service sectors, the share of renting out farmland is about 15% and the share of renting in farmland is about 12%.

EMPIRICAL MODEL AND IDENTIFICATION STRATEGY

Estimating the effect of participation in the LRM on an outcome variable (labor productivity and work time in this study) poses significant challenges if the study fails to address the selection biases that originates from observed and unobserved heterogeneity (Khanal and Mishra, 2014; Khonje et al., 2018). Recent literature has adopted propensity score matching (PSM) to solve the observable selection bias (Liu and Lynch, 2011). However, PSM fails to correct selection bias from unobserved factors (Kassie et al, 2015). Unlike PSM, the multinomial endogenous switching treatment regression (MESTR) can be used to correct for the observable and unobservable biases, by using a selection correction method. This method includes an inverse Mills ratio (IMR) using the theory of truncated normal distribution and latent factor structure (Khonje et al., 2018). The advantages of MESTR method has been highlighted in several articles (Di Falco and Veronesi, 2013; Kassie et al, 2015; Khonje et al, 2018).

In our case, rural Chinese households self-selected themselves into participating in the LRM. For example, rural Chinese households may choose to participant in LRM based on a series of observable and unobservable factors, including family assets, agricultural production ability, and land quality (Feng and Heerink, 2008; Deininger and Jin, 2005). The above

factors may affect participation in the LRM and labor productivity simultaneously. Thus, if unaccounted for, self-selection could lead to biased and inconsistent estimates. To control potential selection bias and disentangle the pure effect of LRM participation on labor productivity, the MESTR model was adopted (Bourguignon et al., 2007; Di Falco and Veronesi, 2013; Kassie et al, 2015). Under the MESTR framework, household's land rental choice (no participation, renting in and renting out) is firstly modeled using a multinomial logit choice model. Thereafter, the effect of participation in LRM and its effect on labor productivity is estimated using an ordinary least squares (OLS) with selectivity correction terms.

Assuming that rural Chinese households maximize utility, households' choice whether to participate in LRM depends on the comparison of benefits and costs, so their decisions to participate in LRM can be expressed as a choice model:

$$U(R_{ji}^{*}) = \alpha_j X_{ji} + \varepsilon_{ji} \qquad (2)$$

where $U(R_{ji}^{*})$ is household utility for land rental choice *j*, including no participation, renting in and renting out farmland. X_{ji} is a vector of observable exogenous factors (such as household head's characteristics, family land and labor endowment, assets and regional variables). The utility from participation in the LRM is unobservable, but households can make choices by ranking the utility. Households' choices are based on:

$$U(R_{ji}^{*}) > \max_{m \neq j} U(R_{mi}^{*}) \quad or \quad \theta_{ji} < 0 \qquad j=1,2,3 \qquad (3)$$

where *j*=1, *j*=2 and *j*=3 represent no participation, renting in and renting out farmland, respectively. $\theta_{ji} = \max_{m \neq j}(U(R_{mi}^{*}) - U(R_{ji}^{*})) < 0$ (Bourguignon et al., 2007). Equation (3) implies that household will choose land rental regime, *j*, when anticipating that the utility from the

choice, *j*, is greater than that from the choice, *m*. Thus, the probability of household *i* choosing land rental regime, *j*, can be specified by a multinomial logit model (McFadden, 1973).

$$P_{ji} = pr\left(\theta_{ji} < 0 | X_{ji}\right) = \frac{\exp\left(\alpha_j X_{ji}\right)}{\sum_{m\neq 1}^{j} \exp\left(\alpha_m X_{ji}\right)} \quad (4)$$

Based on the multinomial logit model, the endogenous switching treatment is established in order to investigate the treatment of LRM participation on family labor productivity, both farm and non-farm sectors. Family labor productivity model for land rental regime, *j*, (non-participation, renting in and renting out farmland) is shown: $Y_{ji} = \beta_j S_{ji} + u_{ji}$ j=1, 2, 3 (5)

where Y_{ji} is labor productivity measured in net income per family worker months in the farm and non-farm sectors, for household *i* in LRM regime, *j*. S_{ji} is a vector of variables affecting family labor productivity, including head of household's characteristics, family assets, hired labor and mechanization services and regional variables (see table 3). u_{ji} is the error term. If u_{ji} and ε_{ji} are not independent, a consistent estimation of β_j requires the inclusion of the selection correction terms of the alternative choices in equation (5). The augmented endogenous switching treatment model can be represented as:

$$Y_{ji} = \beta_j S_{ji} + \sigma_j \lambda_{ji} + \grave{o}_{ji} \quad j=1, 2, 3 \quad (6)$$

where $\grave{o}_{ji}$ is the error term, σ_j is the covariance between u_{ji} and $\grave{o}_{ji}$, λ_{ji} is the inverse Mills ratio (IMR) computed from the estimated probabilities in equation (4) and can be shown as: $\lambda_{ji} = \sum_{m\neq j}^{j} \rho_j \left[\frac{\hat{P}_{mi} \ln(\hat{P}_{mi})}{1-\hat{P}_{mi}} + \ln(\hat{P}_{ji}) \right]$; ρ_j is the correlation coefficient between u_{ji}

and $\grave{o}_{ji}$. In the multinomial choice setting, there are two selection correction terms that are included in the labor productivity model. To get consistent estimation, it requires that X_{ji} include at least one instrumental variable that affects household's LRM participation but is excluded from S_{ji} that does not directly affect household's labor productivity. Following Zhang et al. (2018), we use the share of households in the village participating in LRM[12] as an instrumental variable. Results from the simple falsification test (Kassie et al, 2015) confirms that, in nearly all cases, the instrumental variable is significant in LRM choices equation (table 4) but not in the family labor productivity equation (see Appendix table A1-A2), which proves the validity of the instrumental variables.

