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# How Does Land Transfer Impact the Household Labor Productivity in China? Empirical Evidence from Survey Data in Shandong

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**Abstract:** As the transfer speed of land use rights accelerates, the production efficiency of farmer households keeps increasing as well. Based on field survey data of 1368 farmer households in Shandong in 2019, this paper applied the average treatment effect (ATE) and propensity score matching (PSM) to investigate the impact of land transfer on the productivity of farmer households. The results indicate that land transfer has a positive effect on the overall labor productivity of farmer households participating in land transfer. The impact of land transfer on productivity has an obvious asymmetry between transfer-in households and transfer-out households. More specifically, land transfer-in plays a greater role in promoting participants' overall labor productivity, while land transfer-out has some positive effect on non-agricultural productivity. This study is of great significance in improving the overall welfare level of farmer households and promoting the reform and high-quality development of farm businesses.

**Keywords:** land transfer; average treatment effect; labor productivity of farmer households



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## 1. Introduction

The economic level of rural areas in China has improved significantly since the reform and opening up. Farmers are most concerned about productivity, income level and other issues related to their actual welfare. In 2021, the per capita disposable income in rural areas reached CNY 18,900 [1], a significant increase from CNY 134 in 1978 [2]. However, as a result of the funds shortage, lack of dynamism and other problems that limit the further development of rural areas, there is currently a significant income gap between urban and rural residents. The scattered distribution of rural land in China is striking. At present, the scale of the agricultural production of Chinese farmers is generally small, and the arable land per capita of farmers is only 3.66 mu [3]. Land distribution is an important factor in the productivity gap in developing countries [4]. The fragmentation of land resources hinders the development of large-scale agriculture, resulting in low agricultural productivity, which leads farmers to increase household income through part-time management. In order to improve the conditions, in 2014–2022, for 9 consecutive years, the Central Documents No. 1 proposed that it is urgent to promote the transfer of land to develop a moderate land size and increase the efficiency of agriculture [5–13]. The continuously deepening reform of rural land policy promotes the constant improvement of land transfer efficiency in China [14]. It is of great significance to improve the allocation efficiency of land and agricultural productivity. With the acceleration of urbanization in China and the increasing demand for construction land, the utilization efficiency of land has attracted much attention [15,16]. By the end of 2020, the area of land transfer in China reached 565 million mu, accounting for 36.2% of the total contracted land area [1]. For farmers, it is an important decision whether to participate in land transfer [17].

Land assets are important operating assets for farmer households. General farmer households take land assets as the main production element to engage in agricultural production. In China, there is a large rural population with a small per capita arable land area. The production efficiency of traditional small-scale farming is low, and the fragmented distribution of land resources is not conducive to large-scale agricultural development. The successive introductions of market rules and policies under land reform are encouraging farmers to change their farm structures [14]. Land transfer is gradually becoming an important approach for farmers to break through limitations of resources and innovate their mode of production. Farmers expand the scale of agricultural production by transferring in land or release their labor force by transferring out land to engage in a more beneficial sector to improve the efficiency of household labor production. After farmers participate in land transfer, they are no longer engaged in a single agricultural production mode, and their production efficiency in both agricultural and non-agricultural production fields affects the overall economic status of their families [18]. Land transfer effectively improves the concentration of land and optimizes farmers' resource allocation. Therefore, it is a key issue to explore how to improve the production efficiency of farmer households through land transfer, which needs to be taken into account in rural economic development. The isolated analysis of the agricultural productivity of farmer households could not provide a comprehensive view about the mechanism of land transfer. Therefore, it is required to further discuss the promoting effect and functional channel of land transfer on agricultural productivity and non-agricultural labor productivity.

This study tries to make innovations from the following points: First, this paper attaches importance to the position of Shandong Province in the agricultural field, takes the labor production efficiency of rural households in Shandong Province as the research object and enriches relevant research on the role of land transfer in Shandong Province; Secondly, the data used in this study are first-hand data obtained from a household survey, which can effectively reflect the situation of rural areas and meet the research needs. Considering the non-randomness of rural households when they choose whether to participate in land transfer, the average treatment effect, a policy evaluation method commonly used in econometrics, is adopted in this paper when estimating the labor productivity effect of land transfer. On the basis of the ATE, this paper uses the propensity score matching (PSM) method to match rural households that have participated in land transfer with virtual households that have not participated in land transfer and estimates the impact of participating in land transfer on the labor productivity of farmer households; namely, the average treated effect (ATT) is obtained. The following research questions are investigated: First, does land transfer significantly improve household labor productivity? Second, are the effects of land transfer on labor productivity significantly differentiated according to the directions of land transfer? Third, is there any difference in the effect of land transfer on different types of household labor productivity?

The organization of the remainder of this study is as follows: In Section 2, we focus on the literature review. Section 3 describes the study area and data sources. Section 4 shows the theoretical framework, variables and methods. Section 5 reports the results of the average treatment effect (ATE) and the average treated effect (ATT) and analyzes the possible causes. Finally, we outline the conclusions and suggestions in Section 6.

## 2. Literature Review

This paper reviews relevant literature from three aspects, including the factors of land transfer intention, factors of household productivity and the effect of land transfer on productivity.

The economic behavior theory for farmer households takes farmers as rational persons, who pursue the maximization of the benefits in the family operation process, especially for the land operation [17]. Land resources are the main operational assets of farmers. Farmers choose whether to participate in land transfer according to their productivity conditions and resource endowment. The studies on the influence factors of land transfer had a relatively

large range. The relevant studies mainly investigated the economic factors of the farmer households, individual factors of heads of households and social security factors. Land quality is an important factor affecting agricultural production and an important reference condition for farmers' families to participate in land transfer. Fertile land is conducive to improving farmers' willingness to participate in land transfer [19]. Family economic conditions, such as land property right confirmation, land rights policy, the scale of rural land, net household income and crop insurance, as well as the educational background of the household head, all affect the intention of land transfer [20,21]. Land ownership confirmation and certification reduces the cost of land transactions and improves the intention of land transfer by determining land property rights [22–24]. The overall situation of the village where the farmers live affects the intention of land transfer [25]. The villages with developed infrastructure that are close to cities tend to transfer-out their land and shifted to non-agricultural production; in contrast, villages with relatively advantageous natural conditions tend to transfer-in land [26].

The labor productivity of farmer households is related to economic and social welfare, which is an important index that agricultural management subjects pay attention to [27,28]. As a result, scholars take the labor production efficiency of peasant households as the research object to carry out a specific analysis. The digitalization and mechanization of agriculture can improve the overall labor productivity [26]. Technological progress has made an important contribution to the average productivity growth in Northeast China [29]. According to the analysis of farm development in different countries, farm size affects the overall production capacity [30].

The current land system of China still has certain space for improvement. The separation of ownership rights, contract rights and management rights injects more vitality to the operation rights of land and motivates the enthusiasm of farmer households in land transfer. Land transfer has changed the management structure of farmers, leading to the reasonable allocation of the agricultural land resources and innovation in the production mode. According to producer equilibrium theory and production possibility boundary theory, land resources tend to be transferred from farmers with relatively lower productivity to those with relatively higher productivity [31]. The large-scale operation of agriculture could also facilitate the introduction and promotion of digital and green production technologies. In the scaled agricultural production process, farmer households could invest more capital and labor force to optimize the resources allocation [32]. Land transfer has a certain promoting effect on improvements in production efficiency [33]. However, opinions of scholars are divided in the functioning mechanism of the land transfer to the total agricultural productivity. The relevant studies mainly focused on the scale economy and labor force allocation arising from land transfer. The dispersed distribution of land will significantly reduce agricultural production efficiency [34–36]. Farmers obtain more land resources by renting land, which promotes agricultural-scale operation and technology popularization, thus improving the efficiency of agricultural land management [37]. Driven by the effect of economies of scale, farmers' evolution from small-scale production to a large-scale operation mode has improved agricultural production efficiency [38,39]. However, the effect of the scale economies after land transfer needs certain conditions. The improvement in the productivity can only be promoted by adding new production elements or improving the quality of the original production elements after the transfer of rural land [40]. There is no optimal agricultural structure in any single economy and the optimal scale of agricultural production changes along with the economic development stage [41]. Land transfer improves the output and total productivity of farmer households through the promotion of resource allocation [42]. The separation of operation rights and contracting rights reduces the migration cost of the labor force and creates rental income [23]. When farmer households select to transfer-out land, the agricultural production mode of the farmer household comes across in the transformation and expands from single agricultural production to the domain of non-agricultural production [18,31,43]. The farmer households with relatively low agricultural productivity transfer their labor force to non-agricultural

domains [44]. The labor flux can obtain non-agricultural income through working, asset operation and other relevant approaches to increase the utilization rate of the residual labor force and promote the growth of the aggregate labor productivity [45].

