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How Does Land Rental Affect Agricultural Labor Productivity? An Empirical Study in Rural China

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Abstract: Due to the striking gap in agricultural labor productivity (ALP) between China and developed countries, improving agricultural labor productivity is critically important. This study investigates the effect of land rental on agricultural labor productivity from two levels including household agricultural labor productivity and aggregated village-level agricultural labor productivity by employing propensity matching methods and instrumental variables method. Mediation analysis is also applied to explore the influencing mechanism and underlying paths for household agricultural labor productivity improvement. The results analyses based on the nation-wide data sets in 2017 reveal that renting-in land has a significant positive impact on promoting household agricultural labor productivity and renting-out land has significant opposite effects. The mediation analysis indicates that renting-in land affects household ALP indirectly through the land-labor ratio, intermediate inputs, and agricultural assets investment. Moreover, from the village perspective, we further found that the development of the land rental market positively affects the improvement of aggregated agricultural labor productivity of the village. Land rental is an effective channel to stimulate land transferred from lower agricultural labor productivity to higher ones and then promote the resource allocation within the village.

Keywords: land rental; household agricultural labor productivity; village aggregated agricultural labor productivity; China



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1. Introduction

It is widely recognized that low productivity in agriculture is one of the most important causes of poverty in poor countries [1–3]. Increasing the productivity of farmland is therefore a central goal of agricultural development. Much attention is given in this respect to land policy and reform in many developing countries [4–6]. The difference in the allocation of production factors may explain why agricultural productivity differs greatly across countries [7]. Misallocation of resources in agriculture has been identified as a major cause of low productivity in poor regions [8]. Thus, improving the allocation efficiency of the labor, land, and other factors of production play important roles in the productivity improvement of the agricultural sector and thereby reducing rural poverty.

According to the data from the World Bank [9], land productivity measured by cereal yield in China raised from 4756 kg/ha to 6081 kg/ha between the years 2000 and 2018, which was close to that of high-income countries (6075 kg/ha). However, in terms of agricultural labor productivity (agriculture value added per worker), although it has increased considerably from CNY 1473.1 in 2000 to CNY 5257 in 2018 in China, it is still seriously behind that of developed countries (CNY 39,043.9). The striking agricultural labor productivity gaps constrain economic growth and have become the crucial weakness of agricultural competitiveness in China [10]. From the perspective of different production sectors, the values added per worker in non-agricultural sectors is far higher than in the

agricultural sector, which reveals that the labor is misallocated across different sectors, especially in developing countries including China [11]. Furthermore, given the special condition of abundant farm labor resources and less land endowment in rural China, agricultural labor productivity is naturally at a distinct disadvantage. Under China's special land system (the so-called household responsibility system (HRS)), the land was divided into many small pieces and the use right was assigned equally to each member of the collective organization in the early 1980s [12]. As a result, farmers must spend more resources to travel between different plots because of land fragmentation, which also induces a negative impact on the marginal agricultural labor productivity [13]. Thus, it is necessary for us to understand how to improve agricultural labor productivity under the special national conditions of rural China.

What are the main factors which may contribute to the growth of agricultural labor productivity? Schultz [14] noted that labor productivity gaps between regions can be partially explained by differences in human capital investment and agricultural modernization. At the macro level, technological improvement, accumulation of inputs and resource endowments are also regarded as the sources of growth of agricultural labor productivity [15,16]. Some scholars note that the land lease market also plays a crucial role in enhancing resource allocation [17,18]. The labor surplus model assumes that marginal agricultural labor productivity is zero in (almost) purely agricultural countries due to the huge scale of agricultural labor endowments which is called disguised unemployment [19,20]. Therefore, at the micro level, expanding farm size may be an effective pathway to fully make use of 'disguised unemployment' labor and thus improve agricultural labor productivity.

The abundant discussions of agricultural labor productivity at the macro level are supplied in previous literature, which mainly focus on determinants of agricultural labor productivity, the regional disparity, and convergence of agricultural labor productivity [21–24]. Limited attention has been paid to household-level agricultural labor productivity. Moreover, the existing literature also supplied many relevant studies about land use and agricultural productivity [25–29]. Jin and Deininger [30] found that land transfer is always an effective way to promote equality and productivity, especially in developing countries. If land can be effectively allocated, the resource misallocation would be reduced [31]. However, the productivity debates at the micro level mostly are focused on land or total factor productivity in existing literature. The empirical study on the association of land market participation and household agricultural labor productivity improvement remains limited. In addition, for existing research, the propensity score matching (PSM) method is commonly employed to eliminate the selection bias in estimating the impact of land rental on productivity [32,33]. The households with higher agricultural labor productivity would have a higher probability of renting-in land. The endogeneity problem caused by the simultaneity and omitted unobservable variables are typically ignored in the existing literature. Furthermore, the attention paid on the examine the underlying mechanism of land rental participation and household agricultural labor productivity is still limited. Therefore, this study aims to fill the aforementioned possible research gap in the literature. We employed both PSM and instrumental variable approaches to investigate whether the land rental affects the household agricultural labor productivity. In particular, we theoretically explored the underlying mechanism of how land rental affects household agricultural labor productivity by using mediation analysis. Furthermore, in previous research, little attention has been paid to land transfer market development and village agricultural labor productivity improvement. In this study, in order to detect whether the development of land rental markets can promote the agricultural labor productivity at the village-level, we explored a new perspective from the village and estimate the impact of land transfer on aggregated village agricultural labor productivity.

This study is organized into six parts. A brief introduction and previous research findings are outlined in the first part. In the second part, a mechanism framework is developed to analyze the potential impact channels of land transfer on household agricultural labor productivity (ALP). The propensity score matching (PSM) method, instrumental variable

regression method (IV) approach, and mediation analysis method used in this study are introduced in the third part. Then, we present a detailed description of the data set and descriptive statistics of the variables used in the empirical analysis in Section 4. Section 5 discusses the results of the PSM, IV approach and mediation analysis. Then we further analyze whether land transfer affects village aggregated agricultural labor productivity in Section 6. In the last section, we conclude and put forward policy suggestions.

2. The Mechanism Framework for Impact of Land Rental on Household Agricultural Labor Productivity

To further explore the potential mechanism of impact of land rental on household agricultural labor productivity (ALP), we decomposed agricultural labor productivity into two parts based on the formulation of it, which is expressed as follows:

$$\frac{Y}{L} = \frac{A}{L} * \frac{Y}{A} \text{ or } \log\left(\frac{Y}{L}\right) = \log\left(\frac{A}{L}\right) + \log\left(\frac{Y}{A}\right) \quad (1)$$

where Y is expressed as the index of agricultural production output. L and A denote household labor and land input, respectively. In Equation (1), agricultural labor productivity $\frac{Y}{L}$ is described by agricultural production output per labor force input [10,34,35]. It is decomposed into two parts, $\frac{A}{L}$ and $\frac{Y}{A}$. According to the formulation, we can see that the ALP is determined by the land-labor ratio and land productivity ($\frac{A}{L}$ and $\frac{Y}{A}$). The land-labor ratio presents the labor intensity of production that depends on the allocation of household land and agricultural labor input. Land productivity is measured by cereal yield per acre or gross revenue per acre. Based on the decomposition analysis of ALP above, we further explored how land rental affects household ALP and the potential impact mechanism.

