Can farmland transfer reduce vulnerability to poverty among the mid-aged and elderly in rural China?

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ABSTRACT

Exploring the influence of farmland transfer on poverty among the mid-aged and elderly rural households is of great value in preventing them from returning to poverty and in solving the problem of rural poverty. Based on the propensity score matching with differences in differences approach, this paper measures and compares the effects of farmland transfer-in and transfer-out on the vulnerability to poverty of the mid-aged and elderly rural households by using the tracking survey of China Health and Retirement Longitudinal Study (CHARLS) in 2015 and 2018. The findings reveal that: (1) The anti-poverty effect of farmland transfer is "asymmetric". Farmland transfer-in can significantly reduce the vulnerability to poverty of the lessee households, but farmland transfer-out has no such effect. (2) Obvious regional and household differences exist in the anti-poverty effect of farmland transfer. The anti-poverty effects of farmland transfer-in in the eastern and central regions are higher than in other regions. The greater vulnerability to poverty is associated with the more obvious anti-poverty effect of farmland transfer-in. These results benefit the government to strengthen the reforms related to farmland transfer and anti-poverty.

1. Introduction

Poverty is one of the main problems currently plaguing low-and middle-income countries [1,2]. In China, rural settings are the areas that are prone to poverty [1], in which farmland is essential for the livelihoods of poor households [3]. A series of reforms related to farmland contracts in China have laid a solid institutional foundation for land transfer and made farmland transfer play an increasingly prominent part in poverty alleviation [4]. However, farmland transfer may also pose multiple risks to rural households, e. g., the loss of farmland management rights caused by farmland transfer-out or the increase of agricultural management risk caused by farmland transfer-in. In China, because a large number of the young agricultural population work in the non-agricultural sector, most of the family members still in rural homes are mid-aged and older adults and children. The rural mid-aged and older adults face a high risk of returning to poverty because of the decline in labor ability. Therefore, it is worthwhile to discuss the anti-poverty effect of farmland transfer among the mid-aged and older adults in rural settings and the heterogeneity of this anti-poverty effect.

Many researchers have studied how farmland transfer influenced income change [5–8]. The related studies had mixed results. Li et al. [9] identified that farmland transfer-in and transfer-out were both positively associated with net income. Some researchers revealed that farmers who transferred out farmland earned more money than those who transferred in farmland, because those who transferred out farmland obtained not only rental income, but also non-agricultural employment income, while those who transferred

in farmland faced cost constraints [10–12]. Other studies believed that the impact of farmland transfer-out on labor force release was insufficient, while farmland transfer-in had a more significant effect on income poverty prevention [5,13]. Si et al. [14] indicated that farmland rental contracts positively and significantly improved lessees' family welfare in China. Some empirical studies targeting developing countries have also confirmed the poverty reduction effect of farmland transfer-in. For example, Kijima and Tabetando [15] found that the increase in owned land helped decrease poverty in Uganda. Ayalew et al. [16] identified that the land certification could promote the rental market participation and hire labor for poor households in rural Ethiopia, thereby improving their welfare. However, some researchers found that the participation in farmland transfer did not necessarily lead to poverty alleviation [17,18].

Considering that the existing studies have not yet reached a unified conclusion on whether farmland transfer can truly alleviate poverty, further in-depth research is needed to accumulate more evidence. Moreover, the existing studies on the anti-poverty effect of farmland transfer had some limitations. First, previous studies focused on how farmland transfer reduced income poverty, which only observes the current welfare level of individuals or households [6,8,13,15]. However, "Anti-poverty" needs a forward-looking projection, which can predict the future welfare changes of individuals or households caused by farmland transfer. Vulnerability to poverty is an ex-ante measure of poverty risk, which can identify the population who are prone to suffer impoverishment in the future [19,20]. Vulnerability to poverty is defined as the likelihood that a household would suffer at least one episode of impoverishment shortly or over a given number of periods [21,22]. Chaudhuri et al. [23] believed that vulnerability to poverty makes a great impact on the future of anti-poverty interventions. Therefore, assessing how farmland transfer affects households' vulnerability to poverty can strengthen the pertinence of anti-poverty policies from the perspective of risk prevention. Second, there existed some researches purely focused on farmland transfer-in or transfer-out, but these two types of transfer have different mechanisms and risks on income-raising [5–8,11]. Very few studies systematically compared the "anti-poverty" effects between farmland transfer-in and transfer-out. The contribution of this paper is to focus on the risk of rural households falling into poverty in the future after the transfer of farmland, introducing the concept of vulnerability to poverty to compensate for the shortcomings of using the current income to measure poverty. This study also aims at measuring and comparing the impact of farmland transfer-in and transfer-out on vulnerability to poverty, as well as evaluating the heterogeneity of such impact from multiple perspectives.