It could be seen from the literature review that the current studies have different points of views on the aspects of the land system, influence factors of land transfer and effects of land transfer on productivity. Firstly, in explaining the effect of land transfer on the productivity of farmer households, most studies failed to consider the functioning path of labor productivity arising from behavioral differences in land transfer and ignored the influences of land transfer on productivity in different categories. Secondly, as existing studies are mostly based on macro data, there are many limitations in the selection of variables. Thirdly, the impact of regional differences may be ignored in the process of analyses. In addition, the agricultural achievement in Shandong Province plays an important role in promoting the national agricultural development. However, few studies have analyzed the productivity effect of land transfer in Shandong Province. This study is based on the primary data obtained from a household investigation in Shandong Province. The research group especially designed questionnaires according to the research content and extensively collected data, including the individual head of household, family economy, village environment and other aspects. This study divides the household labor productivity to further explore the impact of land transfer on different types of labor productivity. According to the direction of land transfer, the farmers with land transfer are divided into land transfer-in and land transfer-out households. This study takes the regional differences into account to improve the reliability of the research conclusions.

In order to study the effect of land transfer on the labor productivity of farmer households, this study appreciates the basic models of Carter and Yao [46] and Conning and Robinson [47], which took the farmer household as the unit and applied the average income per labor of families to evaluate the aggregate labor productivity of farmer families.

## 3. Study Area and Data Source

### *3.1. Study Area*

As a traditional agricultural province, Shandong Province has a strong and comprehensive strength in agriculture. In 2020, the total value of agricultural output in Shandong Province reached CNY 1.019 trillion [2], and Shandong Province became the first province in China to exceed CNY 1 trillion. The value of processed agricultural products in Shandong accounts for 1/6 of the country, and the export value of agricultural products has been in the forefront in China for 22 consecutive years. Shandong Province is known as the "vegetable basket" and is the most important supplier of vegetables in China. In the first half of 2022, the total value of agricultural output in Shandong was CNY 516.382 billion [48], ranking first in China. Shandong pays attention to the modernization of agriculture and promotes large-scale land management. In 2020, the land transfer area of Shandong Province reached 41.289 million mu, with the transfer rate reaching 44.7 percent [49], which is top-ranked nationwide. In 2021, there were 94,800 family farms and 235,900 farmer cooperatives, featuring diversified agricultural production methods [49]. Agricultural production has changed to large-scale farming. The large-scale operation of agriculture in Shandong Province has promoted the integrated development of industry in rural areas. With the improvement of agricultural operation modes and cropping structures, the efficiency of agricultural production has been increased, and the household income of farmer households has increased year by year. The income of rural households in Shandong Province has increased year by year, with the annual per capita income of farmers reaching CNY 18,753 in 2020 [2]. Therefore, it is significant to pay attention to the influence of land transfer on the labor productivity of rural households in Shandong Province to accumulate agricultural development experience and explore the path of agricultural progress.

### *3.2. Data Source*

#### 3.2.1. Sample Distribution

In 2019, the research group conducted a questionnaire survey for 16 prefecture-level cities in Shandong. The contents of the questionnaire mainly include the basic personal information of household members, family economic conditions, production factors, social relations, etc. This article conducts empirical analysis for the micro data obtained from the survey. The objects of investigation include 48 county-level cities in 16 prefecture-level administrative regions of Shandong. A total of 100 farmer households were investigated in each prefecture-level administrative region. In accordance with the village construction standard in the new era, the research group selected 1 demonstration village, 1 advanced village and 1 general village with respective questionnaire distribution quantities of 30, 30 and 40 to guarantee the balance and comprehensiveness of the sample distribution. A total of 1600 questionnaires were distributed and collected in this survey. Data related to this paper mainly include whether households transfer land, including transfer-in and transfer-out land; the area of land transfer; the income of households; the labor force size; the capital input, the age of the household head; the education level of the household head, the transportation convenience of cultivated land; and village infrastructure. We obtained 1368 valid samples after eliminating questionnaires from households who do not participate in agricultural production, households failing to have any major variables and households with untruthful data before the empirical analysis. Table 1 and Figure 1 show the geographical distribution of the samples.

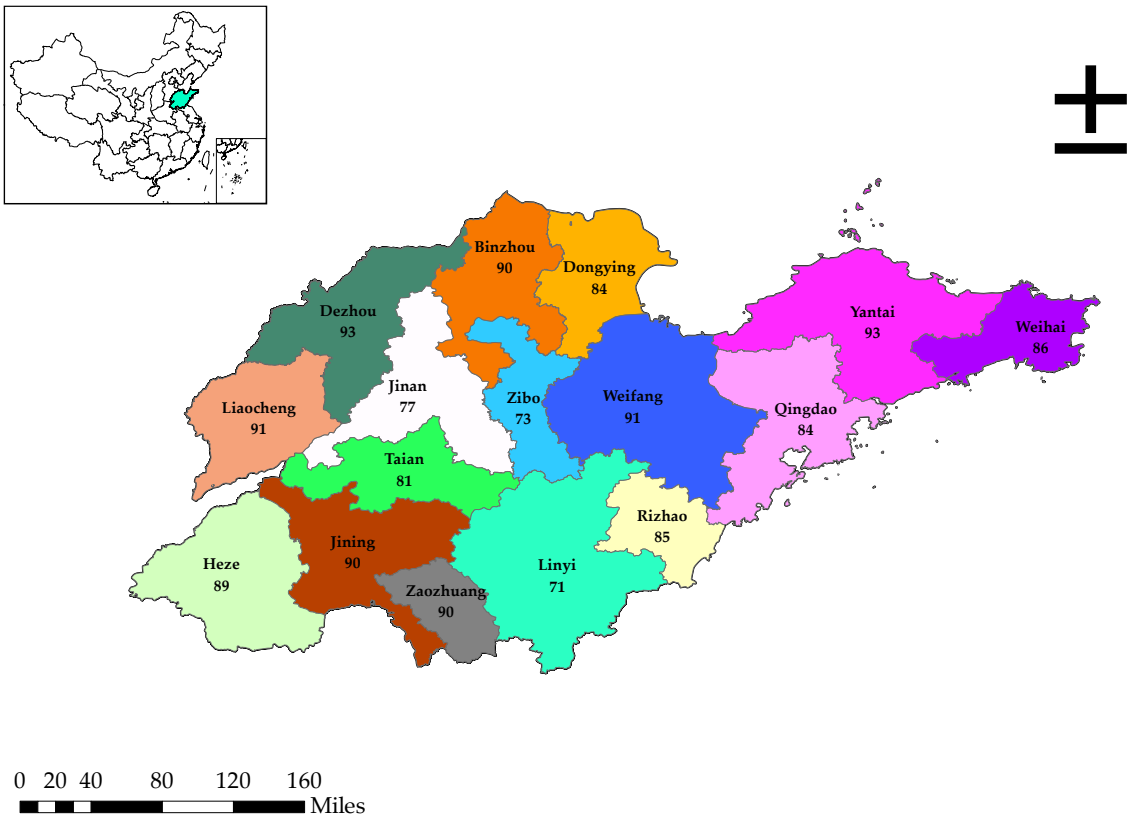


**Figure 1.** Geographical Distribution of Samples.

**Table 1.** Geographical Distribution of Samples.

| Survey Location | The Number of Questionnaires | The Number of Valid Questionnaires |
|---|---|---|
| Jinan | 100 | 77 |
| Qingdao | 100 | 84 |
| Yantai | 100 | 93 |
| Weihai | 100 | 86 |
| Rizhao | 100 | 85 |
| Weifang | 100 | 91 |
| Zibo | 100 | 73 |
| Linyi | 100 | 71 |
| Tai'an | 100 | 81 |
| Heze | 100 | 89 |
| Dezhou | 100 | 93 |
| Liaocheng | 100 | 91 |
| Dongying | 100 | 84 |
| Binzhou | 100 | 90 |
| Jining | 100 | 90 |
| Zaozhuang | 100 | 90 |
| Total | 1600 | 1368 |

Note: The data are sourced from field investigation.

#### 3.2.2. Information about Land Transfer

It could be seen from the survey data that 524 households among the 1368 valid samples transferred land, including 113 households that transferred in land and 411 households that transferred out land. A total of 844 households did not transfer land.

The average land transfer area of farmer households transferring in land is 6.54 mu. However, there is a certain difference between cities. As seen from Table 2, farmer households participating in land transfer in Dongying took the highest proportion in the samples, which was as high as 82.14%; farmer households participating in land transfer in Dezhou took the lowest proportion in the samples, which was only 11.11%; Binzhou had the largest area of land transfer, reaching as large as 19.50 mu; Zibo had the smallest average area of land transfer, which was only 1.38 mu. Among the farmer households participating in land transfer, the average transfer-in rate of land was 21.56%. Among them, the proportion of transfer-in farmer households was highest in Weifang. In the samples for participation in land transfer, about 66.04% of the farmer households in Weifang transfer in land.

**Table 2.** Basic Information about the Land Transfer of Farmer Households.

| Region | Participation Proportion of Land Transfer | Land Transfer Area | | |
|---|---|---|---|---|
| | | Maximum Value | Minimum Value | Mean Value |
| Overall | 38.30% | 350.00 | 0.30 | 6.54 |
| Jinan | 35.06% | 8.00 | 1.40 | 1.70 |
| Qingdao | 36.90% | 200.00 | 1.00 | 10.81 |
| Yantai | 40.86% | 79.30 | 1.00 | 6.59 |
| Weihai | 17.44% | 8.00 | 0.60 | 2.55 |
| Rizhao | 58.82% | 83.00 | 0.30 | 3.24 |
| Weifang | 58.24% | 200.00 | 0.85 | 11.77 |
| Zibo | 46.58% | 4.00 | 0.50 | 1.31 |
| Linyi | 50.70% | 34.00 | 1.00 | 3.75 |
| Tai'an | 40.74% | 100.00 | 1.00 | 5.11 |
| Heze | 52.81% | 8.20 | 0.97 | 1.48 |
| Dezhou | 6.45% | 20.00 | 2.00 | 7.58 |
| Liaocheng | 34.07% | 11.50 | 1.00 | 4.34 |
| Dongying | 82.14% | 350.00 | 0.30 | 12.86 |
| Binzhou | 11.11% | 60.00 | 4.00 | 19.50 |
| Jining | 37.78% | 95.00 | 0.50 | 7.13 |
| Zaozhuang | 11.11% | 10.00 | 2.75 | 4.93 |

Note: the data are sourced from field investigation.