The land operation scale naturally increases with renting-in land, which may induce the growth of household agricultural labor intensity [36]. As a result, the cultivated land-labor ratio ($\frac{A}{L}$) prospectively increase along with renting-in land and contribute to the improvement of household ALP. Land rental may affect household ALP through improving the cultivated land-labor ratio ($\frac{A}{L}$). Therefore, the land-labor ratio might be a potential mediating path in the improvement of household ALP. Moreover, since larger farms have better access to the credit market than small farms, the larger farms tend to invest more in agricultural fixed assets and intermediate inputs [37–40]. Investing in labor-saving machinery would effectively increase the adoption of agricultural mechanization, which is conducive to land productivity improvement and thus contributes to the growth of household ALP [41]. Meanwhile, based on existing research, intermediate inputs use is another crucial determinant of agricultural production [42]. The intensive use of modern intermediate inputs can substantially induce the agricultural production enhancement and then improve land productivity and labor productivity [25,34]. Therefore, household ALP is anticipated with renting-in land and the cultivated land-labor ratio, intermediate inputs and agricultural fixed assets investment may be the vital mediating variables in household ALP improvement.

Referring to the effect of renting-out on household ALP, in most cases, renting-out land results in the decrease in land operations scale, as well as labor and other inputs [43]. Shi [44] noted renting-out land can stimulate off-farm employment. The households tend to reduce the household labor input on agricultural production and allocate family labor on the non-agricultural sector after renting-out. In these cases, as land operation scale and agricultural labor input are adjusted simultaneously, the effect of renting-out land on household ALP is ambiguous. In some households, in which land endowment is more abundant than family labor resources and idle land is rented out, household ALP may not suffer a loss after renting-out land. Furthermore, with a decline of cultivated land, other inputs such as intermediate input and agricultural investment would decrease; household ALP may suffer a decrease after land rented out. Thus, the effect of renting-out on household ALP is not clear and needs to be further examined in the following empirical study.

3. The Estimation Strategy

Households with higher labor productivity usually have a higher probability of participating in the land rental market. The land rental decisions and household ALP is affected simultaneously. Thus, in order to control potential endogeneity bias, we employed the propensity score matching method (PSM) to control selection bias and instrumental variable regression method (IV) to control inverse causality. In addition, mediation analysis methods are used to further explore the influencing mechanism of the impact of renting-in land on household ALP.

3.1. Propensity Score Method (PSM)

Since a land use right transfer is a process of self-selection, the probability of observations entering our treatment group is nonrandom and endogenous in our model where selection bias occurs. In order to overcome this kind of selection bias, Rosenbaum and Rubin [45] proposed a counterfactual framework, known as the propensity score matching (PSM) method. It matches observable variables from treatment and control groups based on propensity scores. This method allows us to eliminate selection bias to some extent and evaluate the true average treatment effect (ATT) under some certain assumptions. In this study, PSM is introduced to estimate the true average treatment effect of land rental participation on household ALP.

We assume T_i is a binary treatment variable that indicates whether households receive treatment. In this study, T_i is equal to 1 if rural households involved in the farmland transfer and 0 if not). Y_i depends on T_i is an outcome variable, which denotes household ALP in this study. X is designated as a vector of pre-treatment variables. The effect of land transfer on household ALP can be noted as:

$$\begin{aligned} ATT &= E(Y_{1t}|T_i = 1) - E(Y_{0t}|T_i = 1) \\ &= E(Y_{1t}|T_i = 1) - \underbrace{E(Y_{0t}|T_i = 0)}_{ATE} \\ &\quad - \underbrace{E(Y_{0t}|T_i = 1) - E(Y_{0t}|T_i = 0)}_{Selection\ Bias} \end{aligned}$$

We divided full samples into treatment group and control group by whether households are involved in farmland transfer. Then, we generated as many control variables that can potentially affect farm households' participation in land rental market and agricultural labor productivity as we can to estimate the propensity score. The commonly used matching approach nearest neighbor matching (NNM) and kernel-based matching method (KBM) were used in the following study.

3.2. Instrumental Variable Regression Method (IV)

It is widely recognized that land is typically transferred from low efficient producers to households with relatively higher agricultural operation ability [35]. A family with higher agricultural labor productivity has higher motivation to expand land operation scale by renting-in land. By contrast, a family with lower agricultural productivity is more likely to rent-out land and allocate family labor to other production sectors. Econometrically, a reverse causal effect makes independent variables endogenous. Although PSM allows us to eliminate selection bias, it cannot completely remove the endogeneity caused by inverse causality and omitted unobservable variables. The aggregated community-level information is commonly used to solve the endogenous problem at the micro level [46–49]. In order to further deal with the potential endogeneity problems of land rental in our model, following Hou et al. [39] and Li et al. [50], we used the share of households in the village that take part in land rental participation as the instrumental variable. The village-level information is unlikely correlated with an individual household's ALP. This variable is also used to measure the transaction cost and development of land rental development. A better functioning land market can stimulate more land leases. Therefore, the share

of households in the village participating in land rental markets is directly related to the decision of household land rental [43]. In order to estimate the effect of land tenancy on household ALP, we specified the following models:

$$\text{Household ALP}_{ip} = a_1 + b_1 \text{land_rentin}_{ip} + c_1 Z_{ip} + d_1 D_p + \varepsilon_i \quad (2)$$

$$\text{Household ALP}_{ip} = a_2 + b_2 \text{land_rentout}_{ip} + c_2 Z_{ip} + d_2 D_p + \varepsilon_j \quad (3)$$

where *Household ALP_{ip}* represents the agricultural labor productivity of household *i* in province *p*. It is measured by the average agricultural output value added per family agricultural labor input [23,51]. *land_rentin_{ip}* and *land_rentout_{ip}* both are binary variables that indicate whether households rent-in or rent-out land in the province; *p.land_rentin_{ip}* = 1 if rural household renting-in land and otherwise *land_rentin_{ip}* = 0. *land_rentout_{ip}* = 1 if household rent land out and otherwise *land_rentout_{ip}* = 0. *a₁* and *a₂* are the constants. *Z_{ip}* is a vector of control variables including household head characteristics, household, and village-level characteristics. *D_p* are province dummies which aim to control district and institutional difference across different provinces. *ε_i* and *ε_j* denotes the error term which is assumed to be independently and identically distributed.