2. The influence mechanisms of farmland transfer on vulnerability to poverty

The farmland transfer discussed in our paper means the transfer of farmland management rights, that is, the rural household with farmland management rights transfers the farmland management rights to another rural household, economic organizations or entities. Since farmland transfer-in and transfer-out are various in obtaining income and encountering risks, we discussed the two situations separately.

2.1. Effects of farmland transfer-in on vulnerability to poverty

Rural households' income comes from multiple sources. The rural population can transfer land to those with higher agricultural production levels, thus improving the utilization rate of farmland resources and labor production efficiency. For the lessee households, they need to pay a certain farmland rent, thus increasing the cost of agricultural production in the short term. However, since the lessee households have more farmland, they can develop agricultural mechanized production and apply new technologies into production, to continuously improve the agricultural operating income [24], which can directly increase the household's ability to resist risks in the future. For farmland transfers between relatives, neighbors or friends, the farmland rental rate is zero or even negative [25]. Furthermore, in reality, considering the seasonality of agricultural production, the small volume of farmland transfer-in may limitedly affect the non-agricultural income of the lessee households. In addition, to encourage rural households to transfer-in farmland, several subsidy and incentive policies have taken effect in China, which has reduced the cost of agricultural production of the lessee households [26]. Consequently, in the long run, the benefits to the lessee households will outweigh the risks that they face. So their ability to resist poverty will also be enhanced.

Hypothesis 1. Farmland transfer-in can reduce the vulnerability to poverty of the mid-aged and elderly rural households.

2.2. Effects of farmland transfer-out on vulnerability to poverty

Farmland and labor are the two main assets of rural households. Theoretically, farmland transfer-out can improve the allocation efficiency of household farmland and labor resources, and change the income structure. However, the effect of farmland transfer-out on the overall welfare of the lessor households is ambiguous. On the one hand, the lessor households obtain relatively sustainable and stable farmland rent income through the transfer-out of farmland management rights. On the other hand, transfer-out farmland results in a decline in gross farm revenue. At the same time, farmland transfer-out can increase the non-agricultural employment within the rural household [27,28] or allocate funds to other higher-income business projects, thus increasing the non-agricultural income. Previous studies have confirmed that farmland transfer-out is significantly related to the non-agricultural employment of family members [29] and can improve the wage income, operating income, and transfer income of the lessor households [13,26]. In addition, in the process of employment in urban sectors, the rural population can broaden their knowledge, change their value norms, enhance their social competitiveness, and then eventually achieve poverty prevention. However, this view ignores the possibility that the middle-aged and elderly transfer out farmland because of the decline of labor ability or the desire to increase leisure time, and in the rural households with the middle-aged and elderly, the young family member may already work in the non-agricultural sector before

farmland transfer-out. Therefore, farmland transfer-out may play a less obvious role in reducing vulnerability to poverty than farmland transfer-in in a rural household with the mid-aged and elderly.

Hypothesis 2. The effect of farmland transfer-out on the vulnerability to poverty of the mid-aged and elderly rural households is weaker than that of farmland transfer-in.