3.2.3. Land Transfer and Aggregate Labor Productivity of Farmer Households

Before the empirical analysis, we conduct a simple exploration of the relationship between land transfer and the aggregate labor productivity of farmer households. According to the previous assumptions and survey data, we can calculate the labor productivity of farmer households. Based on the results, we calculate the averages of the labor productivity of farmer households transferring land and households not transferring land. Furthermore, the results are divided into different grades for statistical analysis. As seen from Table 3, the average value of the labor productivity of farmer households participating in land transfer was CNY 22,705.01 and the average value of the labor productivity of farmer households not participating in land transfer was CNY 15,269.14. Among farmer households participating in land transfer, the labor productivity of 10.31% of farmer households reached CNY 50,000, and the proportion of households with a labor productivity above CNY 100,000 reached as high as 3.44%. The proportion of farmer households with a labor productivity below CNY 5000 was 15.08%. In contrast, the proportion of labor productivity exceeding CNY 50,000 in farmer households not participating in land transfer was only 4.03%. It is obvious that the labor productivity of farmer households participating in land transfer is higher than those not participating in land transfer.

**Table 3.** Distribution of Farmer Households Participating in Land Transfer and Their Labor Productivity.

| Distribution of Labor Productivity of Farmer Households (CNY/Person) | Proportion of Farmer Households Participating in Land Transfer | Proportion of Farmer Households Not Participating in Land Transfer |
|---|---|---|
| PE < 5000 | 15.08% | 26.30% |
| 5000 ≤ PE < 10,000 | 15.65% | 15.17% |
| 10,000 ≤ PE < 50,000 | 58.97% | 54.50% |
| 50,000 ≤ PE < 100,000 | 6.87% | 3.55% |
| PE ≥ 100,000 | 3.44% | 0.47% |
| Total | 100% | 100% |
| Average Labor Productivity (CNY/person) | 22,705.01051 | 15,269.14025 |

Note: the data are sourced from field investigation.

## 4. Methodology

### *4.1. Theoretical Analysis Framework*

As shown in Figure 2, on the one hand, farmers with a relatively higher agricultural labor productivity are willing to transfer-in land to expand the scale of agriculture. The expansion of the agricultural production scale changes the agricultural production mode, which leads to the effects of scale economies and improves the agricultural labor production efficiency of farmer households. On the other hand, households with a relatively low agricultural labor productivity are willing to transfer-out land and release part of the labor force from the agricultural sector to the non-agricultural sector [50]. The development of the labor force in the non-agricultural sector improves their skills and non-agricultural labor productivity. Finally, the aggregate labor productivity of farmers' families participating in the land is improved.

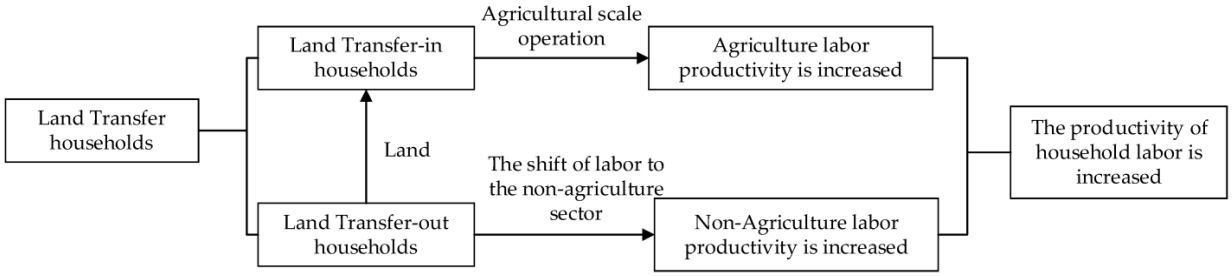


**Figure 2.** Theoretical analysis framework.

### *4.2. Variable Selection*

According to the aforesaid theoretical analysis, this study assumes that land transfer could improve the aggregate labor productivity of farmer households. It takes whether a typical farmer family transfers land as a binary random variable, which is selected as the core explanatory variable. According to the assumption about the aggregate labor productivity of the farmer households in the previous parts, this paper applies $F_i$ to indicate the total income of the farmer family, while $L_i$ represents the total number of laborers in the farmer family, and then $PE_i = \frac{F_i}{L_i}$ represents the aggregate labor productivity that could be observed for a typical farmer family [51]. In the same way, it could obtain the agricultural labor productivity and non-agricultural labor productivity of households.

In addition to the core explanatory variable, land transfer, and based on the availability of data, this paper selects four categories of factors as control variables (X): the factors related to family agricultural operations, individual factors of heads of households, fundamental factors of rural land and village factors [52].

The factors related to family agriculture operations include agricultural area and agricultural capital inputs. Agricultural operation area decides agricultural production scale and factors allocation. The agricultural capital affects agricultural production efficiency.

The variables related to the head of household include the age and the educational level. As the decision-maker for household management, the age and education level are expected to significantly affect the decision of land transfer, family income and crops planted. The traffic conditions of the farmland are a fundamental factor of rural land, which could influence its agricultural mechanization. Moreover, the level of agricultural land infrastructure affects the mode of agricultural production and then affects the labor production efficiency of the household. The village environment affects the production conditions and farming habits of farmers, which can influence the productivity of farmers. In consideration of the differences among prefecture-level cities, we set the virtual variable $Z_i$ for regions to avoid endogenous problem arising from factors beyond observation due to regional gaps. The variables involved in this study and their definitions are shown in Table 4.

**Table 4.** Description of variables.

| Name | Variables | Definition |
| --- | --- | --- |
| Total household labor productivity | PE | PE = Total household income/total household labor force. |
| Household agricultural labor productivity | PE_a | PE_a = Household agricultural income/total household agricultural labor. |
| Household non-agricultural labor productivity | PE_n | PE_n = Household off-farm income/total household off-farm labor force. |
| Land transfer | Trans | The value of trans is decided by whether the farmer participate in land transfer. Trans = 1 represents that the farmer household participates in land transfer while trans = 0 indicates not. |
| Land transfer-in | Trans_in | The value of trans_in is decided by whether the farmer transfers in land. Trans_in = 1 represents that the farmer household transfers in land while trans_in = 0 indicates it does not. |
| Land transfer-out | Trans_out | The value of trans_in is decided by whether the farmer transfers out land. Trans_out = 1 represents that the farmer household transfers in land while trans_out = 0 indicates it does not. |
| Capital input | K | Household capital inputs to agricultural production, including the expenditure of seeds, plastic film, fertilizers, pesticides, water and electricity for irrigation, machinery, insurance, etc. |
| Agricultural operating area | T | The operating area of household agricultural production. |
| Age of the head of the household | Age | The age of the head of the household. |
| The educational level of the head of the household | Edu | The value of edu is assigned according to the educational level of the head of the household. To be specific, edu = 0 when the head of the household has not been to primary school, edu = 1 when he has primary school education, edu = 2 when he has junior high school education, edu = 3 when he has technical secondary school education, edu = 4 when he has vocational and technical school education, edu = 5 when he has high school education, edu = 6 when he has junior college education, and edu = 7 when he has undergraduate education [53]. |

**Table 4.** *Cont.*

| Name | Variables | Definition |
| --- | --- | --- |
| Land traffic conditions | Transport | The value of transport is assigned according to the traffic conditions of the land. To be specific, transport = 1 when the traffic conditions of the land are underdeveloped, transport = 2 when they are less developed, transport = 3 when they are general, transport = 4 when they are relatively developed, and transport = 5 when they are very developed [14]. |
| Conditions of infrastructure | Infrastructure | The value is assigned according to the situation of the agricultural infrastructure in the village: imperfect infrastructure = 1, not very sound infrastructure = 2, relatively sound infrastructure = 3, medium infrastructure = 4, and very sound infrastructure = 5 [14]. |
| Region dummy variable | Z | This study assigns values of 1–16 to regional dummy variables according to different prefecture-level cities [51]. |

### *4.3. Model Specifications*

In order to evaluate the influence of land transfer on the aggregate labor productivity of farmer households, this study firstly applies the average treatment effect (ATE) generally used in policy evaluation to perform the empirical analysis. Whether farmer households participate in land transfer is not selected randomly but is a behavior in the land transaction market determined according to the initial level of the production efficiency. Therefore, farmer households have the issue of "self-selection". This study applies PSM (propensity score matching) to resolve "Self-selection" to guarantee the robustness of the study results.