3.3. Mediation Analysis

Mediation analysis is commonly used to analyze the causal mechanism. The standard mediation model reflects a causal sequence from independent variables to dependent variables through mediators [52]. Based on the analysis of the mechanism framework, we further examined the potential channels behind the effect of renting-in land on household ALP including the land-labor ratio, intermediate materials input, and agricultural fixed assets investment. Following Baron and Kenny [52] and Heyes and Preacher [53], we conducted a simple mediation function with independent variables renting-in decision *X*, dependent variables household agricultural labor productivity *Y* and a sector of mediators *M* to test mediation effects. The general mediation equations are expressed as follows:

$$Y = a_1 + cX + \varepsilon_1 \quad (4)$$

$$M = a_2 + aX + \varepsilon_2 \quad (5)$$

$$Y = a_3 + c'X + bM + \varepsilon_3 \quad (6)$$

To test the mediation causal effect, we regressed Equations (4)–(6) and tested the significance of the coefficients. Specifically, the total effect of *X* on *Y* in this study is quantified as the sum of the direct effect of renting-in behavior on household ALP which does not work through a mediator and indirect effect through the impact chain of renting-in behavior→mediators (land-labor ratio, intermediate materials input and agricultural assets investment)→household ALP. In the mediation models above, *c* and *c'* denote total effect and direct effect, respectively, and indirect effect is defined as *ab* which is interpreted as the effect of *X* on *Y* through *M* [53,54]. Checking the significance of the coefficient of *X* and *M* in Equations (4)–(6) is the most important step in mediation analysis, which are employed to make inferences for the existence of mediating effects. If the coefficient of *X* in Equation (4) is significant, we continue to examine the significance of *a* and *b* in Equations (5) and (6). If *a* and *b* is both statistically different from zero, the mediation effects of renting-in land on household ALP are confirmed. If *a* or *b* is not different from zero we must further test *ab* = 0. Since the rental decisions of households can be endogenous in our estimation models, we followed Dippel et al. [55] and Frlich and Huber [56] and estimated the intermediate effect by employing the instrumental variable to identify the causal chains of land renting-in behavior on household ALP.

4. Data and Descriptive Evidence

4.1. Data and Samples

The data set used in this study is based on the cross-sectional data which are derived from the Chinese Family Database (CFD) conducted by Zhejiang University and China Household Finance Survey (CHFS) conducted by Southwestern University of Finance and Economics in 2017. To ensure the randomness and representation of samples, the data sets introduced the stratified three-stage sampling (selecting counties from 29 provinces, committees or rural villages from counties, household from urban committees or rural villages) and probability proportional to the size sampling method. This survey collected data sets from three different levels including individual, household, and village level. It is an overall investigation involving details on household demographic characteristics, income and consumption, agricultural input and production, assets and investment, employment, land market participation, etc. The data sets we employed in this study collected detailed information on plots, land rental market participation, and household income composition. In this study, we mainly focused on discussing the effect of land rental on household ALP. Therefore, we restricted our sample framework to rural households with land and working on the farm. After data cleaning, 9536 households were involved in our data framework. Out of the 9536 interviewed households, almost 1370 households rented in land, accounting for 14% in full sample and 1054 (nearly 11%) households rented out land. Since a few households rented in land and rented out land simultaneously, the sum of subsamples (rent-in, rent-out, and autarkic group) is not equal to the number of full samples. The detailed definitions and descriptions of key variables are shown in Table 1.

Table 1. Descriptive statistics of key variables Data source: China Household Finance Survey 2017.

Variable	Definition and Measurement	Full Sample		Rent-in		Autarkic		Rent-out	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household ALP (CNY 1000)	Average agricultural output value added per family agricultural labor input	5.10	7.08	8.65	10.06	4.67	6.39	3.73	6.45
Head Characteristics									
Age	Age of household head (year)	56.15	11.19	54.26	10.53	56.16	11.19	58.57	11.57
Sex	0 = Female, 1 = Male	0.91	0.29	0.93	0.26	0.91	0.29	0.88	0.33
Health condition	1 = very good, 2 = good, 3 = normal, 4 = bad, 5 = very bad	2.85	1.06	2.86	1.02	2.84	1.07	2.94	1.05
Education	Education level of head (year)	7.18	3.25	7.21	3.12	7.16	3.28	7.29	3.23
Household Characteristics									
Contracted farm size	Farmland contracted by households (mu)	7.36	8.59	10.28	12.39	6.94	7.87	6.50	6.39
Family size	The total number of family members	3.76	1.77	3.93	1.69	3.78	1.78	3.44	1.77
Dependency ratio	Ratio of non-working age members to working age members	0.59	0.70	0.50	0.60	0.59	0.70	0.71	0.78
Migration	The proportion of migration	0.27	0.40	0.24	0.38	0.27	0.40	0.28	0.40
Agricultural machine rental	The cost of renting-in agricultural machinery (CNY 1000)	0.67	1.60	1.03	1.98	0.64	1.58	0.45	0.95
Land Certification	Dummy variable of land certification (0 = No, 1 = Yes)	0.67	0.47	0.67	0.47	0.66	0.47	0.71	0.45
Village cadre	Dummy variable of village cadre in household (0 = No, 1 = Yes)	0.05	0.22	0.06	0.24	0.05	0.22	0.04	0.20
Village Characteristics									
Distance to county center	The distance to county center (km)	6.38	7.36	7.10	9.38	6.30	7.12	5.96	6.27
Free market	Dummy variable of free market in village (0 = No, 1 = Yes)	0.16	0.36	0.15	0.36	0.16	0.36	0.16	0.37
Mediation variables									
Land-labor ratio	The ratio of land operation scale to family agricultural labor input	4.15	5.03	5.89	6.75	3.92	4.70	3.53	4.20
Intermediate inputs	Including the cost of pesticide, fertilizer, seed, and herbicides (CNY 1000)	3.78	6.74	7.52	11.49	3.30	5.42	2.37	5.23
Agricultural investment	Summed value of agricultural machinery and animal power (CNY 1000)	3.25	12.03	7.25	23.04	2.76	9.23	1.53	5.13
Number of observations	9536	9536		1370 (14.4%)		7209		1054 (11.1%)	

4.2. The Descriptive Statistics Analysis

Table 1 shows the definitions and descriptive statistics of the key variables used in the empirical study. The dependent variable used in this study was household agricultural labor productivity which is defined as the average agricultural output value added per family agricultural labor input. The key independent variable is land participation

decision, which is measured by whether the households rented in or rented out the land (Yes = 1; No = 0).

In addition, we selected control variables from three levels: individual level, household, and village level. At the individual level, in general, the household head is the leading decisionmaker of land rental market participation, so their characteristics depicted by the heads' age, education level, health conditions, and sex ratio are commonly used as control variables in the research relevant to land rental behavior [57,58]. Column (1) in Table 1 shows that most household heads are middle-aged males and less educated (only 7.18 years of education on average). Over 90% of household heads consist of males and the average age of them is 56.15 years. Moreover, the average household heads' self-evaluation health condition is between good and normal.