To estimate the pure effects of LRM participation on family labor productivity and work time, we should know the actual participation effects and the counterfactual effects. Following Kassie et al (2015), the MESTR model can be used to compute the counterfactual and actual effects of participation in LRM for rural Chinese households. From equation (6), the following conditional expectations for each outcome variable (family labor productivity and work time) can be computed with four equations listed below.

Participants' actual outcome:

$$E\left[Y_{ji} \mid R=j, S_{ji}, \lambda_{ji}\right]=\beta_j S_{ji}+\sigma_{j\varepsilon}\lambda_{ji}. \quad (7)$$

Non-participants' actual outcome:

$$E\left[Y_{1i} \mid R=1, S_{1i}, \lambda_{1i}\right]=\beta_j S_{ji}+\sigma_{j\varepsilon}\lambda_{ji}. \quad (8)$$

Participants' counterfactual outcome:

[12] Because CFPS2012 did not have village level questionnaire, the share of households in the village participating in land rental markets is generated by the ratio of households participating in land rental markets (exclude the investigated household) to total investigated households in the village.

$$E\left[Y_{1i} \mid R=j, S_{ji}, \lambda_{ji}\right]=\beta_1 S_{ji}+\sigma_{1\varepsilon}\lambda_{ji}. \quad (9)$$

Non-participants' counterfactual outcome:

$$E\left[Y_{ji} \mid R=1, S_{1i}, \lambda_{1i}\right]=\beta_j S_{1i}+\sigma_{j\varepsilon}\lambda_{1i}. \quad (10)$$

Equation (7) and (8) represent the actual family labor productivity for rental and non-participating households, while Equation (9) and (10) represent the counterfactual household labor productivity (similarly we assess the effect on work time as well). Therefore, the average treatment effects of LRM participation can be derived by subtracting equation (7) from equation (9):

$$ATT=E\left[Y_{ji} \mid R=j, S_{ji}, \lambda_{ji}\right]-E\left[Y_{1i} \mid R=j, S_{ji}, \lambda_{ji}\right]$$

$$=\beta_j S_{ji}+\sigma_{j\varepsilon}\lambda_{ji}-\beta_1 S_{ji}-\sigma_{1\varepsilon}\lambda_{ji}$$

$$=S_{ji}(\beta_j-\beta_1)+\lambda_{ji}(\sigma_{j\varepsilon}-\sigma_{1\varepsilon}) \quad (11)$$

RESULTS AND DISCUSSION

Decision to Participate in Land Rental Market

We first describe the results of the rural household's decision to participate in LRM. Table 4 reports the parameter estimates of the multinomial logit model. Results show that female head of household (HH) has a significantly positive effect on renting out farmland, indicating that female HHs are about 3% (see column 5, table 4) more likely to rent out farmland, compared to male HH. Our finding is consistent with Jin and Jayne (2013) and Chamberlin and Ricker-Gilbert (2016) for African farmers. The coefficient on age of HH is significantly negative and positive for renting in and renting out farmland, respectively. Results suggest that an additional year decreases renting in farmland by about 4.5% and increases renting out farmland by about 5.1%, respectively. A plausible reason could be that age had a negative

effect on the physical strengthen to cultivate land; aging farmers look forward to retiring and renting out the farmland (Zou, Mishra, Luo, 2018). Table 4 shows that an additional year of schooling of HH increases more likelihood of renting out farmland by about 2.7%, maybe because educated HH have higher opportunity cost for farm work and possess ability to work in the non-farm sector.

The coefficient on family size is negative and significant in the case of renting out farmland. Large family with more members are likely to work on the farm and hence less likely (1.7%) to rent out farmland (Column 4, table 4). In contrast, the coefficient on dependency ratio is significantly negative and positive for renting in renting out model, respectively. The marginal effects show that increased dependency ratio by 10%, decreases the likelihood of renting in farmland by about 4.0% and increases renting out farmland by 4.4% (Column 3 and Column 5, table 4). The coefficient on farmland area per adult is positive and significant in the farmland renting out (column 2, table 4) model. Result indicate that LRM transfers land from higher land-labor ratio (land rich but labor shortage) households to lower land-labor ratio (land poor but labor rich households). Our finding is consistent with Deininger and Jin (2005) and Jin and Deininger (2009). Results in table 4 show that agricultural fixed assets have positive and negative effect on farmland renting in and renting out decision, respectively. In contrast, non-agricultural fixed assets have a significantly negative and positive effect on farmland renting in and renting in decision of rural Chinese households. These findings demonstrate the endowment-dependent effects on the household's behavior from the perspective of land rental decisions.

The coefficient on hired labor market is significantly positive and negative for renting in

and renting out decision. The marginal effects of 0.12 for renting in decision and -0.19 for renting out decision indicates that a 10% increase in the share of hired labor in the village increases the likelihood of renting in about 12%; decreases the likelihood of renting out by about 19% (column 3 and column 5, table 4). Access to hired labor in the village enables farming households to expand farm size by renting in farmland; farming households with labor shortage could still farm the land by hiring labor to do farm work, thereby may reducing the likelihood renting out farmland. Other regional and market conditions also affect the likelihood of participation in LRMs. The negative coefficient on distance to the business center for renting out equation indicates that greater distance from the village business center decrease the probability of renting out farmland. Perhaps, findings indicated the demand for farmland rental. Finally, farms located in the central and eastern regions of China are more likely to rent out farmland. In addition, farms located in the eastern region are less likely to rent in farmland.