#### 4.3.1. Model for the Effect of Land Transfer on the Aggregate Labor Productivity of Farmer Households

Before introducing a measurement model, we firstly describe the conditional mean independence (CMI), an important assumption in the method of average treatment effect [54]. According to the previous assumptions, the independence assumption for the effect of land transfer on the labor productivity of farmer households could be represented as: $E(PE_{ni}|X_i, trans_i) = E(PE_{ni}|X_i), (n = 0, 1)$, where $n$ = 1 indicates the farmer households participate in land transfer, and $n$ = 0 indicates no.

Given $p_n = E(PE_{ni})$, the aggregate labor productivity of farmer households participating in land transfer and farmer households not participating in land transfer are $PE_{0i} = p_0 + q_{0i}$ and $PE_{1i} = p_1 + q_{1i}$, respectively, and then we obtain the following:

$$E(PE_{0i}|X_i, trans_i) = p_0 + E(q_0|X_i) \cdot E(PE_{1i}|X_i, transi) = p_1 + E(q_1|X_i) \quad (1)$$

Therefore, the independence assumption of this model is represented as follows:

$$\begin{aligned} &E(PE_{ni}|X_i, trans_i) = E(PE_{ni}|X_i), (n = 0, 1) \\ &= p_0 + (p_1 - p_0)trans_i + [E(q_{0i}|X_i) - E(q_{1i}|X_i)]trans_i + E(q_{0i}|X_i) \end{aligned} \quad (2)$$

According to the definition, $p_1 - p_0 = E(EP_{1i} - EP_{0i})$ is the average value of the contribution of the participation in land transfer to the aggregate labor productivity of farmer households, which is the average treatment effect (ATE) of the land transfer on the aggregate labor productivity of farmer households. Given $\alpha = p_1 - p_0$, we use the measurement model to estimate the value of the average treatment effect. Based on the basic principles and proofs of Wooldridge [54], the I–III econometric models could be constructed. Assuming that $E(q_{ni}|X_i) = h_n(X_i')$, then Equation (2) could be expressed as follows:

$$E(PE_{ni}|X_i, trans_i) = p_0 + (p_1 - p_0)trans_i + [h_1(X_i') - h_0(X_i')]trans_i + h_0(X_i') \quad (3)$$

After eliminating the conditional expectation symbol, we obtain

$$PE_{ni} = p_0 + \alpha trans_i + [h_1(X_i') - h_0(X_i')]trans_i + h_0(X_i') + e_i \quad (4)$$

Based on the heterogeneity among different farmer households and different assumptions of effect functions, we could obtain different empirical analysis results. To estimate the value of the ATE in a more scientific manner, we design models for different forms of $h_n(X_i')$ to perform the discussion and analysis. Considering issues in the empirical analysis process, such as the data range among different variables, we select logarithms for the aggregate labor productivity of farmer households, lnPE. In a similar way, we select the logarithms for capital with lnk and operating area with lnt.

(1) Firstly, in model I, we assume that there is no heterogeneity, and assuming that $h_0(X_i') = \beta X_i'$ is a linear function, then Equation (4) is expressed as follows:

$$\ln PE_{ni} = p_0 + \alpha trans_i + \beta X_i' + \gamma Z_i + e_i \tag{5}$$

(2) Considering the heterogeneity between farmer households participating in land transfer and farmer households not transferring land, the condition is expressed as $h_1(X_i') \neq h_0(X_i')$. Assuming that $h_1(X_i') - h_0(X_i') = (X_i - \bar{X}_i)'\delta$, where $\overline{X_i}$ represents the average value of $X_i$, we could then obtain model II as follows:

$$\ln PE_{ni} = p_0 + \alpha trans_i + \delta(X_i - \overline{X_i})' \times trans_i + \beta X_i' + \gamma Z_i + e_i \tag{6}$$

(3) Assuming $h_n(X_i')$ is not a linear function any more, we use the estimated value $P(X_i)$ of PSM to replace it. Since the issue of whether the farmer households participate in land transfer is a selection model, the estimated value of the propensity score in this paper is obtained from the Logit model. At the same time, considering the heterogeneity between farmer households participating in land transfer and those not participating in land transfer, the average value of $P(X_i)$ is represented as $\overline{P(X_i)}$, and then we obtain model III:

$$\ln PE_{ni} = p_0 + \alpha trans_i + \delta[P(X_i') - \overline{P(X_i')}] \times trans_i + \beta P(X_i') + \gamma Z_i + e_i \tag{7}$$

4.3.2. Model for the Effect of Land Transfer-in on the Aggregate Labor Productivity of Farmer Households

Using $trans\_in_i = 1$ to represent that the farmer household transfers in land, while using $trans\_in_i = 0$ to represent that the farmer household does not participate in land transfer, the assumption could be represented as $E(PE_{ni}|X_i, trans\_in_i) = E(PE_{ni}|X_i), (n = 0, 1)$.

In similar manner, we obtain models for the effect of land transfer-in on the aggregate labor productivity of farmer households.

(1) Model I

$$\ln PE_{ni} = p_0 + \alpha_{in} trans\_in_i + \beta X_i' + \gamma Z_i + e_i \tag{8}$$

(2) Model II

$$\ln PE_{ni} = p_0 + \alpha_{in} trans\_in_i + \delta(X_i\ \overline{X_i})' \times trans\_in_i + \beta X_i' + \gamma Z_i + e_i \tag{9}$$

(3) Model III

$$\ln PE_{ni} = p_0 + \alpha_{in} trans\_in_i + \delta[P(X_i')\ \overline{P(X_i')}] \times trans\_in_i + \beta P(X_i') + +\gamma Z_i + e_i \tag{10}$$

4.3.3. Model for the Effect of Land Transfer-out on the Aggregate Labor Productivity of Farmer Households

Using $trans\_out_i = 1$ to represent that the farmer household transfers out land, while using $trans\_out_i = 0$ to represent that the farmer household does not participate in land transfer, the assumption is represented as $E(PE_{ni}|X_i, trans\_out_i) = E(PE_{ni}|X_i), (n = 0, 1)$.

In a similar manner, we obtain models for the effect of land transfer-out on the aggregate labor productivity of farmer households.

(1) Model I

$$\ln PE_{ni} = p_0 + \alpha_{out} trans\_out_i + \beta X_i' + \gamma Z_i + e_i \tag{11}$$

(2) Model II

$$\ln PE_{ni} = p_0 + \alpha_{out} trans\_out_i + \delta(X_i\ \overline{X_i})' \times trans\_out_i + \beta X_i' + \gamma Z_i + e_i \quad (12)$$

(3) Model III

$$\ln PE_{ni} = p_0 + \alpha_{out} trans\_out_i + \delta[P(X_i')\ \overline{P(X_i')}] \times trans\_out_i + \beta P(X_i') + \gamma Z_i + e_i \quad (13)$$

## 5. Results and Analysis

In order to discuss the impact of land transfer on the labor productivity of farmer households, this study investigates the effect of land transfer on the productivity of farmer households in the process of empirical analysis. According to the previous assumptions, we adopt each of the three models described above to conduct regression analysis. The variable being explained in the model is the aggregate labor productivity of farmer households, and the coefficient of the core explanatory variable is the ATE.

### *5.1. Results of Basic Regression Analysis*

#### 5.1.1. Regression Results of Aggregate Labor Productivity of Farmer Households

Each of the three models, including I, II and III, is used to conduct regression analysis for the total samples to investigate the effect of land transfer on the aggregate labor productivity of farmer households. Table 5 presents the results of the regression.

**Table 5.** Estimation Results of the Average Effect on the Total Productivity of the Whole Sample.

| | **Model I** | **Model II** | **Model III** |
|---|---|---|---|
| | lnPE | lnPE | lnPE |
| Trans | 0.2370 *** | 0.2635 *** | 0.2809 *** |
| | (0.0647) | (0.0762) | (0.0929) |
| Lnk | −0.0446 *** | −0.0409 *** | – |
| | (0.0091) | (0.0129) | – |
| Lnt | 0.1456 *** | 0.1532 *** | – |
| | (0.0316) | (0.0469) | – |
| Age | −0.0269 *** | −0.0300 *** | – |
| | (0.0025) | (0.0033) | – |
| Edu | 0.1208 *** | 0.1130 *** | – |
| | (0.0211) | (0.0303) | – |
| Transport | 0.0805 ** | 0.1279 *** | – |
| | (0.0324) | (0.0397) | – |
| Infrastructure | 0.0662 ** | −0.0099 | – |
| | (0.0315) | (0.0404) | – |
| Xlnk | – | −0.0133 | – |
| | – | (0.0180) | – |
| Xlnt | – | −0.0031 | – |
| | – | (0.0610) | – |
| Xage | – | 0.0082 | – |
| | – | (0.0050) | – |
| Xedu | – | 0.0196 | – |
| | – | (0.0402) | – |
| Xtransport | – | −0.1311 ** | – |
| | – | (0.0610) | – |
| Xinfrastructure | – | 0.1642 *** | – |
| | – | (0.0620) | – |
| Xps | – | – | −0.2194 |
| | – | – | (0.2825) |
| _pscore | – | – | 1.4986 *** |
| | – | – | (0.2392) |
| _cons | 9.7998 *** | 10.0677 *** | 8.5835 *** |
| | (0.2211) | (0.2709) | (0.0889) |
| N | 1368 | 1368 | 1368 |
| $R^2$ | 0.303 | 0.310 | 0.191 |

Note: *** and ** represent the significance levels of 1% and 5%, respectively.