At the household level, we further controlled contracted farm size, family size, dependency ratio, migration, agricultural machinery leasing cost, land certification, and household social capital. Since household labor and land endowment affect both land rental participation decision and agricultural labor productivity [59,60], they are controlled in the estimation model. The labor endowment is presented by family size. In Column (1) of Table 1, the average family size is 3.76. The land endowment is depicted as the household contracted farm size. Table 1 shows that each family owns 7.36 mu of farmland on average. The households with larger land endowment and lower dependency ratio have a higher probability to renting-in land [61]. The dependency ratio calculated by the ratio of non-working age (age < 15 or age > 65) family members to working-aged ($15 \leq \text{age} \leq 65$) family members was also controlled. Additionally, Restuccia et al. [7] noted the share of off-farm employment plays a crucial role in determining agricultural labor productivity. We thus further controlled the share of migrants to family size in estimations. On average, nearly 27% of family members are involved in migration. Since family farms in China prefer to rent-in mechanization service rather invest in machinery [62], the expenditure in renting-in mechanization service was also controlled. The cost of agricultural machinery rental is about CNY 670 per year. Another explanation variable at the household level in this analysis are proxy variables referring to plot tenure security and social capital. Plot tenure security is presented by proxy variable whether the household received land certification. The statistics results show that about 67% of investigated households completed land certification by 2017. We used whether there is a village cadre in the household to measure household social capital [43]. Only 5% of households have at least one family member working as the village cadre.

In addition, we also employed two village-level variables including average distance to the county center and whether there is free market within village to control the economic development difference between communities. Column (1) in Table 1 reports that the average distance from the village to the county center is about 6.38 km. The development of market in the village is relatively backward. Only 16% of villages have a free trading market.

With respect to the mediation variables, Column (1) in Table 1 suggests that the average operation scale (including land rented in) per family agricultural labor input is 4.15 mu in the full sample. On average, the expenditure on agricultural intermediate inputs including chemical fertilizer, pesticides, seeds, and herbicides is nearly CNY 3780 for a household in 2017. Moreover, the average agricultural fixed assets investment possessed by a household is about CNY 3250.

Furthermore, a simple subdivision by household land rental participation status (renting-in land, autarkic, and renting-out land) allows us to compare the difference in household characteristics and household ALP outcomes between different groups. Some interesting findings are worth noting here. It is obvious from Columns (2)–(4) in Table 1 that there are many visible distinctions between rent-in, rent-out, and autarkic groups. For the different land renting status, we noted that household ALP of the rent-in group is much higher than autarkic groups (CNY 8650 per labor vs. CNY 4670 per labor). Meanwhile, the household ALP of renting-out land is much lower than those who do not participate in

the land rental market (CNY 3730 per unit of labor vs. CNY 4670 per unit of labor). These interesting findings indicate that household ALP is probably tightly associated with land transfer behavior. Land tenancy may play an essential role in household ALP improvement. In the following part, we employed PSM and instrument variable method to make empirical analysis to assess the effect of land transfer on household agricultural labor productivity.

5. Empirical Results Analysis

This study provides both estimation results of PSM and instrument variable. We used PSM to eliminate the selection bias and instrument variable to control the inverse causal effect. The detailed empirical estimation results are analyzed in this part.

5.1. PSM Results and Discussions

5.1.1. Logit Model on Determinants of Participation in Land Rental Market

As mentioned before, land transfer decision is a process of self-selection. Therefore, we employed PSM to control selection bias in this section. In order to derive the propensity score to match land rental participation farmers with non-participation farmers, we estimated a logit model to predict the likelihood of renting-in or -out land of a household at the first. Table 2 reports the results of logit formulation in terms of two kinds of land rental status. To facilitate the interpretation of the impact of independent variables on land rental decisions, the relevant marginal effects are reported in Columns (2) and (4) in Table 2. The results present that the age of household head, sex, and education level exert an opposite effect on renting-in and renting-out decision. Along with the growth of age, the older heads face more obstacles to working on farming. Thus, the older household heads prefer renting-out land and they are less likely to rent-in land, which is consistent with Zhang et al. [63]. The male heads tend to rent-in land and rent less land out. It might be explained that male-headed households always hold more farming ability and labor endowments than female-headed households. As a result, male-headed households may have a lower probability to rent out the land. Better education of household heads increases the probability of renting-out land and decreases the likelihood of renting-in land. That may be because household heads with higher education are more likely to take part in off-farm employment and thus prefer to rent out the land. In addition, the effect of contracted farm size and household size on renting-in land is significant, which is consistent with Ward and Shively [61].

Table 2. Logit model result of factors affecting land rental decision.

Variables	Rent-in			Rent-out		
	Coefficient Standard Error		Marginal Effect	Coefficient Standard Error		Marginal Effect
	(1)	(2)		(3)	(4)	
Head's age	−0.012 *** (0.003)	−0.001 *** (0.002)	0.013 *** (0.004)	0.001 *** (0.004)	0.001 *** (0.004)	0.001 *** (0.004)
Head's gender	0.240 ** (0.120)	0.029 ** (0.012)	−0.369 *** (0.112)	−0.036 *** (0.012)	−0.036 *** (0.012)	−0.036 *** (0.012)
Head's health status	0.056 ** (0.028)	0.007 ** (0.003)	0.058 * (0.032)	0.006 * (0.032)	0.006 * (0.032)	0.006 * (0.032)
Head's education	−0.022 ** (0.010)	−0.003 ** (0.001)	0.050 *** (0.012)	0.005 *** (0.012)	0.005 *** (0.012)	0.005 *** (0.012)
Contracted farm size	0.030 *** (0.003)	0.004 *** (0.001)	−0.006 (0.005)	−0.001 (0.005)	−0.001 (0.005)	−0.001 (0.005)
Family size	0.037 ** (0.017)	0.004 ** (0.002)	−0.096 *** (0.024)	−0.009 *** (0.024)	−0.009 *** (0.024)	−0.009 *** (0.024)
Dependency ratio	−0.163 *** (0.049)	−0.019 *** (0.005)	0.200 *** (0.049)	0.019 *** (0.005)	0.019 *** (0.005)	0.019 *** (0.005)
Migration	−0.112 (0.115)	−0.013 (0.011)	0.132 (0.110)	0.013 (0.110)	0.013 (0.110)	0.013 (0.110)
Agricultural machine rental	0.021 * (0.011)	0.003 * (0.002)	−0.026 ** (0.012)	−0.003 ** (0.012)	−0.003 ** (0.012)	−0.003 ** (0.012)
Land Certification	0.046 (0.072)	0.005 (0.007)	0.212 ** (0.090)	0.020 ** (0.090)	0.020 ** (0.090)	0.020 ** (0.090)
Village cadre	0.172 (0.127)	0.021 (0.012)	−0.142 (0.157)	−0.014 (0.157)	−0.014 (0.157)	−0.014 (0.157)
The distance to county center	0.005 (0.007)	0.001 (0.001)	−0.007 (0.006)	−0.001 (0.006)	−0.001 (0.006)	−0.001 (0.006)
Free market	−0.000 (0.118)	−0.000 (0.000)	0.016 (0.137)	0.002 (0.137)	0.002 (0.137)	0.002 (0.137)
Constant	−1.759 *** (0.260)		−2.807 *** (0.288)		−2.807 *** (0.288)	
Number of observations	9536	9536	9536	9536	9536	9536

Notes: (i). * Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level. Standard errors in parentheses. (ii). The standard errors are clustered at the village level.