Treatment Effect on Labor Productivity and Work Time

Recall that our primary objective is to assess the impact of participation in LRM on family labor productivity and work time, both in farm and non-farm sectors. For brevity and space in the journal we do not discuss the factors affecting rural Chinese households' labor productivity, however, estimation results are provided in Appendix table A1 and A2 as supplementary materials. Moving on Table 5 shows the effect of LRM on family labor productivity in the farm sector. Recall that actual outcome and counterfactual outcome are calculated based on equations (7) and (9) separately. The actual outcome is the expected labor productivity in the farm sector when the rural Chinese household is participating in the

LRM. On the other hand, the counterfactual case estimates the effects if the rural households that did not participate in LRM, but had participated. Then we compare columns (2) and (3) of table 5 to calculate the average treatment effects (ATTs) for participation in LRM (columns 4 and in percentage in column 5, table 5). Table 5 reveals that rural Chinese households renting in farmland have significantly improved family labor productivity in the farm sector by about 55%, after controlling for the selection bias stemming both from unobserved and observed factors. On the other hand, rural Chinese households renting out farmland lower farm labor productivity (13%) than rural households not participating in the LRM. This finding indicated that rural Chinese households with surplus farming labor can significantly improve family labor productivity through renting in farmland. Lastly, households renting out farmland reduced land input in production or exiting farming, thus reducing family labor productivity in the farm sector.

Table 6 shows the effects of participation in LRM on family labor productivity in the non-farm sector. Results show that the decision to rent in farmland by rural Chinese households decreased family labor productivity in the non-farm sector by about 6%. A plausible explanation could be that some family members, mainly engaged in non-farm employment, may also have to work on the farm, perhaps after hours and thereby, decreasing non-farm productivity. This finding is consistent with Feng and Heerink (2008) who found a trade-off between renting in farmland and family labor migration decisions. However, considering the gains of labor productivity in the farm sector (627 Yuan/family worker, column 4, table 5), overall, rural Chinese households benefit from renting in farmland. It is interesting to note that the decision to rent out decreased family labor productivity in the non-

farm sector by 9% (column 5, table 6). The reason may be that renting out farmland, some family members with relative low marginal return on non-farm labor[13], may choose to work in the non-farm sector, leading to a lower family labor productivity in the non-farm sector. Readers should note that a slightly reduction in the family labor productivity in non-farm sector does not mean the efficiency loss of land renting out decision for households, because more family members may be working in the non-farm sector after renting out land. To demonstrate this, in the following sections we present the estimates of participation in the LRM on the work time per family labor input in the farm sector and non-farm sectors in the following section.

Table 7 shows[14] that, on the one hand, rural Chinese households who rented in farmland increased working time per family worker in the farm sector by 11% (column 5, table 7). On the other hand, rural Chinese households who rented out farmland significantly reduced working time per family worker in the farm sector by 7%. Finally, Table 8 shows the ATTs of LRM participation on work time per family worker in the non-farm sector.[15] Results show that, on the one hand, rural Chinese households who rented in farmland decreased working time per family worker in the non-farm sector by 7%. On the other hand, rural Chinese households who rented out farmland increased working time per family worker in the non-farm sector by 5%. Therefore, our finding underscores that although family labor productivity in the farm sector has decreased after renting out farmland, they may have more workers transferred to the non-farm sector with relatively higher work time and productivity.

[13] In the absence of land rental markets, some family members who choose to stay on farm sector may be based on their comparative advantage of labor marginal productivity with other members.
[14] LRM participation on work time per family labor input in the farm sector is presented in Appendix A3.
[15] Complete estimation results are shown in Appendix A4.

CONCLUSIONS AND POLICY IMPLICATIONS

Improving the productivity of rural labor is important in increasing household income and reducing poverty and income disparity between rural and urban residents in developing countries. This is especially important for China, the most populated country in the world. Since the inception of land rental market in rural China, farming households have been participating in land rentals, both renting in and renting out farmland. Participation in LRM could increase labor productivity. This study used a nationally representative household survey of 8,086 from rural Chinese households to examine the effects of LRM on family labor productivity in the farm and non-farm sectors. Additionally, study also investigated the impact of participation in LRM on work time of family workers in the farm and non-farm sectors. Using MESTR technique the study first modeled household's LRM choices. The study found that the gender and age of household head, family land and labor endowment, fixed productive assets, hired labor and access to mechanization services, and location of the farm significantly affects participation in the LRM. Findings indicate that LRMs transfer land from high land-labor ratio households to labor rich but land poor households, improving resources allocative efficiency.

The ATT effects of LRM showed an increase in family labor productivity in the farming sector by 55% when rural household rented in farmland, reducing the gap of the labor productivity between farm and non-farm sectors. Additionally, renting in farmland decreased family labor productivity in the non-farm sector by 6%. On the contrary, renting out farmland decreased both family labor productivity in farm and non-farm sectors, by about 13% and 9%, respectively. The reason may be that the relatively low-productive family workers

remained in production, while the high-productive family workers migrated to non-farm work, after renting out farmland. The study also found that households renting in land supplied more labor time in agricultural production and reduced non-farm work time. Findings suggest that renting in farmland not merely puts family surplus workers into agricultural production, but also use part of the non-farm family workers in production agriculture, thus a negative effect on family's non-farm labor supply and productivity.