The ATEs of the three regression models for the effects of land transfer on the aggregate labor productivity of farmer households are significant at the level of 1%, which demonstrates that land transfer improves the total productivity of farmer households. In model III, the ATE is 0.2809, which has been reported in the literature to have a good fit with micro data. We could conclude that the land transfer of farmer households could increase their aggregate labor productivity by 32.43% (e^0.2809-1). The result indicates that the aggregate labor productivity of farmer households transferring land is improved for 32.43% compared with that of farmer households that do not participate in land transfer. Therefore, it is confirmed that participation in land transfer is a critical factor for boosting the aggregate labor productivity of farmer households [32].

As previously mentioned, there is divergence in the effect on the labor productivity between transfer-in and transfer-out farmer households. Table 6 displays the results of the regression with models I, II and III.

**Table 6.** Estimation Results for the ATE of Aggregate Labor Productivity of transfer-in and transfer-out Households.

| **Farmer Household Subject** | **Effect of Households with Land Transfer-In** | | | **Effect of Households with Land Transfer-Out** | | |
|---|---|---|---|---|---|---|
| Model | Model I | Model II | Model III | Model I | Model II | Model III |
| $Trans_{\_in}/trans_{\_out}$ | 0.3164 *** | 0.3154 ** | 0.2917 ** | 0.2109 *** | 0.2523 *** | 0.2057 ** |
| | (0.1054) | (0.1312) | (0.1233) | (0.0738) | (0.0817) | (0.0812) |
| Lnk | −0.0417 *** | −0.0393 *** | – | −0.0419 *** | −0.0397 *** | – |
| | (0.0114) | (0.0138) | – | (0.0102) | (0.0130) | – |
| Lnt | 0.1326 *** | 0.1334 *** | – | 0.1328 *** | 0.1529 *** | – |
| | (0.0430) | (0.0494) | – | (0.0378) | (0.0483) | – |
| Age | −0.0298 *** | −0.0300 *** | – | −0.0271 *** | −0.0303 *** | – |
| | (0.0031) | (0.0033) | – | (0.0027) | (0.0033) | – |
| Edu | 0.1153 *** | 0.1197 *** | – | 0.1207 *** | 0.1130 *** | – |
| | (0.0283) | (0.0317) | – | (0.0226) | (0.0304) | – |
| Transport | 0.1122 *** | 0.1137 *** | – | 0.0804 ** | 0.1296 *** | – |
| | (0.0376) | (0.0400) | – | (0.0340) | (0.0401) | – |
| Infrastructure | −0.0144 | −0.0268 | – | 0.0640 * | −0.0036 | – |
| | (0.0381) | (0.0413) | – | (0.0333) | (0.0406) | – |
| Xlnk | – | −0.0089 | – | – | −0.0152 | – |
| | – | (0.0232) | – | – | (0.0218) | – |
| Xlnt | – | −0.0122 | – | – | −0.0444 | – |
| | – | (0.0832) | – | – | (0.0778) | – |
| Xage | – | 0.0024 | – | – | 0.0095 * | – |
| | – | (0.0087) | – | – | (0.0054) | – |
| Xedu | – | −0.0021 | – | – | 0.0190 | – |
| | – | (0.0613) | – | – | (0.0429) | – |
| Xtransport | – | 0.0172 | – | – | −0.1510 ** | – |
| | – | (0.0934) | – | – | (0.0648) | – |
| Xinfrastructure | – | 0.1091 | – | – | 0.1588 ** | – |
| | – | (0.0861) | – | – | (0.0675) | – |
| Xps | – | – | −0.4693 | – | – | −0.0795 |
| | – | – | (0.4530) | – | – | (0.3842) |
| _pscore | – | – | 1.8160 *** | – | – | 0.7848 *** |
| | – | – | (0.3114) | – | – | (0.2460) |
| _cons | 10.1986 *** | 10.2299 *** | 8.9626 *** | 9.8018 *** | 10.0214 *** | 8.8481 *** |
| | (0.2581) | (0.2742) | (0.0487) | (0.2309) | (0.2729) | (0.0761) |
| N | 957 | 957 | 957 | 1255 | 1255 | 1255 |
| $R^2$ | 0.352 | 0.353 | 0.245 | 0.270 | 0.278 | 0.137 |

Note: ***, ** and * represent the significance levels of 1%, 5% and 10%, respectively.

Both transfer-in and transfer-out have positive effects on the aggregate labor productivity of farmer households. The results of the ATEs of transfer-in and transfer-out households

estimated by the three models were significant at the 5% level, which was in line with the previous theoretical assumption. In model I, the ATE is 0.3164 at the 1% significant level, which means that after transferring in land, the farmer households could increase their aggregate labor productivity by 37.22% (eˆ0.3164-1) without considering individual heterogeneity among farmers. The ATE of model II is 0.3154 at the 1% significance level, which is similar to the coefficient of model I, indicating small individual differences among farmers involved in land transfer-in. When individual differences of farmers are fully considered, farmers' participation in land transfer-in can increase their aggregate labor productivity by 37.08% (eˆ0.3154-1). The regression result of model III shows that, under the non-linear assumption, land transfer still has a significant positive impact on labor productivity, but the ATE at this time is 0.2917, which is relatively small. In conclusion, the participation of farmers in land transfer-in can significantly improve their labor productivity. Although the heterogeneity of households affects the effect of land transfer, land transfer-in is still an important decision for farmers to improve their agricultural operating conditions. There is little difference among the three regression results of the effect of land transfer-out on labor productivity. However, the coefficient of model II is the largest, and the ATE is 0.2523, which is significant at the 1% level. This indicates that the aggregate labor productivity of farmers increased by 28.70% (eˆ0.2523-1) after transferring out land. In this model, the joint test of the interaction terms of transportation and infrastructure all met the significance level of 5%, indicating that the heterogeneity of farmers involved in land transfer-out has a great impact on labor productivity. Therefore, farmers should fully evaluate their resource endowment and production conditions to decide whether to participate in the land transfer market. The regression coefficient of model III is similar to that of model I, which means land transfer-out can significantly improve the overall labor production efficiency of farmer households under either linear or non-linear assumptions, and it is an important path to change the production conditions of farmers with a relatively low labor production efficiency in agriculture. In addition, all of the coefficients of the aggregate labor productivity of the transfer-in households are higher than that of transfer-out households, which means that land transfer-in plays a greater role in enhancing the total productivity of farmer households than land transfer-out. It also demonstrates that the effect of scale economy on productivity is obviously higher than the effect on productivity brought by transferring out land and releasing the labor force in agricultural production.

#### 5.1.2. Regression Results of Aggregate Labor Productivity in Different Regions

Because of the different geographical locations among cities, farmers' resources and economic conditions vary greatly. It is important to discuss the impact of land transfer on farmers' labor productivity in different regions to analyze the influence of regional heterogeneity on the research content. According to the administrative division, Shandong Province is divided into the eastern region, central region and western region. This paper respectively analyzes the ATE of the three regions with the sample data. Table 7 shows the regression results obtained by model II. Figure 3 shows the distribution of ATE among different regions in Shandong Province, which means the impact of land transfer on the labor productivity of rural households. The eastern regions include Qingdao, Yantai, Weihai, Rizhao, Weifang, Linyi and Dongying. The central regions are Jinan, Zibo, Tai'an, Binzhou, Jining and Zaozhuang. The western regions are Liaocheng, Heze and Dezhou. The effect of land transfer on labor productivity varies greatly among different regions. The coefficient in the eastern Shandong is the smallest and not significant, which is related to the relatively developed economic conditions in the eastern region. The cities in eastern Shandong are mostly coastal cities where port transportation and diversified industrial development provide more employment opportunities for farmers. Therefore, the skills and age are more important for farmers to improve labor efficiency in eastern Shandong. The regression coefficient of western Shandong Province is the largest and meets the significance level of 1%. The western regions mainly include Liaocheng, Heze and Dezhou, where the economic conditions are relatively backward, where the labor is restricted by economic

development and stays in rural areas. Thus, land transfer is an important way to improve labor productivity. The overall labor force level of farmer households in western Shandong can be increased by 72.19% (e^0.5434-1) through transferring land. The dependence on land of farmers in the central region is lower than that in the western region, but land transfer can also significantly improve their productivity. Labor productivity will be increased by 31.57% (e^0.2744-1) after transferring land.