3. Methods and materials

3.1. Vulnerability to poverty

This study used vulnerability as expected poverty (VEP) to assess vulnerability to poverty. VEP is the probability that the expected per capita consumption (or income) of the household in the future is lower than a certain value (usually the poverty line), referring to the likelihood that the household will suffer impoverishment in the future [23]. Other indicators that measure vulnerability to poverty include uninsured exposure to risk (VER) and vulnerability as low expected utility (VEU). VER represents an ex-post measure of the extent to which the growth rate of household consumption varies with the household income growth rate [30]. VEU uses the difference between the utility of consumption level and the expected utility of future consumption as a vulnerability measure value [31], but is less straightforward to interpret [32]. VEP is an ex-ante approach to poverty risk [23]. Since we were especially interested in the probability of rural households falling into poverty in the future, we focused on VEP that has a forward-looking perspective and is easier to interpret.

Denoted by *VUL*, vulnerability to poverty in this paper is defined by the following equation (1):

$$VUL_{i,t} = \Pr\left(Y_{i,t+1 \leq} Z\right) \tag{1}$$

where $Y_{i,t+1}$ is the rural household's per-capita annual net income level at time $t+1$ and Z is the suitable poverty line. *VUL* at time t is decided by Y at time $t + 1$.

To measure the vulnerability to poverty, we must first predict the future income of rural households. The formula is expressed by the following equation (2):

$$\ln Y_i = \alpha + \beta X_i + e_i \tag{2}$$

where $\ln Y_{i,t}$ is the logarithm of the per capita annual net income level for household i; X_{it} represents the characteristics that affect income, including household head characteristics and family characteristics. α represents intercept, β is a vector of parameters, and e_i is a mean-zero disturbance term.

We allow the variance of e_i to depend upon observable rural household characteristics in some parametric way. We assume the variance of e_i with an extremely simple functional form can be calculated using the following equation (3):

$$\sigma_{e,i}^2 = X_i \theta \tag{3}$$

We estimate β and θ relying on a three-step feasible generalized least squares procedure [33]. Then, the expected log income is expressed by the following equation (4):

$$\widehat{E}[ln \, Y_i | X_i] = X_i \widehat{\beta} \tag{4}$$

and the variance of log income can be calculated using the following equation (5):

$$\widehat{V}[ln \, Y_i | X_i] = \sigma_{e,i}^2 = X_i \widehat{\theta} \tag{5}$$

Finally, letting Φ (.) denote the cumulative density of the standard normal, the estimated *VUL* is expressed by the following equation (6):

$$\widehat{VUL}_i = \widehat{Pr}(ln \, Y_i < lnZ | X_i) = \varphi\left(\frac{lnZ - X_i\widehat{\beta}}{\sqrt{X_i\widehat{\theta}}}\right) \tag{6}$$

3.2. Propensity score matching with differences in differences (PSM-DID) estimator

We evaluated the anti-poverty effect of farmland transfer by evaluating the differences in *VUL* among rural households before and after the farmland transfer. Since farmland transfer is a choice made by rural households according to their different situations, this may result in the problems of self-selection and endogeneity, which the traditional regression cannot account for. PSM is the method to reduce such bias [34,35]. By matching a treatment group with a control group based on observational characteristics, the two groups are observationally comparable except for whether the treatment has taken place. However, this method cannot account for the difference between treatment and control groups resulting from unobservable or omitted variables [36], whereas a method of DID can [37]. Therefore, we applied the PSM-DID to overcome the problem of sample selection bias and endogeneity more effectively, and increase comparability between treatment and control groups [38], to scientifically evaluate the net effect of different farmland transfer models on poverty-alleviation. We followed the steps below:

First, we used a logistic model to calculate the conditional probability of the mid-aged and elderly rural households participating in farmland transfer, aiming at estimating the propensity score.

Second, we matched the samples of the farmland transfer group and the non-transfer group according to the propensity score.