5.1.2. PSM Matching Quality

Efficient estimation in PSM should be based on both the balancing hypothesis and the common support assumption. Before reporting the PSM results of the impact of land transfer on household agricultural labor productivity, it is necessary to check the PSM matching quality. We reported a series of indicators of matching quality including the mean of the treated group and control group, bias reduction after matching and *t*-test about matching quality based on the nearest neighbor matching (NNM) method (Appendix A Table A1), and kernel-based matching (KBM) method (the matching quality results of kernel-based matching (KBM) method can be obtained from the authors upon request). Bias reduction in Table A1 presents how much the overall bias reduced because of matching. After matching, the mean of the two groups is very close and the results of the *t*-test show that there is no significant difference between the land rental participation group and the non-participation group, which indicates matching is satisfied with the balancing hypothesis [64]. Figures 1 and 2 also provide evidence of the kernel distribution density function of two groups before and after matching, which show that the kernel density distribution of two groups is completely similar after matching. In addition, the distribution of the predicted propensity scores for the treated group and the untreated group is presented in Appendix A Figure A1. As a result, only a few observations are of support, that is, in conformity with the common support assumption.

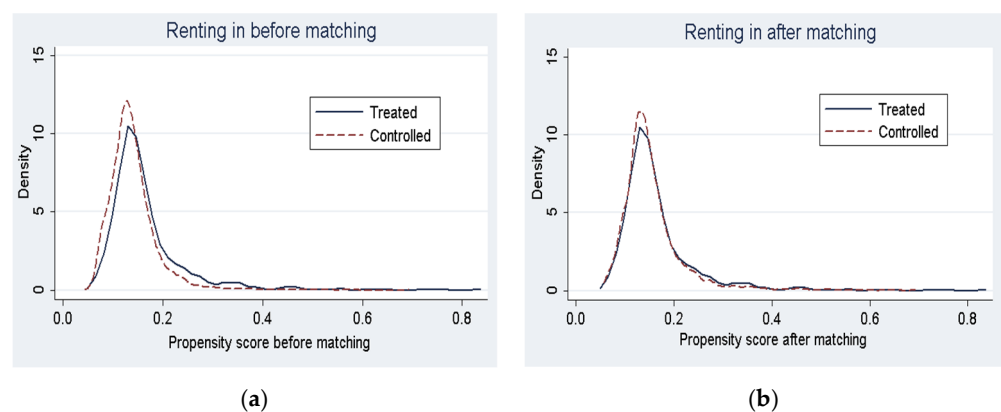


Figure 1. Common support assumption test for renting-in land density distribution of *p*-scores before and after matching. (a) Renting in before matching; (b) Renting in after matching.

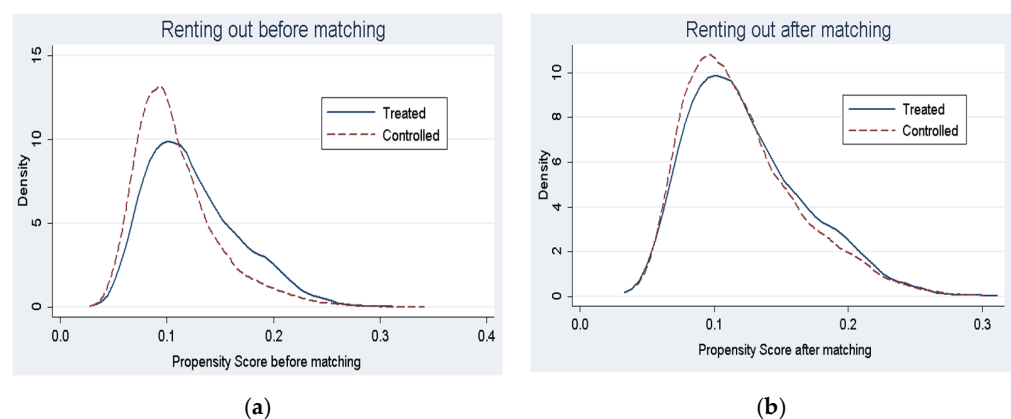


Figure 2. Common support assumption test for renting-out land density distribution of *p*-scores before and after matching. (a) Renting out before matching; (b) Renting out after matching.

5.1.3. PSM Estimation Results across Different Land Rental Decisions

The estimation for the average treatment effect of land transfer on the household ALP based on NNM and KBM methods are reported in Table 3. As a result, land transfer signif-

icantly affects the household ALP at 1% significance level regardless of which matching methods are used. The findings are consistent with the descriptive evidence analysis shown in the previous subsection. Concerning renting-in land, the ATT estimation results before matching denote that the average household ALP of rural households that rented-in land is 69.3% higher than that did not rent-in land at 1% level of significance. Meanwhile, the effect estimation of renting-in land on household ALP decreases to 48.2% after matching. This result is consistent with our expectations. On the contrary, the ATT estimation results in the rent-out group reveal that renting-out land has a negative impact on household ALP. The average household ALP for the rent-out households is lower by about 28.1% (based on NNM results) at 1% level of significance than control groups after matching. Comparing the estimated ATT before and after matching, the impacts of land rental on household ALP are overestimated because of selection bias. Furthermore, the results based on KBM are consistent with findings based on NNM in Table 3.

Table 3. Logit model result of factors affecting land rental decision.

Variables	Sample	Rent-in (Based on NNM, $n = 5$)				Rent-out (Based on NNM)			
		Treated	Control	ATT	<i>t</i> -Test	Treated	Control	ATT	<i>t</i> -Test
Household ALP	Before-matching	8.450	7.757	0.693 ***	19.99	7.505	7.900	−0.395 ***	−10.02
	After-matching	8.448	7.966	0.482 ***	12.53	7.505	7.786	−0.281 ***	−6.65
		Rent-in (Based on KBM)				Rent-out (Based on KBM)			
Household ALP	Before-matching	8.450	7.757	0.693 ***	19.99	7.505	7.900	−0.395 ***	−10.02
	After-matching	8.448	7.900	0.547 ***	15.57	7.505	7.841	−0.336 ***	−8.04
Observations		9536				9536			

Note: *** Significant at 1% level.

Since the application of PSM does not fully explain the story on the existence of the endogenous problem caused by the inverse causal effect, we employed instrumental variable methods to further control the inverse causal effect and reexamine the effect of land transfer on household agricultural labor productivity in the following analysis.

5.2. Instrumental Variables Estimation Results and Discussions

In this subsection, we estimated the impact of land transfer behavior on household ALP based on the instrumental variable method (IV). Table 4 presents the estimation results which indicate that household ALP is highly affected by the land participation decision. Column (1) in Table 4 reports the results for ordinary least squares (OLSs) which reveal that renting-in land is positively correlated with household ALP. Households that rented-in land had higher household ALP, about 45.6% more at 1% level of significance than those who did not participate in renting-in land. Column (2) reports the IV results that are consistent with the main results in Column (1). After controlling for the endogeneity, the effect of renting-in land increases to 68.2% and maintains 1% significance level. In addition, Columns (3) and (4) of Table 4 reports the results of OLS and IV regression for renting-out behavior, respectively. The coefficient of renting-out land in OLS estimation is negative and significant at 1%, denoting that renting-out land would statistically decrease household ALP by about 31.7%. Similarly, after introducing the instrumental variable in Column (4), this negative effect increases to approximately 31.7% and it is still significant at 1%. Overall, the findings in Table 4 are basically consistent with the estimation results by using PSM, which suggests that our main results are robust and convincing. In addition, we also reported the results of weak instrument test which suggest that the instruments are strong. Furthermore, in order to control non-time variations bias across the province, we also controlled the provincial differences and converge standard error to the community level in OLS estimation.