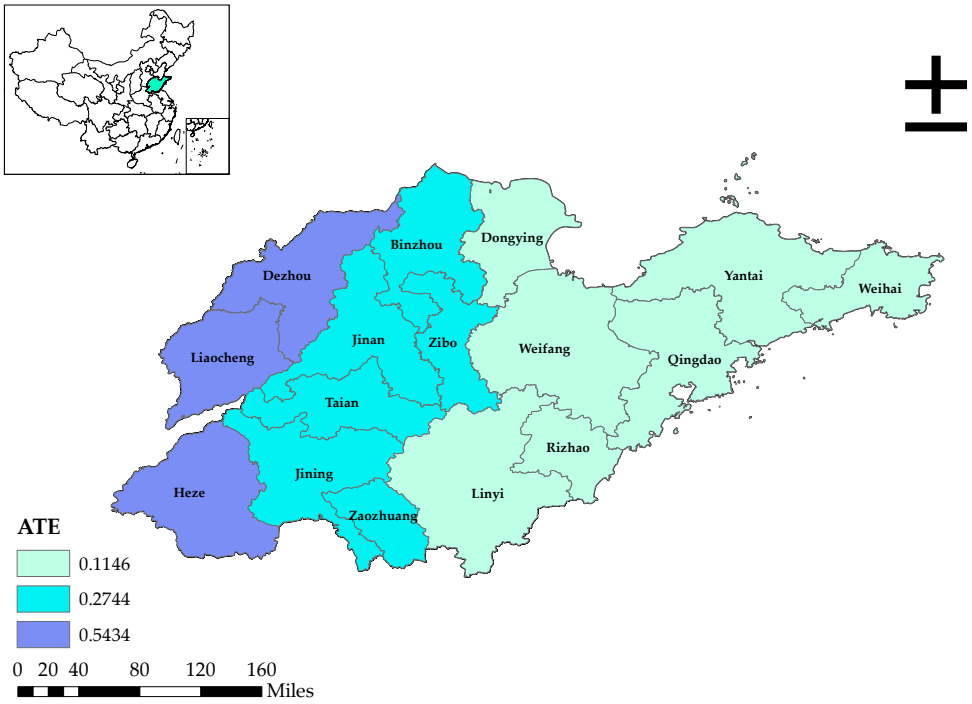


**Figure 3.** The ATEs of Three Regions.

5.1.3. Regression Results of Labor Productivity in Different Varieties

The previous parts of the paper perform theoretical analysis for the growth paths of the labor productivity of farmer households after participating in land transfer. In the theoretical hypothesis, it is believed that the improvement of agricultural labor productivity is the reason for promoting the aggregate labor productivity of transfer-in farmer households, while the improvement in the non-agricultural labor productivity is an important factor for the growth of the aggregate labor productivity of transfer-out farmer households. In order to further verify this hypothesis, we take the agricultural labor productivity and non-agricultural labor productivity of transfer-in households and transfer-out households as the variables being explained to conduct regression analysis. The regression results are shown in Tables 8 and 9, respectively.

Table 8 displays the regression results of the effect of land transfer-in on different kinds of labor productivity of households with models I, II and III. The effect of land transfer-in on the non-agricultural labor productivity of farmer households is not significant, indicating that land transfer could not significantly change the non-agricultural labor productivity of farmer households. The regression results of models I and II of the effect of land transfer-in on agricultural labor productivity are not significant. After relaxing the linear hypothesis, the regression coefficient of land transfer-in affecting agricultural labor productivity is positive. There is a non-linear relationship between land transfer and farmers' agricultural labor productivity. In model III, the ATE of land transfer-in on agricultural labor productivity is 0.7720, and the regression results are significant at the 10% level, which proved the heterogeneity among farmer households in different varieties. The ATE means that agricultural labor productivity will increase by 116.41% after transferring in land, which shows that land transfer-in boosts growth in the labor productivity of agricultural

production. In addition, the result of agricultural labor productivity is obviously higher than that of the effect on aggregate labor productivity. It could be concluded that the growth in the aggregate labor productivity of farmer households with transfer-in land is influenced by the growth in the agricultural labor productivity. The results confirms that land transfer caused the scale economy effect of farmers engaged in agricultural production, which is consistent with Huo and Chen [32]. Hence, on the basis of discussing the impact of land transfer on agricultural labor production efficiency, this paper further confirms the mechanism of land transfer-in promoting an improvement in the productivity of farmers by optimizing the agricultural management mode.

**Table 7.** Estimation Results for the ATE of Aggregate Labor Productivity in Different Regions.

| | **Eastern Region** | **Central Region** | **Western Region** |
|---|---|---|---|
| | lnPE | lnPE | lnPE |
| Trans | 0.1146 | 0.2744 ** | 0.5434 *** |
| | (0.1107) | (0.1313) | (0.2070) |
| Lnk | −0.0535 *** | −0.0107 | −0.0722 ** |
| | (0.0204) | (0.0212) | (0.0300) |
| Lnt | 0.1085 | 0.0893 | 0.4074 *** |
| | (0.0757) | (0.0744) | (0.1362) |
| Age | −0.0300 *** | −0.0281 *** | −0.0321 *** |
| | (0.0057) | (0.0050) | (0.0063) |
| Edu | 0.0540 | 0.1159 *** | 0.2108 *** |
| | (0.0490) | (0.0445) | (0.0673) |
| Transport | −0.0083 | 0.2478 *** | 0.0005 |
| | (0.0663) | (0.0600) | (0.0757) |
| Infrastructure | 0.1068 * | −0.1162 * | −0.0024 |
| | (0.0638) | (0.0614) | (0.0959) |
| Xlnk | −0.0181 | 0.0194 | −0.0027 |
| | (0.0265) | (0.0362) | (0.0407) |
| Xlnt | 0.0333 | −0.0439 | −0.1614 |
| | (0.0881) | (0.1322) | (0.1763) |
| Xage | 0.0048 | 0.0148 | 0.0078 |
| | (0.0076) | (0.0091) | (0.0115) |
| Xedu | 0.0523 | 0.0256 | −0.0281 |
| | (0.0623) | (0.0691) | (0.0760) |
| Xtransport | −0.0375 | −0.1745 * | −0.1083 |
| | (0.0938) | (0.1016) | (0.1878) |
| Xinfrastructure | 0.0399 | 0.2604 ** | 0.1365 |
| | (0.0851) | (0.1206) | (0.1732) |
| _cons | 10.5714 *** | 9.7092 *** | 10.1880 *** |
| | (0.4600) | (0.4163) | (0.6029) |
| N | 594 | 501 | 273 |
| $R^2$ | 0.299 | 0.310 | 0.400 |

Note: ***, ** and * represent the significance levels of 1%, 5% and 10%, respectively.

Table 9 displays the regression results of the effect of land transfer-out on different kinds of labor productivity of households with models I, II and III. Except for model II, the coefficients for the effect of land transfer-out on the agricultural labor productivity are in negative values. However, the results of these three models are insignificant. In the models of the effect of land transfer-out on the non-agricultural labor productivity of farmer households, the coefficients of land transfer-out are all significant, meeting the significance level of 1%. The conclusion is consistent with the previous theoretical hypothesis, which proves that farmer households improved their productivity in the non-agricultural sector by transferring out land and labor. Moreover, the land transfer-out of farmer households has a positive influence on non-agricultural labor productivity, and the results are significant at the level of 5%, which conformed with the previous theoretical hypothesis. In addition, the ATE of land transfer-out on the non-agricultural productivity is obviously higher than

the ATE on aggregate labor productivity. In model I of the effect of land transfer-out on non-agricultural labor productivity, the ATE is 0.8562 at the 1% significant level, which means that non-agricultural labor productivity will increase by 135.42% after transferring out land. When considering the heterogeneity of peasant households, the regression coefficient is 0.8253, which is similar to the coefficient of model I, but the coefficients of each interaction term are not significant, indicating there is little heterogeneity among land transfer-out farmers. The regression result of model III is similar to the result of model II while relaxing the linear assumption. Thus, it can be seen that the non-agricultural labor productivity of farmer households can be significantly improved after they transfer-out land [32]. The result demonstrates that land transfer liberates labor productivity and promotes the effective allocation of human resources. Farmers with low agricultural labor production efficiency can significantly improve their production conditions and increase their overall labor productivity by changing the family labor allocation.

**Table 8.** Effect of Land transfer-in on Different Kinds of Labor Productivity of Farmer Households.

| | **Effect on the Agricultural Production Efficiency** | | | **Effect on Non-Agricultural Production Efficiency** | | |
|---|---|---|---|---|---|---|
| | Model I | Model II | Model III | Model I | Model II | Model III |
| $Trans_{\_in}$ | 0.0985 | 0.0475 | 0.77720 * | −0.5730 | −0.9097 | −0.5620 |
| | (0.1417) | (0.1701) | (0.4237) | (0.6437) | (0.9093) | (0.7486) |
| Lnk | 0.7825 *** | 0.7633 *** | – | 0.0410 | −0.0031 | – |
| | (0.0178) | (0.0213) | – | (0.0594) | (0.0594) | – |
| Lnt | 0.1355 ** | 0.1722 ** | – | −0.6741 ** | −0.6746 ** | – |
| | (0.0682) | (0.0853) | – | (0.2633) | (0.2764) | – |
| Age | 0.0155 *** | 0.0183 *** | – | −0.0439 *** | −0.0515 *** | – |
| | (0.0054) | (0.0058) | – | (0.0147) | (0.0149) | – |
| Edu | −0.0106 | −0.0002 | – | 0.3581 ** | 0.3117 ** | – |
| | (0.0540) | (0.0595) | – | (0.1472) | (0.1538) | – |
| Transport | 0.0085 | 0.0143 | – | 0.1559 | 0.0861 | – |
| | (0.0653) | (0.0703) | – | (0.1611) | (0.1648) | – |
| Infrastructure | −0.0231 | −0.0343 | – | 0.1194 | 0.2307 | – |
| | (0.0720) | (0.0799) | – | (0.1960) | (0.2103) | – |
| Xlnk | – | 0.0763 ** | – | – | 0.1787 | – |
| | – | (0.0300) | – | – | (0.1825) | – |
| Xlnt | – | −0.1185 | – | – | 0.1949 | – |
| | – | (0.0930) | – | – | (0.7210) | – |
| Xage | – | −0.0309 *** | – | – | 0.0861 | – |
| | – | (0.0117) | – | – | (0.0668) | – |
| Xedu | – | −0.1346 | – | – | −0.0532 | – |
| | – | (0.0985) | – | – | (0.6208) | – |
| Xtransport | – | −0.0430 | – | – | 0.7897 | – |
| | – | (0.1468) | – | – | (1.0522) | – |
| Xinfrastructure | – | 0.0494 | – | – | −0.8657 * | – |
| | – | (0.1516) | – | – | (0.4999) | – |
| Xps | – | – | 0.5086 | – | – | −1.3355 |
| | – | – | (1.6360) | – | – | (3.0902) |
| _pscore | – | – | −6.3758 *** | – | – | −0.3960 |
| | – | – | (1.0448) | – | – | (1.6768) |
| _cons | −0.4304 | −0.5188 | 6.0179 *** | 9.4001 *** | 9.9906 *** | 8.2575 *** |
| | (0.4672) | (0.5019) | (0.1395) | (1.2534) | (1.3005) | (0.2134) |
| N | 847 | 847 | 847 | 532 | 532 | 532 |
| $R^2$ | 0.795 | 0.796 | 0.336 | 0.165 | 0.179 | 0.113 |