Third, we employed the DID to evaluate the anti-poverty effect of farmland transfer using the matched treatment and control groups. Equation (7) shows the average treatment effect, $ATT_{\text{PSM-DID}}$, is expressed as:

$$ATT_{\text{PSM-DID}} = \mathrm{E}\left(Y_{18}^{\mathrm{T}} - Y_{15}^{\mathrm{T}} | X, D = 1\right) - \mathrm{E}\left(Y_{18}^{\mathrm{C}} - Y_{15}^{\mathrm{C}} | X, D = 0\right) \tag{7}$$

where Y represents the impact of farmland transfer on vulnerability to poverty; the subscripts 18 and 15 represent the year of 2018 and the year of 2015, respectively; and the superscripts T and C denote the treatment group and the control group, respectively. X denotes a vector composed of multiple covariates, which mainly include individual characteristics, family characteristics, and dummy variables of regions. D is a dichotomous variable, and D = 1 means participating in farmland transfer, while D = 0 means not participating in farmland transfer.

3.3. Dataset

The dataset in this study is sourced from the China Health and Retirement Longitudinal Study (CHARLS) implemented by Peking University. CHARLS is a longitudinal survey that aims to be representative of the residents in mainland China aged 45 and older. The CHARLS questionnaire mainly includes personal basic information, family structure and economic support, health status, medical service utilization and medical insurance, work, retirement, pension, income, consumption, assets, etc. A stratified (by per capita GDP of urban districts and rural counties) multi-stage (county/district-village/community household) Probability Proportional to Size random sampling strategy was adopted [39]. A total of 150 counties or urban districts were chosen with probability proportional to population size. For each county-level unit, 3 villages and urban neighborhoods are randomly chosen with probability proportional to population [40].

This study utilized the data from two waves of CHARLS in 2015 and 2018. In the 2018 round, a total of 19,000 respondents in 12,400 households had been surveyed. The samples came from 26 out of 31 provinces in China, covering the eastern, central, western, and northern regions of China, and are representative.

This study chose the 2015 CHARLS data as the starting year for the survey, as the reason that in 2015, the Chinese government issued the "Decision of the Central Committee of the Communist Party of China and the State Council on Winning the War of Poverty Alleviation", which emphasized farmland transfer as an important way to increase the income of impoverished households. The latest data released by CHARLS was from 2018, so this study chose 2015 and 2018 as the monitoring years.

This study selected households living in rural areas as the sample. To study the anti-poverty effect of farmland transfer, we kept the samples who did not transfer farmland in 2015. To form a balanced panel data, only the households interviewed in both 2015 and 2018 were included in the analysis and the samples with missing values and abnormal observations in the data were deleted. In the end, a total of 3218 rural households were finally kept, including 161 rural households that did not transfer farmland in 2015 but transferred in farmland in 2018, and 486 households that did not transfer farmland in 2015 but transferred out farmland in 2018. All the rural households who transferred in or out farmland accounted for 20.1 % of the total sample.

3.4. Variables and their measurement

Table 1 briefly summarizes all relevant variables, with means and standard deviations. The dependent variable was vulnerability to poverty. At the Central Conference on Poverty Alleviation and Development in November 2011, the China's central government decided to set a national poverty standard of 2300 yuan per capita net income for rural residents (at 2010 prices). We also took the World Bank's extreme poverty line of US $1.9 per day and high poverty line of US $3.1 per day to conduct a robustness test [41].

We defined the key independent variables as whether rural households transferred in or transferred out farmland. This paper used whether to rent in cultivated land to represent farmland transfer-in and whether to rent out cultivated land to represent farmland transfer-out. Two categories of control variables were included in this study: individual characteristics and family characteristics. We selected age, gender, marital status, education, and self-reported health status of the household head as individual characteristics [23, 42,43]. We included the household size, the proportion of household labor force, as well as value of productive, durables, and financial assets as family characteristics [23,44,45]. Meanwhile, we also introduced dummy variables of regions to control the fixed effects of regions.[1] It is noted that the key independent variable and family characteristics variables were defined at the household level. The household head characteristics variables were defined in the individual level.