Table 4. The effects of land rentals on household labor productivity, instrumental variable regression.

Variables	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
Renting-in	0.456 *** (0.034)	0.682 *** (0.089)		
Renting-out			−0.317 *** (0.039)	−0.462 *** (0.090)
Head's age	−0.002 (0.001)	−0.001 (0.001)	−0.002 (0.001)	−0.002 (0.001)
Head's sex	0.083 ** (0.040)	0.078 ** (0.039)	0.081 ** (0.040)	0.075 * (0.040)
Head's health status	−0.092 *** (0.011)	−0.094 *** (0.011)	−0.088 *** (0.011)	−0.087 *** (0.011)
Head's education	0.011 *** (0.004)	0.012 *** (0.004)	0.012 *** (0.004)	0.013 *** (0.004)
Contracted farm size	0.049 *** (0.004)	0.048 *** (0.002)	0.052 *** (0.004)	0.052 *** (0.002)
Family size	−0.038 *** (0.007)	−0.040 *** (0.007)	−0.038 *** (0.007)	−0.039 *** (0.007)
Dependency Ratio	−0.095 *** (0.017)	−0.091 *** (0.017)	−0.099 *** (0.017)	−0.096 *** (0.017)
Migration	−0.124 ** (0.050)	−0.121 *** (0.029)	−0.129 ** (0.051)	−0.128 *** (0.029)
Agricultural machine rental	0.053 *** (0.005)	0.052 *** (0.004)	0.055 *** (0.005)	0.055 *** (0.004)
Land certification	0.073 ** (0.029)	0.075 *** (0.024)	0.075 ** (0.029)	0.077 *** (0.024)
Village cadre	0.034 (0.050)	0.029 (0.050)	0.040 (0.049)	0.038 (0.050)
The distance to county center	0.003 (0.003)	0.003 (0.002)	0.003 (0.003)	0.003 (0.002)
Free market	−0.146 *** (0.054)	−0.147 *** (0.032)	−0.143 *** (0.055)	−0.142 *** (0.032)
Constant	7.867 *** (0.139)	7.824 *** (0.107)	7.967 *** (0.137)	7.974 *** (0.105)
R ²	0.278	0.274	0.268	0.267
Wald F-test		684.439 ***		989.234 ***
Observations	9536	9536	9536	9536

Note: (i). * Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level. Standard errors in parentheses. (ii) Province dummies are controlled and standard errors are clustered to community level.

Furthermore, some other interesting findings are also worth highlighting in Table 4. Based on the comprehensive analysis of Columns (2) and (4), the results show that the coefficient on the sex of the household head is significantly positive, suggesting that male-headed households have about 8% higher household ALP than female-headed families. As it mentioned in previous research, female heads have less access to productive resources than male heads, especially credit service, agricultural training, and land input [56,65]. Thus, male-headed households obtain higher household ALP gains. Moreover, the results show that an additional year's education of heads contributes to 1.2% increase in household ALP and it is statistically significant at 1%. Human capital is always regarded as the source of agricultural labor productivity [18]. Therefore, a plausible explanation can be that education is a crucial determinant of the ability to acquire new knowledge and use advanced technologies. Better educated heads possess the higher managerial ability of a family, which contributes to household resource allocation and improvement of productivity. By contrast, household ALP decreases with the increase in household dependency ratio. The negative effect of dependency ratio on household ALP is about 9% and significant at 1%. That may be because a higher dependency ratio means fewer

working-age labors and more non-working age family members. More time should be spent on taking care of non-working age family members, which can have a negative impact on agricultural labor input and household ALP. Moreover, the impact of migration on household ALP is also negative, which is understandable as the households with more migrants suffer more labor constraints on agricultural production which may reduce the agriculture operation scale. The labor loss effect increases with migration. When labor loss effects on agricultural production exceeds the compensating impact from remittance, the net effect of migration on labor productivity is be negative [66]. Since machinery leasing can substitute for family labor input [67], the coefficient of hiring labor-saving machinery is statistically positive. Furthermore, previous studies show that secure property rights can stimulate agricultural investment and thus lead to productivity growth [6], which cater to estimation results that the land certification would positively affect the household ALP. With respect to village-level explanation variables, we found the coefficient of the free market in the village to be negative, suggesting that the household villages with a more active free marketplace have lower household ALP than those living in the village without free marketplace. The free marketplace is commonly regarded as an indicator to measure the development of the off-farm market. A better off-farm employment market can stimulate more land lease [12,18]. Thus, the free market negatively affects household ALP through stimulating renting-out land.

5.3. Causal Mediation Analysis

Massive variations in agricultural labor productivity between developing countries and developed countries motivate us to make more effort on the research of the improvement of household ALP. In the previous section, we proved that renting-in land has a significant positive effect on household ALP. Thus, in this subsection, we further focus on exploring the underlying mechanism of the impact of renting-in land on household ALP improvement which will help us better understand through which channels improve agricultural labor productivity can improve at the micro level. To examine the potential influence channel, we employed a classic three-path mediation model [56,68]. The final mediation analysis results are presented in Table 5. Column (1) of Table 5 shows the instrumental variable regression results of the impact of renting-in land on household ALP without mediation variables which are reported in Column (2) of Table 4. Columns (2) to (4) in Table 5 estimate the effect of renting-in land on mediation variables. In detail, Column (2) reveals that renting-in land significantly enhances the operated land-labor ratio by approximately 63.7%, indicating that expanding farm size tends to induce higher intensive labor input. Column (3) implies that after renting-in land, the average intermediate inputs increase by 88.9% with 1% significant level. At the same time, the coefficient of renting-in land on agricultural fixed assets investment is 3.339 and significant at 1% level, suggesting the households with renting-in land possess over three times more agricultural fixed assets investment than households that do not rent-in land (Column (4), Table 5). The plausible explanation is that bigger farms have more access to the credit market. Thus, the farmers are more likely to invest in agricultural fixed assets to substitute for labor after renting-in land [34]. Moreover, due to the scale threshold of machinery use, big machines may be more efficiently operated on larger farms than small plots [69]. Therefore, households renting-in land tend to invest more in agricultural fixed assets.

After controlling the three mediators, we found that the coefficient of renting-in land decreased to 0.323 but is still significant at 1% in Column (5), which presents the direct effect caused by renting-in land. The coefficient on the land-labor ratio, intermediate inputs, and agricultural assets investment are all significant, implying that the indirect effect attributed to these three mediators is about 0.359. Among them, the indirect effect on the increase in household ALP was mainly through agricultural assets investment which contributes 18.3%. This suggests that agricultural investment in labor-saving machinery and animal power play an essential role in labor substitutions and stimulate the increase in household ALP. The contribution of intermediate inputs to household ALP is second-most, about

11.8%, suggesting that besides investing in agricultural assets investment, enhancing the intermediate inputs is also important in the improvement of household ALP. In addition, land rental enhances household ALP by about 5.8% indirectly through improving the land-labor ratio. Since the coefficient of renting-in and mediators are statistically significant, it is not necessary to use the Sobel test to detect the significance of the indirect effect. Overall, in Columns (2) to (4), the coefficients on mediators are positive and highly significant. This indicates that the mediation paths are proved, and land-labor ratio, intermediate inputs and agricultural assets investment are key indirect determinants in the process of renting-in land to affect household ALP.