Note: ***, ** and * represent the significance levels of 1%, 5% and 10%, respectively.

**Table 9.** Effect of Land transfer-out on Different Kinds of Labor Productivity of Farmer Households.

| | **Effect on the Agricultural Production Efficiency** | | | **Effect on Non-agricultural Production Efficiency** | | |
|---|---|---|---|---|---|---|
| | Model I | Model II | Model III | Model I | Model II | Model III |
| Trans_out | −0.2280 | 0.1215 | −0.0682 | 0.8562 *** | 0.8253 *** | 0.8351 *** |
| | (0.1664) | (0.2483) | (0.2573) | (0.2449) | (0.2870) | (0.2524) |
| Lnk | 0.7449 *** | 0.7622 *** | – | −0.0310 | −0.0183 | – |
| | (0.0194) | (0.0209) | – | (0.0380) | (0.0570) | – |
| Lnt | 0.1246 | 0.1070 | – | −0.5550 *** | −0.6505 ** | – |
| | (0.0882) | (0.0924) | – | (0.1783) | (0.2763) | – |
| Age | 0.0146 *** | 0.0185 *** | – | −0.0480 *** | −0.0510 *** | – |
| | (0.0051) | (0.0058) | – | (0.0096) | (0.0146) | – |
| Edu | 0.0629 | 0.0221 | – | 0.1734 ** | 0.2805 * | – |
| | (0.0574) | (0.0574) | – | (0.0877) | (0.1509) | – |
| Transport | 0.0057 | 0.0009 | – | 0.0968 | 0.1350 | – |
| | (0.0629) | (0.0695) | – | (0.1127) | (0.1638) | – |
| Infrastructure | −0.0597 | −0.0331 | – | 0.1854 | 0.1891 | – |
| | (0.0698) | (0.0801) | – | (0.1167) | (0.2041) | – |
| Xlnk | – | −0.0877 * | – | – | −0.0220 | – |
| | – | (0.0458) | – | – | (0.0783) | – |
| Xlnt | – | 0.0512 | – | – | 0.2387 | – |
| | – | (0.1995) | – | – | (0.3357) | – |
| Xage | – | −0.0240 * | – | – | 0.0070 | – |
| | – | (0.0124) | – | – | (0.0198) | – |
| Xedu | – | 0.2311 | – | – | −0.2353 | – |
| | – | (0.1501) | – | – | (0.1742) | – |
| Xtransport | – | 0.0205 | – | – | −0.0859 | – |
| | – | (0.1612) | – | – | (0.2044) | – |
| Xinfrastructure | – | −0.1101 | – | – | −0.0196 | – |
| | – | (0.1404) | – | – | (0.2241) | – |
| Xps | – | – | 8.7420 *** | – | – | −1.5021 |
| | – | – | (3.2900) | – | – | (1.1963) |
| _pscore | – | – | −8.6851 *** | – | – | 3.1269 *** |
| | – | – | (1.6825) | – | – | (0.9610) |
| _cons | −0.1180 | −0.4322 | 7.0140 *** | 10.2732 *** | 10.1010 *** | 7.3144 *** |
| | (0.4583) | (0.4994) | (0.3465) | (0.8598) | (1.2868) | (0.3814) |
| N | 918 | 918 | 918 | 781 | 781 | 781 |
| $R^2$ | 0.724 | 0.728 | 0.274 | 0.155 | 0.158 | 0.102 |

Note: ***, ** and * represent the significance levels of 1%, 5% and 10%, respectively.

### *5.2. Propensity Score Matching Results*

There is the issue of "self-selection" in deciding whether to participate in land transfer due to the decision-making characteristics of different farmer households. Therefore, this study analyzes the effect of land transfer on the aggregate labor productivity of farmer households that have already participated in land transfer-in or transfer-out and further explores the influence path based on the consideration of the "self-selection" behaviors. It refers to the PSM analysis process of Rosenbaum and Rubin (1983) [55], Heckman et al. (1997) [56] and Augrist (1998) [57] to further test the effect of land transfer on labor productivity. In this study, we take the farmer households not participating in land transfer as the control group, while the transfer-in and transfer-out households are the experimental group. According to the previous measurement model, the aggregate labor productivity of farmer households meets the assumption of conditional mean independence (CMI). The ATTs calculated for the transfer-in and transfer-out households matched with the propensity score matching method could be, respectively, represented with $ATT = \frac{1}{N_1}\sum_{i,trans\_in=1}(PE_{1i} - PE_{0i})$ and $ATT = \frac{1}{N_2}\sum_{i,trans\_out=1}(PE_{1i} - PE_{0i})$. $N_1$ and $N_2$ represent the number of transfer-in households and number of transfer-out households, respectively. Both the agricultural labor productivity and non-agricultural labor

productivity meet the conditional independence assumption. The corresponding ATTs could be calculated in the same way.

This study applies four PSM methods (Kernel Matching, Radius Matching, Neighbor Matching and Mahalanobis Matching) to estimate the average treated effect (ATT). $ATT_K$, $ATT_R$, $ATT_N$ and $ATT_M$ are used to represent the ATTs estimated by the above four methods, respectively. In order to further study the heterogeneity of the effect of land transfer on the total productivity of farmer households participating in land transfer, land transfer-in and land transfer-out households are both matched with households not participating in land transfer to estimate the ATT. The specific results are shown in Tables 9 and 10.

**Table 10.** Basic Estimation Results of ATT for the Productivity of Land Transfer-in Households.

| Variable Being Explained | | Trans-in | | | |
|---|---|---|---|---|---|
| | | **$ATT_K$** | **$ATT_R$** | **$ATT_N$** | **$ATT_M$** |
| Aggregate Labor | Coefficient | 0.4950 | 0.5858 | 0.5599 | 0.5599 |
| Productivity of Households | t | 3.70 | 3.93 | 3.93 | 4.58 |
| Agricultural Labor | Coefficient | 0.2486 | 0.2146 | 0.2415 | 0.2415 |
| Productivity of Households | t | 0.53 | 0.41 | 0.46 | 044 |
| Non-agricultural Labor | Coefficient | −1.4622 | −1.1474 | −1.2173 | −1.2173 |
| Productivity of Households | t | −1.88 | −1.34 | −1.45 | −1.49 |

#### 5.2.1. ATT Estimation Results of Households with Land Transfer-in

Table 10 displays the four kinds of ATT estimation results of the effect of land transfer-in on the aggregate labor productivity of farmer households. All of the ATTs are significant at the level of 1%, which was consistent with the direction of the ATE results obtained from regression analysis. On the one hand, the ATT estimation results of the sample for farmer households with land transfer-in demonstrate that land transfer-in obviously increases the aggregate labor productivity. Moreover, the lowest value of ATT is 0.4950, which is higher than those obtained from regression analysis. The results demonstrate that after transferring land, the growth rate of farmer households with land transfer-in is higher than that of households in any other sample groups. On the other hand, the ATT of the agricultural labor productivity and non-agricultural labor productivity of farmer households participating in land transfer-in are not significant. The results mean that land transfer-in could improve the aggregate labor productivity of the farmer households, but their agricultural labor productivity and non-agricultural labor productivity did not have significant increases.

#### 5.2.2. ATT Estimation Results of Households with Land Transfer-out

Table 11 displays the four kinds of ATT estimation results of the effect of land transfer-out on the aggregate labor productivity of farmer households. The four kinds of ATT estimation results of the effect of land transfer-out on the aggregate labor productivity and agricultural labor productivity are both consistent with the direction of ATE obtained from regression analysis. However, all results are insignificant. On the one hand, as indicated in the estimation results, the land transfer-out significantly increases the non-agricultural labor productivity of farmer households. The ATT values are significant at the level of 1%. The ATT of it is greater than 0.6589, which is obviously higher than the ATE values. After transferring out land, as indicated above, the growth rate of the non-agricultural labor productivity of households with land transfer-out is higher than that of the non-agricultural labor productivity of any sample households. On the other hand, the results also explain that land transfer-out liberalizes the agricultural labor force from land elements, which has significantly improved the efficiency of the farmer households in non-agricultural sectors. Therefore, farmer households with a relatively low agricultural productivity are encouraged to transfer-out land to improve the non-agricultural operation capability

and optimize the allocation of land resources to boost the high-quality development of agricultural production.