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[1] According to the division of China's economic regions, this paper divided China into four regions: the eastern, central, western and northeastern region (reference group).

Table 1
Variables, description, and descriptive statistics.

Variable			Description	2015		2018	
				Mean	SD	Mean	SD
Dependent variable	vulnerability to poverty	Vul1	Adopting China's national poverty standard of 2300 yuan per capita net income (at 2010 prices) to measure *VUL*	0.292	0.198	0.153	0.174
		Vul2	Adopting the World Bank's extreme poverty line of US $1.9 per day to measure *VUL*	0.313	0.204	0.176	0.187
		Vul3	Adopting the World Bank's high poverty line of US $3.1 per day to measure *VUL*	0.539	0.226	0.390	0.259
Independent variable	Farmland transfer	Farmland transfer–in	1 = yes, 0 = not	0	0	0.050	0.218
		Farmland transfer–out	1 = yes, 0 = not	0	0	0.151	0.358
Control variable	Individual characteristic	Gender	1 = male, 0 = female	0.440	0.496	0.440	0.496
		Age(Year)		61.180	10.994	64.180	10.994
		Marital status	1 = married, 0 = unmarried	0.776	0.417	0.738	0.445
		Elementary school or middle school	1 = yes, 0 = not	0.397	0.489	0.397	0.489
		Vocational school, high school or above	1 = yes, 0 = not	0.044	0.206	0.044	0.206
		Self-reported health status	1 = excellent; 2 = good; 3 = normal; 4 = poor; 5 = very poor	2.922	0.983	3.015	0.990
	Family characteristics	Household size	The number of family members	2.278	0.986	2.718	1.589
		The proportion of household labor force	Proportion of household members aged 16 to 59	0.415	0.478	0.467	0.316
		Value of productive assets	The total value of productive assets such as tractor, thresher, harvester, water pump, processing equipment, seeder, etc. (in logarithm)	1.939	3.139	1.617	2.919
		Value of durables assets	The total value of durables assets such as automobiles, electric bicycles, motorcycles, refrigerators, washing machines, televisions, computers, etc. (in logarithm)	7.116	2.878	7.320	2.552
		Value of financial assets	The sum of cash, deposits, bonds, stocks, funds, wealth management products, and other assets (in logarithm)	7.144	2.997	8.847	1.939
	Region	Eastern region	1 = yes, 0 = not	0.368	0.482	0.368	0.482
		Central region	1 = yes, 0 = not	0.304	0.460	0.304	0.460
		Western region	1 = yes, 0 = not	0.284	0.451	0.284	0.451

4. Results

4.1. Estimation and testing of propensity scores

Figs. 1 and 2 and Appendix Table 1 show the results of several balancing tests of PSM. We used the Kernel density estimations to test the common support hypothesis, checking whether the propensity scores of treatment and control groups with a common value range. It could be seen that the propensity scores between treatment and control groups were obviously different before matching. While their Kernel density curves were highly fitted after matching, meeting the common support hypothesis.

The balance hypothesis requires that treatment and control groups have no significant differences in covariates after matching, to correct possible selection biases in the sample effectively. Appendix Table 1 shows the results of covariates balancing. There existed significant differences in some control variables between treatment and control groups before matching, but not after matching. In the case of farmland transfer-in and transfer-out, the absolute standard deviations of the covariates were less than 2.86 % and 2.85 %, respectively, far less than the threshold of 20 % [34]. All the P values of the T tests were larger than 0.1 after matching. These tests showed that the distributions of variables between treatment and control groups were not systematically different after matching.