The reduction of family labor productivity in the non-farm sector does not mean efficiency loss because more family workers were transferred to non-farm sector, after renting out land. The transferred family workers had lower labor productivity than original non-farm family workers, thus lowering the overall productivity of family works in the non-farm sector. In conclusion, LRMs enables family workers to move into sectors that best suits their educational attainment and experience. One can say that comparative advantage is a play in labor allocation decisions of rural Chinese family workers. This transition into non-farm sector means efficiency gains for both households renting in and renting out farmland. Findings from this study underscores the importance of LRMs in increasing the welfare of rural Chinese families and workers. Lesson from this study could provide evidence on the importance of land rental markets in increasing labor market efficiency, productivity and income.

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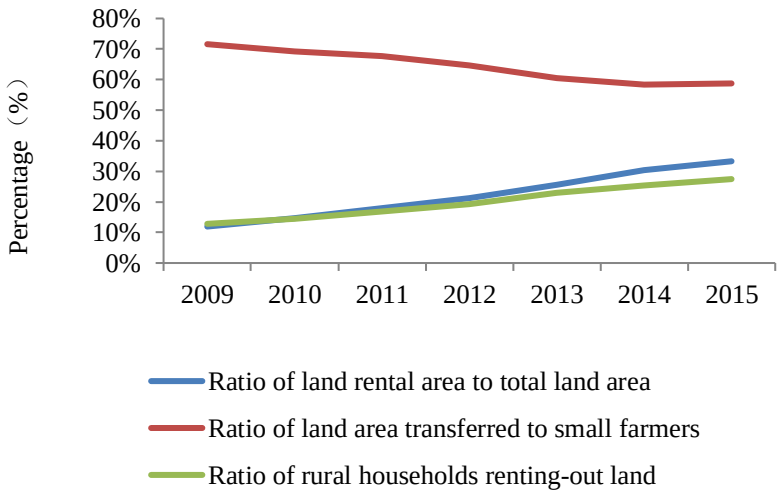

Figure 1. Land rental market development in rural China

Source: calculation from Committee of China Agriculture Yearbook, 2010-2016.

Note: Ratio of land rental area to total land= Total land rental area/ Total area of cultivated land contracted by rural households; Ratio of land area transferred to small farmers= Land area transferred to small farmers/ Total land rental area; Ratio of rural households renting-out land= Number of rural households renting-out their land/ Number of rural households who get land from village collectives