**Table 11.** Basic Estimation Results of ATT for the Productivity of Land Transfer-out Households.

| Variable Being Explained | | Trans$_{-out}$ | | | |
|---|---|---|---|---|---|
| | | **ATT$_K$** | **ATT$_R$** | **ATT$_N$** | **ATT$_M$** |
| Aggregate Labor | Coefficient | 0.0216 | 0.0310 | 0.0254 | 0.0254 |
| Productivity of Households | t | 0.27 | 0.35 | 0.29 | 0.30 |
| Agricultural Labor | Coefficient | −0.3754 | −0.4474 | −0.4285 | −0.4285 |
| Productivity of Households | t | −1.58 | −1.68 | −1.61 | −1.69 |
| Non-agricultural Labor | Coefficient | 0.6589 | 0.8866 | 0.8029 | 0.8029 |
| Productivity of Households | t | 2.42 | 3.16 | 2.79 | 2.95 |

### *5.3. Description about the Robustness of Empirical Analysis*

In investigating the effects of land transfer on farmer households, different regression methods and matching methods have diverse standards, and their results have both advantages and disadvantages. On the basis of the full consideration of heterogeneity, non-linear issues and endogenous issues, three kinds of models are applied to check the effect of land transfer on the aggregate labor productivity of farmer households. In utilizing PSM to resolve the issue of "self-selection", we apply four matching methods, including Kernel Matching, Radius Matching, Neighbor Matching and Mahalanobis Matching. The direction of the regression results is basically the same for each method, and the significance level of all of them is relatively high. In verifying the path with PSM, the effects of land transfer-in on aggregate labor productivity and land transfer-out on non-agricultural labor productivity are both significant in positive values. Therefore, the regression results and ATT estimation results of land transfer on the production efficiency of farmer households could both meet the requirements of robustness.

However, as the income and expenditure of each family are not equivalent, the average labor income to represent agricultural labor productivity may impact the accuracy of the empirical results. Therefore, this article removes the transfer income from the household income of farmers, including agricultural production subsidies, social security income, etc., then takes the logarithm of the average labor income of farmer households after elimination as the new predicted variable, which is expressed as variable lnNPE. Then, the ATE is estimated by using the three models mentioned above to ensure robustness.

Table 12 shows the results of the ATE of the robust test. The results after replacing the explained variables are significant at the level of 1%, and the estimated values of the ATE are similar to the estimated value obtained above. The empirical results show that land transfer could effectively improve the labor productivity of farmer households, which highly supported the conclusions of the previous theoretical analysis.

**Table 12.** Estimation Results of the Average Effect of Robust Test.

| | **Model I** | **Model II** | **Model III** |
|---|---|---|---|
| | lnNPE | lnNPE | lnNPE |
| Trans | 0.2388 *** | 0.2675 *** | 0.2818 *** |
| | (0.0655) | (0.0770) | (0.0940) |
| Lnk | −0.0448 *** | −0.0410 *** | – |
| | (0.0091) | (0.0130) | – |
| Lnt | 0.1470 *** | 0.1557 *** | – |
| | (0.0318) | (0.0473) | – |
| Age | −0.0272 *** | −0.0304 *** | – |
| | (0.0026) | (0.0033) | – |

**Table 12.** *Cont.*

| | Model I | Model II | Model III |
|---|---|---|---|
| Edu | 0.1216 *** | 0.1138 *** | – |
| | (0.0214) | (0.0307) | – |
| Transport | 0.0814 ** | 0.1291 *** | – |
| | (0.0328) | (0.0402) | – |
| Infrastructure | 0.0663 ** | −0.0108 | – |
| | (0.0318) | (0.0407) | – |
| Xlnk | – | −0.0139 | – |
| | – | (0.0182) | – |
| Xlnt | – | −0.0050 | – |
| | – | (0.0615) | – |
| Xage | – | 0.0084 * | – |
| | – | (0.0051) | – |
| Xedu | – | 0.0197 | – |
| | – | (0.0407) | – |
| Xtransport | – | −0.1316 ** | – |
| | – | (0.0617) | – |
| Xinfrastructure | – | 0.1662 *** | – |
| | – | (0.0624) | – |
| Xps | – | – | −0.2152 |
| | – | – | (0.2847) |
| _pscore | – | – | 1.5070 *** |
| | – | – | (0.2417) |
| _cons | 9.8023 *** | 10.0745 *** | 8.5729 *** |
| | (0.2234) | (0.2740) | (0.0898) |
| N | 1368 | 1368 | 1368 |
| $R^2$ | 0.302 | 0.309 | 0.190 |

Note: ***, ** and * represent the significance levels of 1%, 5% and 10%, respectively.

## 6. Conclusions and Policy Recommendations

Under the context of high-quality development of agriculture, this paper investigates the effect of land transfer on productivity from the perspective of farmer households. As demonstrated by the regression analysis results for the total samples, participation in land transfer has a positive effect on the aggregate labor productivity of households in all sample groups and farmer households participating in land transfer. Moreover, the effect on households participating in land transfer is more significant. In addition, there is obvious asymmetry in the effect of land transfer on productivity among farmer households participating in land transfer in different methods. Both the transfer-in and transfer-out of land promote improvements in agricultural productivity, and the transfer-out of land has a positive influence on non-agricultural labor productivity. The growth rate of the aggregate labor productivity of farmer households with land transfer-in is obviously higher than that of the productivity of farmer households as a whole. The ATT values of farmer households with land transfer-out toward the non-agricultural production efficiency are higher than the ATE values obtained from regression analysis, indicating that land transfer-out promotes the labor force to engage in non-agricultural production and thus improves non-agricultural labor productivity. The conclusions of this study are the same as those of Mao Peihua et al. [51] and Liu Weibai et al. [43] and verify the theoretical hypothesis that land transfer can promote the progress of farmers' aggregate labor productivity. Due to the limitation of space and time, the contents of this research are based on the data of farmers in 2018 obtained by the team in Shandong Province. There are certain time and geographical restrictions on the conclusions. It is urgently required to continue to investigate the production conditions of farmers and update the study data in Shandong Province in the future. Furthermore, it is necessary to conduct field investigations in other representative agricultural provinces in China to demonstrate the generality of the conclusions.

This study put forward the following recommendations to facilitate the farmer households to take good command of their direction and adjust their thoughts in future rural construction:

(1) Participating in land transfer could obviously improve the total productivity of farmer households. It is suggested to ameliorate the conditions for farmer households to participate in land transfer to promote more potential households participate. Firstly, the clear property right of farmland is the premise that land enters the circulation market. Therefore, rural land rights confirmation and warrant registration should be carried out continuously. Secondly, the government should bring up and improve land transfer markets at various levels and establish an orderly, fair and transparent transfer system. It is necessary to take full advantage of the information generation and transmission function of the transfer market for rural land to reduce the uncertainty in transactions and incompleteness in information. Then, it is necessary to accelerate the reform of the household register, eliminate the regional protectionism under the household register system and attach high importance to the rural migrant labor force to promote rural–urban integration. Finally, it is critical to reduce the worries and concerns in the transfer of rural lands by creating a stable social security mechanism.

(2) The rural revitalization strategy has promoted the development of some villages, accelerated the upgrading of industry or tourism in rural areas and improved the non-agricultural productivity, as well as the aggregate labor productivity, of farmer households. However, some villages still have problems, such as backward development, the absence of mainstay industries, etc. Therefore, it is required to continue boosting the urban–rural integration and development and attach higher importance on the connected effect in the urban–rural development to create more employment opportunities for farmer households. Meanwhile, it is recommended to establish and improve the employment mechanism for farmers to work in cities. Consequently, it is compulsory to take measures to promote the effective transfer of the residual labor force in villages to improve the aggregate labor productivity of farmer households transferring out land. In addition, it is necessary to take advantage of the educational resources in cities to improve the technical competence of rural migrant workers, which will effectively increase the non-agricultural productivity of the labor force of farmer households.

(3) It is required to increase infrastructure investment and improve agricultural production conditions. According to the research results, infrastructure has an important impact on agricultural productivity. In order to further narrow the gap of production conditions between regions, it is needed to increase the investment in water conservancy, transportation, energy and other aspects, which will improve the agricultural planting environment and raise the efficiency of agricultural labor production. In addition, the level of farmland infrastructure also affects the feasibility of land transfer as improving the agricultural production environment can effectively break the transfer barrier and increase the land transfer rate.

(4) It is also important to enhance the skills training of farmers and improve their ability to generate income. Under the background of an urban–rural dual structure, farmers' skills in the non-agricultural sector are relatively backward compared with urban residents. Through vocational training and other means, we can significantly improve their production capacity, thus improving the overall labor productivity. Therefore, it is necessary for grassroots organizations to properly carry out technical training and introduce scientific research talents with the help of government forces to train farmers. After transferring out the land, the remaining labor force should enrich their skills according to the production field they will be engaged in. They can learn relevant knowledge through the Internet and training institutions to improve their productivity.

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