Table 5. The mediation analysis for improvement of household agricultural labor productivity.

Variable	Household ALP	Land-Labor Ratio	Intermediate Inputs	Agricultural Investment	Household ALP
	(1)	(2)	(3)	(4)	(5)
Rent-in	0.682 *** (0.089)	0.637 ** (0.257)	0.889 *** (0.134)	3.339 *** (0.314)	0.323 *** (0.088)
Land-labor ratio					0.092 *** (0.007)
Agricultural input					0.133 *** (0.009)
Agricultural investment					0.055 *** (0.003)
Head's age	−0.001 (0.001)	−0.005 (0.003)	−0.001 (0.002)	−0.007 * (0.004)	−0.000 (0.001)
Head's sex	0.078 ** (0.039)	−0.463 *** (0.083)	0.224 *** (0.063)	0.853 *** (0.124)	0.044 (0.038)
Head's health status	−0.094 *** (0.011)	0.001 (0.027)	−0.017 (0.016)	−0.165 *** (0.037)	−0.082 *** (0.010)
Head's education	0.012 *** (0.004)	0.002 (0.008)	0.004 (0.006)	−0.002 (0.013)	0.011 *** (0.003)
Contracted farm size	0.048 *** (0.002)	0.500 *** (0.012)	−0.032 *** (0.003)	0.139 *** (0.007)	−0.001 (0.003)
Family size	−0.040 *** (0.007)	−0.258 *** (0.015)	0.008 (0.011)	0.073 *** (0.023)	−0.021 *** (0.006)
Dependency Ratio	−0.091 *** (0.017)	0.126 *** (0.036)	−0.087 *** (0.024)	−0.281 *** (0.059)	−0.076 *** (0.015)
Migration	−0.121 *** (0.029)	0.056 (0.064)	−0.088 ** (0.044)	−0.477 *** (0.100)	−0.089 *** (0.027)
Agricultural machine rental	0.052 *** (0.004)	0.012 (0.011)	0.021 *** (0.005)	−0.166 *** (0.013)	0.057 *** (0.004)
Land certification	0.075 *** (0.024)	0.058 (0.058)	0.050 (0.037)	0.226 *** (0.084)	0.050 ** (0.022)
Village cadre	0.029 (0.050)	−0.018 (0.134)	0.009 (0.069)	0.246 (0.181)	0.016 (0.047)
The distance to county center	0.003 (0.002)	−0.005 (0.005)	0.001 (0.002)	0.016*** (0.006)	0.002 (0.002)
Free market	−0.147 *** (0.032)	−0.003 (0.068)	−0.155 *** (0.052)	−0.376 *** (0.109)	−0.106 *** (0.030)
Constant	7.824 *** (0.107)	1.929 *** (0.264)	5.707 *** (0.173)	2.373 *** (0.376)	6.758 *** (0.114)
R ²	0.278	0.771	0.047	0.192	0.370
Wald F-test	989.234 ***	953.099 ***	953.099 ***	953.099 ***	893.190 ***
Number of observations	9536	9536	9536	9536	9536

Note: (i). * Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level. Standard errors in parentheses. (ii). Province dummies are controlled.

6. The Impact of Land Rental on Agricultural Labor Productivity at Village Level

In the previous sections, we offer evidence that renting-in land has a positive direct effect and indirect effects through three mediation variables on household ALP. However, renting-out land has the opposite effect on household ALP at the household level. Transactions with local neighborhoods who know each other provides effective access to lower transaction costs and better information [70], so land rental always takes place within villages. From the perspective of the village, it is meaningful to analyze whether land rental is an effective way to stimulate land transferred from households with lower household ALP to higher household ALP and facilitates the improvement of aggregated village agricultural labor productivity. Thus, we further employed village-level data sets to examine the relationship between land transfer rate and aggregated village agricultural labor productivity. The results are displayed in Table 6. Column (1) suggests that villages with more households participating in renting-in land have higher village ALP. One unit increase in renting-in ratio leads to 123.3% increase in village ALP. Column (2) presents the opposite effect of the renting-out ratio on village ALP indicating that the negative impact of renting-out land on village ALP is 43.8%. Since renting-in and -out land have the opposite effect on village ALP, we synthetically estimated the comprehensive effect of land transfer on household ALP in Column (3). The estimation results reveal that the village with a higher land transfer rate can have a higher village ALP and the positive effect reaches 31% with 5% significance level. From the perspective of the village, we further estimated the integrated impact of land rental on the improvement of total agricultural labor productivity in village. Although renting-out land has a negative effect on village ALP, it is offset by the positive effect caused by the higher renting-in ratio in the village. Thus, the total effect of land transfer on village ALP is still positive indicating that the development of the land rental market can increase the integrated village ALP. To some extent, the land rental market is an effective way to promote the land transferred from households with lower household ALP to households with higher household ALP. The potential productivity of the agricultural labors can be exploited by land tenancy and thus realize better resource allocation within villages.

Table 6. The impact of land rental on agricultural labor productivity at village level.

Variables	Village Aggregated Labor Productivity		
	(1)	(2)	(3)
Rent-in ratio	1.233 *** (0.182)		
Rent-out ratio		−0.438 ** (0.199)	
Land transfer ratio			0.310 ** (0.153)
Constant	8.654 *** (0.525)	8.829 *** (0.539)	8.783 *** (0.541)
Control Variables	Yes	Yes	Yes
R ²	0.360	0.330	0.329
Number of observations	728	728	728

Notes: (i) ** Significant at 5% level, *** Significant at 1% level. Province dummies are controlled. (ii). All the variables in this table are measured at the village level, amounting to 728 observations. Among them, the independent variable are the share of households within the village taking part in land transfer (including renting-in ratio, renting-out ratio, and land transfer ratio of the village). The dependent variable is agricultural labor productivity for the village, which are aggregated by the household agricultural labor productivity. In terms of control variables, we first controlled the average characteristics of household heads such as age, sex, health, and education. We further controlled the ratio of households that rented in agricultural machinery and the proportion of households that received land certification. Then, we controlled the total area (mu), total registered population, distance to county center and the free market (dummy variable) in the village.

7. Conclusions and Further Discussion

Growth in agricultural labor productivity is regarded as a predictor on poverty reduction in developing countries [71]. At the micro level, the household ALP is the critical determinant of household income and welfare enhancement. From the perspective of the macro level, improving household ALP is conducive to boost the aggregated agricultural labor productivity, which contributes to narrowing the ALP gap with developed countries and thus to increasing agricultural competitiveness. The existing literature mainly focused on labor productivity growth at the macro level. Limited attention has been focused on the improvement of the household ALP and aggregated village ALP. Therefore, this study aimed to analyze how the land rental affects agricultural labor productivity from household and village perspectives based on national data sets in rural China and further detect the underlying pathways of household ALP growth.