4.2. The results of PSM-DID

We used a PSM-DID approach to evaluate the anti-poverty effects of the farmland transfer. The PSM-DID results showed that farmland transfer-in had a significant anti-poverty effect. The negative $ATT_{PSM-DID}$ indicated that farmland transfer-in significantly reduced the vulnerability to poverty among the lessee households. It could be seen that thanks to the vigorous advancement of China's economic development and the poverty alleviation policies, the vulnerability to poverty of rural households had significantly decreased in 2018 compared with 2015. The vulnerability to poverty of the lessee households decreased more than that of the non-transfer households, and the difference between the two groups reached 0.022, which was significant at the level of 0.01.
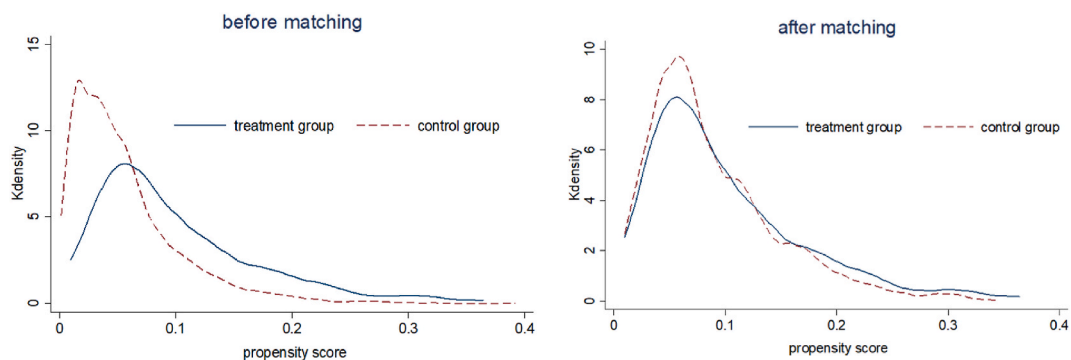
Fig. 1. The left and right panels show the estimated Kernel density distributions of propensity scores related with farmland transfer-in before and after matching, respectively.
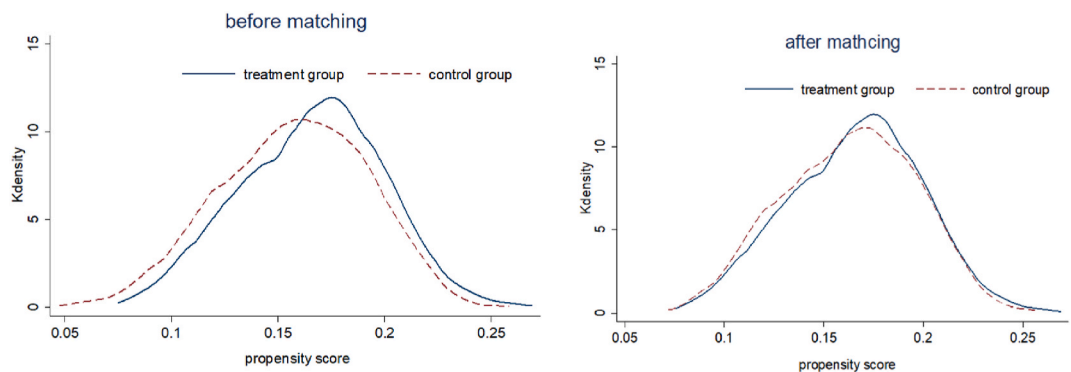

Fig. 2. The left and right panels show the estimated Kernel density distributions of propensity scores related with farmland transfer-out before and after matching, respectively.

Farmland transfer-out had no significant impact on the probability of the lessor households suffering impoverishment in the future. Although the decline in vulnerability to poverty among those who transferred out farmland was slightly higher than that of the non-transfer households, there was no significant difference between them (Table 2).

Table 3 presents the effect of farmland transfer-in and transfer-out on various incomes of the rural households, which verified the results in Table 2 to a certain extent. Compared with those who did not transfer farmland, the total annual per capita income of the lessee households and lessor households increased by 4626.91 yuan/year and 2770.19 yuan/year, respectively. The increase in total annual per capita income among the lessor households was less than that of the lessee households. Among the lessee households, farmland transfer-in led to a significant increase of agricultural operating income. Among the lessor households, farmland transfer-out led to a significant increase in wage income.

4.3. Robustness test

We also conducted a robustness test by changing the matching method of the propensity score and the dependent variable.