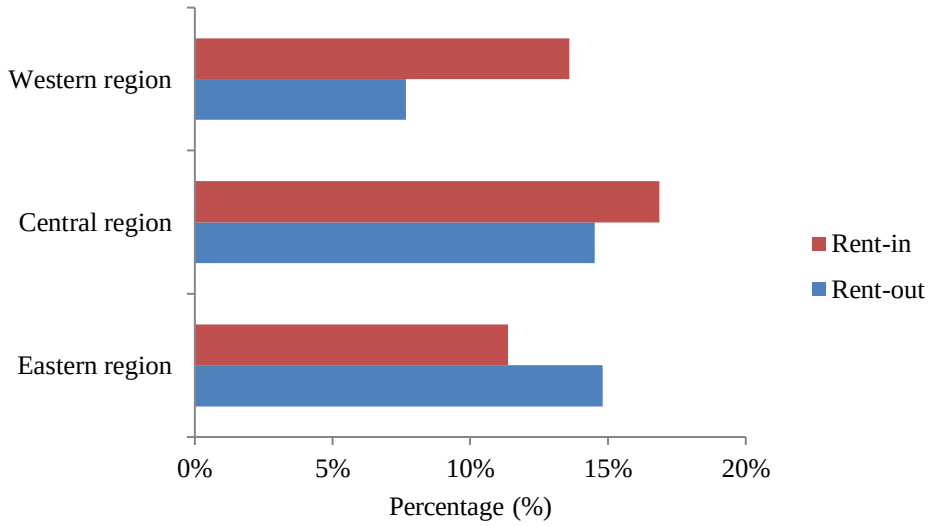

Figure 2. Land rental activity distribution in rural China

Source: Authors' computation based on, CFPS2012

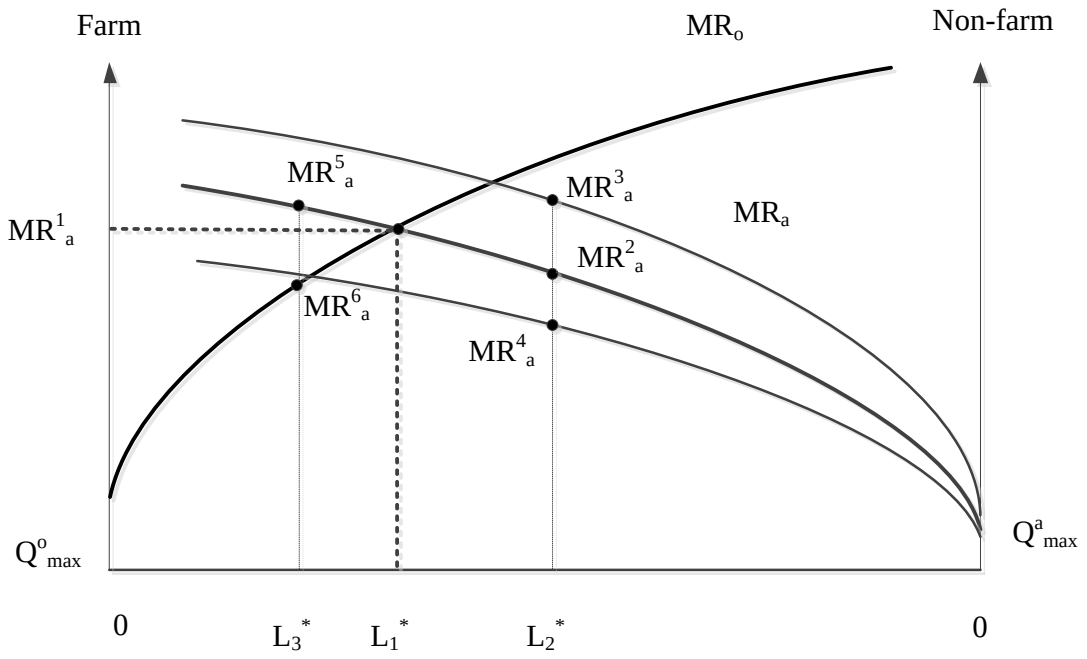

Figure 3. Family farm labor allocation and productivity

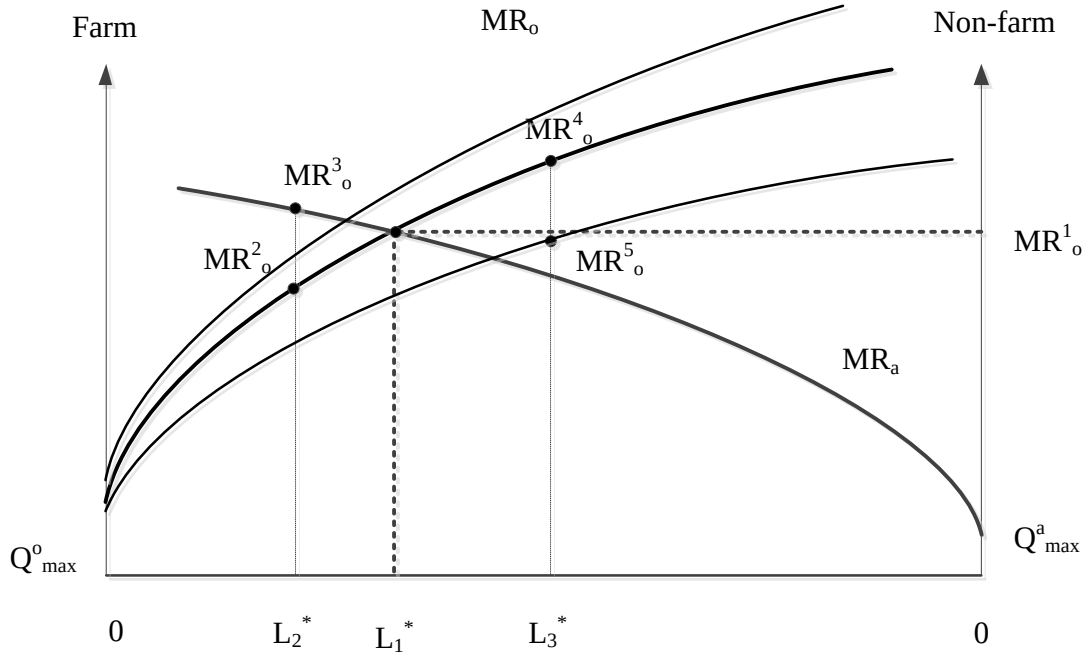

Figure 4. Family non-farm labor allocation and productivity

Table 1: Income sources and composition for households that rent-in, rent-out and non-participating (*Yuan*), CFPS2012

	Non-participating	Rent-in	Rent-out
Household total income[1]	37,006	42,637	42,782
Farm income[2]	6,069 (16.40%)	13,734 (32.21%)	2,355 (5.50%)
crop income	5,977 (16.15%)	12,537 (29.40%)	1,387 (3.24%)
livestock income	92 (0.25%)	1,197 (2.81%)	967 (2.26%)
Non-farm income[3]	28,135 (76.03%)	26,173 (61.39%)	34,535 (80.72%)
Unskilled employee income	1,528 (4.13%)	2,244 (5.26%)	1,391 (3.25%)
Wage employee income	24,307 (65.68%)	21,996 (51.59%)	27,473 (64.22%)
Self-employment income	2,303 (6.22%)	1,933 (4.53%)	5,671 (13.26%)
Number of observations	5,985	1,110	991

Source: Authors' computation based on CFPS2012.

[1] Household total income=farm income+ non-farm income+ property income + transfer income +other income. Property income, transfer income, and other income are not shown here. [2] Farm income=net crop income + net livestock income, net crop income equal to total crop income minus total cost of crop production, net livestock equal to total livestock income minus total cost of livestock production; [3] Non-farm income=Unskilled employee income + Self-employment income + Wage employee income; Values in parenthesis are percentage (%) of income in household total income.

1 Yuan≈0.159 US$ (December 31, 2011)

Table 2: Labor allocation and labor productivity in farm and non-farm sectors for households rent-in, rent-out and non-participating, CFPS2012

	Non-participating	Rent-in	Rent-out
Total number of workers in a family[1]	1.92	2.28***	1.54***
Number of family workers on farm work	1.44	1.94***	0.66***
Number of family workers on non-farm employment	1.12	1.25***	1.22***
orked per family worker	9.30	9.75***	9.86***
Months worked on farm sector per family worker	5.65	6.32***	5.23***
Months worked on non-farm sector per family worker	8.80	8.13***	9.73***
Labor productivity in farm sector (*Yuan/month*)[2]	1,049	1,794***	912
Labor productivity in non-farm sector (*Yuan/month*)[2]	3,443	3,300	3,096
Number of observations	5,985	1,110	991

Source: Authors' computation based on CFPS2012.