Based upon previous literature, this study employed both PSM and the instrumental variable approach to examine whether the land lease would affect the household ALP. As a result, our empirical analyses suggest that no matter which kinds of empirical estimation methods are used (PSM or instrumental variable method) it is consistently proved that renting-in land has a positive and significant impact on household ALP while renting-out land negatively affects household ALP in China. Moreover, by decomposing the formulation of agricultural labor productivity, we extracted three mediation paths named the land-labor ratio, agricultural intermediate inputs, and agricultural assets investment. This study verified these three underlying affecting channels by employing a mediation analysis and we found that the total effect increases by renting-in land are made up by direct effects and indirect effects from these three mediators. This reveals that renting land from other households enhances the agricultural labor productivity by expanding the land-labor ratio, improving the intermediate inputs, and more agricultural assets investment. The mediation effect analysis was always ignored in the previous studies. The findings emphasize that land rental creates a pathway for mediators to promote agricultural labor productivity growth. Finally, from the village research perspective, we further investigated the relationship of land tenancy market development and village aggregated agricultural labor productivity which helps us to better understand land resource allocation efficiency within villages. The empirical evidence shows that the contribution of land transfer to village aggregated agricultural labor productivity in the rural area is positive and significant. This suggests that land transactions stimulate land transferred to households with higher household ALP and then contribute to aggregated agricultural labor productivity enhancement at the village level. In summary, expanding farm size is not only beneficial to household ALP, but also to realizing more efficient allocation of land resources within villages. Thus, the key point of productivity improvement policies is to further encourage management at moderate scales by stimulating land leases.

It is noteworthy that small-scale, fragmentation, and family-contracted are the basic characteristics of agriculture in China. According to the data from the Statistical Annual Report of Operation and Management in rural China, in 2017, there were over 230 million farmers in rural China whose land operation scale was no more than 30 mu [72]. Land fragmentation has a negative impact on the marginal productivity of agricultural labor [73]. Though the land rental market developed rapidly in rural China, there was still only 37% of land in circulation in 2017 [72]. A series of policy arrangements also should be adopted by the government to further promote land leases. Firstly, appropriate legal regulations of stabilizing land use rights should be further improved to encourage investment in the plots [74]. Secondly, since the land can fully or partially support survival needs in the absence of insurance [75], the improvement of the pension system may be an effective way to promote farmers to take part in the land lease market [76]. Thirdly, the policy implications also need to focus on investing in education, improving agricultural social service, establishing a trading platform for land rental, and offering trading information services to reduce information asymmetry between lessee and lessor.

Unfortunately, this study only employed a cross-section data set to evaluate the impact of the land rental on agricultural labor productivity. However, the household agricultural productivity is also probably affected by unobserved time-invariant variables such as land quality, and conditions of heat and light. Meanwhile, our understanding of the changes in impacts of farmland rental on household agricultural labor productivity is limited. Thus, the panel data should be employed in further research to address this concern.

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Conflicts of Interest: The authors declare that there is no conflict of interest.

Appendix A

Table A1. PSM quality indicators before and after matching (Based on NNM, $n = 5$).

Variable		Rent-in				Rent-out			
		Treated Mean	Control Mean	Bias Reduction (%)	T-Test	Treated Mean	Control Mean	Bias Reduction (%)	T-Test
Head's age	U	54.261	56.465		0.000	58.571	55.847		0.000
	M	54.279	54.023	88.4	0.534	58.571	58.805	91.4	0.637
Head's sex	U	0.930	0.905		0.003	0.878	0.912		0.000
	M	0.930	0.930	99.4	0.988	0.878	0.883	83.1	0.677
Head's health status	U	2.863	2.849		0.656	2.937	2.840		0.006
	M	2.865	2.861	75.5	0.933	2.936	2.944	91.9	0.865
Head's education	U	7.214	7.172		0.653	7.285	7.164		0.257
	M	7.213	7.282	−59.7	0.577	7.285	7.224	49.8	0.669
Contracted farm size	U	10.28	6.865		0.000	6.498	7.461		0.001
	M	10.041	9.942	97.1	0.823	6.498	6.350	84.6	0.616
Family size	U	3.928	3.739		0.000	3.436	3.803		0.000
	M	3.923	3.921	98.8	0.972	3.436	3.385	86.1	0.495
Dependency ratio	U	0.495	0.600		0.000	0.708	0.569		0.000
	M	0.500	0.500	97.6	0.914	0.708	0.694	89.9	0.683
Migration	U	0.241	0.269		0.018	0.282	0.263		0.141
	M	0.241	0.242	94.6	0.919	0.282	0.281	95.7	0.963
Agricultural machine rental	U	3.842	3.455		0.000	3.196	3.550		0.001
	M	3.830	3.805	93.3	0.847	3.196	3.125	79.9	0.617
Land Certification	U	0.672	0.669		0.627	0.710	0.660		0.001
	M	0.672	0.677	25.7	0.781	0.710	0.700	80.4	0.626
Village cadre	U	0.062	0.049		0.038	0.044	0.052		0.271
	M	0.062	0.068	58.2	0.556	0.044	0.0444	90.4	0.932
The distance to county center	U	7.101	6.253		0.000	5.959	6.427		0.051
	M	6.953	7.187	72.5	0.487	5.959	6.075	75.2	0.674
Free market	U	0.152	0.157		0.659	0.164	0.156		0.473
	M	0.151	0.152	81.2	0.949	0.164	0.160	53.2	0.804

Note: U: Unmatched; M: Match.

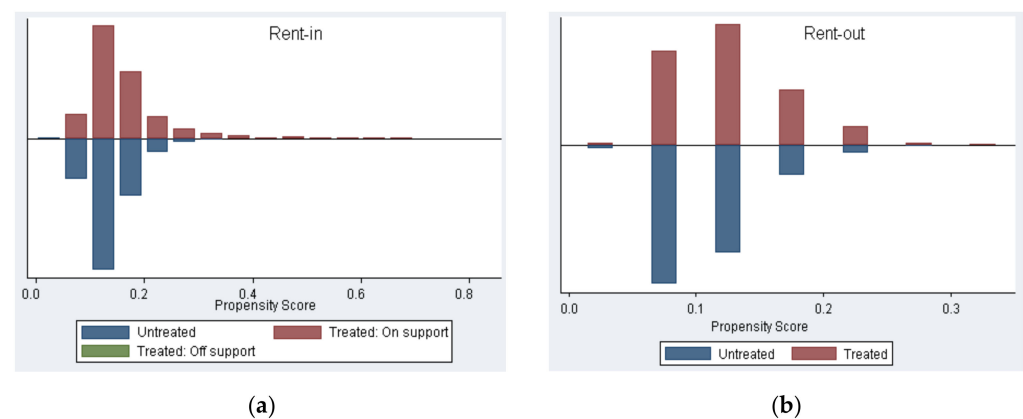


Figure A1. Common support of propensity score (based on NNM). (a) Propensity score of renting-in; (b) Propensity score of renting-out.

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