, *,* * * denotes a statistically significant difference at the 10%, 5% and 1% level of the paired t-test compared to the autarky reference group. [1] Worker means actual worked family members on farm work or non-farm employment in the 2011/2012 production year. [2] Labor productivity calculation is based on households who reported work in farm or non-farm sectors.

Table 3: Socio-economic characteristics of rural Chinese households, CFPS2012

	Non-participating	Rent-in	Rent-out
Female head (dummy, = 1 if household head is female)	0.42	0.40	0.50***
Age of household head	50	48***	53***
Education of household head (*years*)	6.9	7.2***	7.24**
Family size	4.3	4.4**	3.7***
Male adults (ratio of male adults to family size)	0.40	0.41	0.37***
Average schooling of family members, ages 18 and 60 (*years*)	10.5	10.9	10.2
Dependency ratio (ratio of number of members over 65 or below 15 to family size)	0.56	0.51***	0.70***
Farmland area per adult (*mu*)	7.28	7.47	5.81***
Agricultural fixed asset [1](1,000 *Yuan*)	1.16	3.08***	0.31***
Non-agricultural fixed asset[2] (1,000 *Yuan*)	12.07	7.45***	57.95***
Hired labor market[3] (share of households used hired labor in farm production in villages)	0.27	0.35 ***	0.28
Mechanization service market [3] (share of households used mechanization service in farm production in villages)	0.31	0.37**	0.33**
Distance to the business center (*hour*)	0.58	0.53***	0.46***
Western region[4] (dummy, = 1 if households living in western region of China)	0.27	0.35	0.34
Central region[5](dummy, = 1 if households living in central region of China)	0.36	0.30	0.44
Eastern region[6](dummy, = 1 if households living in eastern region of China)	0.42	0.40	0.50
Number of observations	5,985	1,110	991

, *,* * * denotes a statistically significant difference at the 10%, 5% and 1% level of the paired t-test compared to the autarky reference group.

[1] Includes agricultural machines, irrigation pumps, thresher and trucks; [2] Non-farm production plants, buildings, machinery and equipment, etc. [3] Because CFPS2012 did not have village level questionnaire, hired labor market and mechanization service market are generated by the share of the households in the village used hired labor and mechanization service (exclude the investigated household) to total investigated households in the village. [4] Includes Guangxi, Guizhou, Yunnan, Chongqing, Sichuan, Shanxi and Gansu Province. [5] Includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan Provinces. [6] Includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong and Guangdong provinces (municipalities).

Table 4: Parameter estimates of factors affecting participation of land rental market, CFPS2012

Variables	Rent-in		Rent-out	
	Coefficient	MEs	Coefficient	MEs
Female head	-0.075	-0.012	0.324***	0.028***
	(0.075)	(0.008)	(0.081)	(0.007)
Age of household head (log)	-0.368***	-0.045***	0.568***	0.051***
	(0.138)	(0.014)	(0.166)	(0.013)
Education of HH (log)	0.012	-0.002	0.336***	0.027***
	(0.087)	(0.009)	(0.097)	(0.008)
Family size (log)	-0.059	-0.004	-0.214**	-0.017**
	(0.096)	(0.010)	(0.102)	(0.008)
Male adults	0.075	0.008	-0.047	-0.005
	(0.189)	(0.020)	(0.192)	(0.016)
Education of members (log)	0.076	0.008	-0.022	-0.003
	(0.055)	(0.006)	(0.051)	(0.004)
Dependency ratio	-0.328**	-0.040***	0.493***	0.044***
	(0.141)	(0.015)	(0.120)	(0.010)
Farmland area per adult (log)	-0.176***	-0.019***	0.070	0.008
	(0.068)	(0.007)	(0.073)	(0.006)
Agricultural fixed asset (log)	0.106***	0.013***	-0.133***	-0.012***
	(0.010)	(0.001)	(0.014)	(0.001)
Non-agricultural fixed asset (log)	-0.025**	-0.003**	0.054***	0.005***
	(0.013)	(0.001)	(0.011)	(0.001)
Hired labor market	0.682***	0.075***	-0.273*	-0.030**
	(0.135)	(0.014)	(0.153)	(0.012)
Mechanization service market	-0.014	-0.002	0.010	0.001
	(0.114)	(0.012)	(0.126)	(0.010)
Distance to the business center (log)	-0.062	-0.004	-0.194***	-0.015***
	(0.056)	(0.006)	(0.064)	(0.005)
Central region	-0.054	-0.008	0.253**	0.022**
	(0.091)	(0.009)	(0.106)	(0.009)
Eastern region	-0.317***	-0.035***	0.189*	0.019**
	(0.092)	(0.009)	(0.100)	(0.009)
Instrument	2.909***	0.268	3.749***	0.277
	(0.170)	(0.017)	(0.168)	(0.014)
Constant	-1.339**		-6.105***	
	(0.645)		(0.770)	
Observation: 8,086				
Log likelihood = -5,331.19				
Prob > chi^2 =0.0000				

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are in parentheses. Non-participats are the base group. (*) dy/dx is for discrete change of dummy variable from 0 to 1.

Table 5: Average treatment effects (ATT), land renting on labor productivity, farm sector, CFPS 2012

Rental regime	Actual outcome (2)	Counterfactual outcome (3)	ATT (4)=(2)-(3)	% change (5)=(4)\(3)
Rent-in	1766	1139	627***	55***
	(28.2)	(13.3)	(25.5)	
Rent-out	912	1050	-138***	-13***
	(40.5)	(23.5)	(36.4)	

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are in parentheses.

Table 6: Average treatment effects (ATT, land renting on labor productivity, non-farm sector, CFPS 2012

Rental regime	Actual outcome (2)	counterfactual outcome (3)	ATT (4)=(2)-(3)	% change (5)=(4)\(3)
Rent-in	3,301	3496	-195***	-6***
	(31.9)	(37.6)	(42.5)	
Rent-out	3,096	3398	-301***	-9***
	(63.7)	(47.0)	(49.6)	

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are in parentheses.

Table 7: Average treatment effects (ATT), work time per family worker, farm sector (*month*), CFPS 2012

Rental regime	Actual outcome (2)	Counterfactual outcome (3)	ATT (4)=(2)-(3)	% change (5)=(4)\(3)
Rent-in	6.3 (0.04)	5.7 (0.03)	0.6*** (0.04)	11***
Rent-out	5.2 (0.06)	5.6 (0.05)	-0.4*** (0.08)	-7***

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are in parentheses.

Table 8: Average treatment effects (ATT), work time per family worker, non-farm sector (*month*), CFPS 2012

Rental regime	Actual outcome (2)	Counterfactual outcome (3)	ATT (4)=(2)-(3)	% change (5)=(4)\(3)
Rent-in	8.1 (0.05)	8.7 (0.04)	-0.6*** (0.03)	-7***
Rent-out	9.7 (0.05)	9.2 (0.06)	0.5*** (0.03)	5***

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are in parentheses.

Appendix A

Table A.1: Estimation of labor productivity in farm sector, CFPS2012

	Non-participating	Renting-in	Renting-out
Female head	-385.9**	-654.0*	288.8
	(161.0)	(365.8)	(428.1)
Age of household head (log)	-743.3	-139.2	-568.5
	(454.3)	(1,132.3)	(733.4)
Education of HH (log)	-213.9	-152.2	660.6
	(247.9)	(501.1)	(450.0)
Family size (log)	-204.0	-544.2	479.8
	(138.2)	(358.0)	(460.0)
Male adults	196.0	-2603.0***	-1,318
	(565.8)	(820.7)	(1,273)
Education of members (log)	166.0***	578.3	-355.5***
	(43.77)	(363.8)	(130.1)
Dependency ratio	-270.3	796.4	-224.2
	(201.8)	(1237.4)	(706.1)
Farmland area per adult (log)	382.4***	627.4	768.6
	(107.6)	(393.7)	(700.8)
Agricultural fixed asset (log)	122.5*	-168.9	-15.59
	(73.32)	(186.8)	(164.7)
Non-agricultural fixed asset (log)	31.33	121.1	23.91
	(40.59)	(131.0)	(59.51)
Hired labor market	355.0*	-767.0	-193.4
	(210.9)	(779.7)	(855.6)
Mechanization service market	-129.8	708.2	-381.4
	(124.1)	(810.2)	(443.3)
Distance to the business center (log)	-47.16	-299.3	-268.3
	(96.19)	(252.0)	(180.7)
Central region	179.3	458.9	27.70
	(139.1)	(512.9)	(299.6)
Eastern region	121.1	-275.0	830.2
	(174.3)	(481.5)	(613.6)
Constant	3,634 *	4,175	515.2
	(2,092)	(3,575)	(3,679)
	Anciliary		
σ^2	21,773,151	54,633,410	11,072,966
	(177,837,225)	(39,821,310)	(23,851,216)
λ_1		-0.151	0.487
		(0.275)	(0.530)
λ_2	0.424		-0.725
	(0.311)		(0.647)
λ_3	-0.429	0.328	
	(0.302)	(0.401)	

Instrument	F(1,4520) =0.22	F(1,1015) =1.42	F(1,364) = 0.19
Observations		5,988	

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are bootstrapped with 100 replications. Absolute values of z-statistics in parentheses.

Table A.2: Estimation of labor productivity in non-farm sector, CFPS2012

	Non-participating	Renting-in	Renting-out
Female head	-52.36	-517.7	-818.8
	(258.4)	(626.0)	(557.8)
Age of household head (log)	2,282.6***	917.1	368.0
	(705.2)	(1,379.5)	(1,086.7)
Education of HH (log)	36.94	283.9	139.4
	(266.1)	(565.3)	(556.3)
Family size (log)	1,764***	93.77	2,203***
	(375.6)	(710.4)	(820.4)
Male adults	-161.0	-192.3	3,751**
	(891.3)	(1,192)	(1,908)
Education of members (log)	46.15	519.2*	870.8***
	(325.4)	(314.3)	(325.1)
Dependency ratio	-1,174**	-382.7	-168.5
	(557.9)	(1,195)	(773.8)
Farmland area per adult (log)	235.5	-132.6	-588.8
	(276.8)	(427.6)	(476.1)
Agricultural fixed asset (log)	-130.7	111.1	303.9*
	(101.1)	(162.2)	(180.8)
Non-agricultural fixed asset (log)	-26.96	-104.5	-150.1**
	(42.66)	(90.63)	(73.73)
Hired labor market	35.30	1,091	3,509***
	(660.1)	(1,184)	(1,324)
Mechanization service market	-326.9	140.9	-1,317**
	(323.3)	(895.4)	(665.2)
Distance to the business center (log)	320.6	236.3	775.3
	(246.2)	(330.8)	(732.8)
Central region	122.0	797.9	532.0
	(306.0)	(663.2)	(847.9)
Eastern region	348.8	1,096	-444.5
	(346.8)	(810.9)	(999.9)
Constant	-7,523**	-2,879	-2,580
	(3,713)	(4,700)	(5,660)
	Anciliary		
σ^2	578,998,910***	53,716,962	119,057,968
	(19,395,878)	(36,366,137)	(82,837,557)
λ_1		0.387	-0.743***
		(0.343)	(0.117)
λ_2	-0.341		0.974***
	(0.368)		(0.165)
λ_3	0.199	-0.507	
	(0.313)	(0.484)	
Instrument	F(1,3964)= 1.16	F(1,784) = 0.50	F(1,647) =1.23

Observations	5,479

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors were bootstrapped with 100 replications. Absolute values of z-statistics in parentheses.

Table A.3: Estimation of working time per family worker in farm sector (*month*), CFPS2012

	Non-participating	Renting-in	Renting-out
Female head	-0.088	-0.769***	-0.846
	(0.145)	(0.261)	(0.589)
Age of household head (log)	1.093***	0.051	1.891
	(0.261)	(0.562)	(1.263)
Education of HH (log)	0.128	0.058	-0.595
	(0.159)	(0.278)	(0.485)
Family size (log)	-0.071	0.159	0.006
	(0.149)	(0.277)	(0.563)
Male adults	0.103	0.0409	1.223
	(0.299)	(0.585)	(1.191)
Education of members (log)	-0.220**	0.107	0.425
	(0.090)	(0.190)	(0.278)
Dependency ratio	0.432*	0.760	1.040
	(0.236)	(0.561)	(1.150)
Farmland area per adult (log)	0.370***	-0.594***	0.210
	(0.122)	(0.215)	(0.460)
Agricultural fixed asset (log)	-0.038	-0.083	0.053
	(0.037)	(0.101)	(0.328)
Non-agricultural fixed asset (log)	-0.052***	-0.048	-0.052
	(0.018)	(0.056)	(0.111)
Hired labor market	-1.704***	-1.358**	-0.376
	(0.286)	(0.597)	(1.231)
Mechanization service market	-0.180	-0.341	0.187
	(0.172)	(0.303)	(0.610)
Distance to the business center (log)	0.092	-0.184	-0.217
	(0.0877)	(0.149)	(0.306)
Central region	-1.731***	-2.387***	-1.290**
	(0.156)	(0.279)	(0.611)
Eastern region	-0.797***	-0.847**	-0.553
	(0.148)	(0.352)	(0.773)
Constant	2.049	9.429***	-2.440
	(1.303)	(2.000)	(7.046)
	Anciliary		
σ^2	19.43***	9.438***	18.42
	(5.674)	(2.955)	(52.34)
λ_1		-0.027	0.571
		(0.313)	(0.607)
λ_2	-0.904***		-0.692
	(0.166)		(0.829)
λ_3	0.641***	0.343	
	(0.177)	(0.517)	
Instrument	F(1,4512)= 2.15	F(1,1015)=0.07	F(1,364) =0.59

Observations	5,988

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are bootstrapped with 100 replications. Absolute values of z-statistics in parentheses.

Table A.4: Estimation of working time per family worker in non-farm sector (*month*), CFPS2012

	Non-participating	Renting-in	Renting-out
Female head	0.292	0.679	0.657
	(0.178)	(0.487)	(0.510)
Age of household head (log)	-1.054***	0.0495	0.352
	(0.385)	(1.218)	(1.004)
Education of HH (log)	0.101	0.473	0.694
	(0.205)	(0.503)	(0.453)
Family size (log)	0.246	0.470	-0.080
	(0.215)	(0.508)	(0.430)
Male adults	0.972**	3.159***	0.973
	(0.437)	(1.188)	(0.839)
Education of members (log)	0.591***	0.286	0.0437
	(0.162)	(0.417)	(0.309)
Dependency ratio	0.251	-0.730	-0.445
	(0.389)	(1.152)	(0.914)
Farmland area per adult (log)	-0.964***	-0.759*	-0.354
	(0.173)	(0.454)	(0.466)
Agricultural fixed asset (log)	0.052	0.016	0.104
	(0.067)	(0.180)	(0.250)
Non-agricultural fixed asset (log)	0.240***	0.239***	0.197**
	(0.027)	(0.087)	(0.077)
Hired labor market	-0.280	-0.127	-0.833
	(0.426)	(1.186)	(1.115)
Mechanization service market	-0.516**	-0.221	-1.074
	(0.255)	(0.591)	(0.705)
Distance to the business center (log)	-0.167	-0.015	-0.041
	(0.122)	(0.313)	(0.352)
Central region	1.032***	1.256**	0.769
	(0.271)	(0.578)	(0.553)
Eastern region	0.197	0.675	0.147
	(0.257)	(0.747)	(0.548)
Constant	10.56***	2.172	6.457
	(1.836)	(4.235)	(5.562)
	Anciliary		
σ^2	23.44***	34.20**	19.05
	(7.143)	(17.03)	(34.70)
λ_1		-0.556**	-0.068
		(0.263)	(0.498)
λ_2	0.370		0.096
	(0.363)		(0.685)
λ_3	-0.315	0.492	
	(0.336)	(0.465)	
Instrument	F(1,3964)= 0.02	F(1, 784) =0.25	F(1,647) =0.00

Observations	5,479

Note: Statistically significant at: *10, * *5 and * * *1 percent levels; Standard errors are in parentheses.