4.3.1. Replacing the matching method
The radius matching ($c = 0.01$) and the local linear regression matching were used to re-match the propensity score of treatment

Table 2
The estimated results of how farmland transfer affected vulnerability to poverty.

Explained variable	Farmland transfer-in			Farmland transfer-out		
	Mean Difference		$ATT_{PSM\text{-}DID}$	Mean Difference		$ATT_{PSM\text{-}DID}$
	Treatment group	Control Group		Treatment group	Control Group	
vul1	−0.249	−0.227	−0.022***	−0.204	−0.200	−0.004
N	161	2571		486	2571	

Note: (1)***$p < 0.01$, **$p < 0.05$, *$p < 0.1$; (2)PSM method is Kernel matching.

Table 3
The results of the effect of land transfer on various kinds of incomes based on PSM-DID.

Explained variable	Farmland transfer-in			Farmland transfer-out		
	Mean difference		$ATT_{PSM\text{-}DID}$	Mean difference		$ATT_{PSM\text{-}DID}$
	Treatment group	Control group		Treatment group	Control group	
Agricultural operating income	8429.96	933.65	7496.31***	−367.84	530.04	−897.88
Wage income	4384.02	6876.26	−2292.24	8329.88	5451.66	2878.22**
Non-agricultural operating income	1889.94	2895.49	−1005.55	3805.45	2046.35	1759.10
Public transfer income	1720.28	1291.89	428.39	968.99	1938.24	−969.25
N	161	2571		486	2571	

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

and control groups. Then, PSM-DID was used to re-estimate how farmland transfer affected vulnerability to poverty. Table 4 shows that farmland transfer-in could still significantly reduce the vulnerability to poverty among the lessee households, while farmland transfer-out had no significant influence on the probability of the lessor households suffering impoverishment in the future.

4.3.2. Replacing the dependent variable

The dependent variable used above was estimated by the national poverty line of China at a constant price of RMB 2300 per year in 2010 (vul1). In this part, it was replaced by the vulnerability to poverty estimated based on the World Bank's standards of $1.9 per day (vul2) and $3.1 per day (vul3). Table 5 indicates the estimated results of PSM-DID. After replacing the dependent variable, farmland transfer-in still significantly reduced the probability of the lessee households suffering impoverishment in the future, while farmland transfer-out had no significant anti-poverty effect, which further proved the robustness of the test results.

It can be seen in Tables 2 and 5 that with the increase of poverty lines, the absolute value of ATT continues to increase, indicating that when the poverty standards were raised, farmland transfer-in played a greater anti-poverty effect. In 2020, China eliminated absolute poverty and entered the "post-poverty alleviation period" of relative poverty governance. Farmland transfer-in could still become an important means for rural households to prevent poverty.

4.4. Heterogeneity analysis

We then grouped the samples according to the region and the degree of vulnerability to poverty for heterogeneity analysis.

4.4.1. Grouping by region

All the households were classified into eastern, central, western, and northeastern regions, according to the residence. As shown in Table 6, regardless of the different poverty lines, how farmland transfer-in affected the vulnerability to poverty among the lessee households was not balanced regionally. The anti-poverty effects in the eastern and central regions were obvious, while the anti-poverty effects in the other regions were not significant.

4.4.2. Grouping by degree of vulnerability to poverty

According to previous studies [19,21,23], if a household has a 50 % or higher probability of suffering impoverishment in the future, then such household is deemed as vulnerable. This vulnerability line is also called the high vulnerability threshold [23]. In this paper, rural households were divided into two groups according to a 50 % vulnerability line. Table 7 shows that with the increase of vulnerability, the improvement effect of farmland transfer-in on the vulnerability to poverty of the lessee households was more obvious. Farmland transfer-out has no significant anti-poverty effects among the rural households with both high vulnerability and low vulnerability.

Table 4
Robustness test 1.

Explained variable	Matching method	Farmland transfer-in			Farmland transfer-out		
		Mean difference		$ATT_{PSM\text{-}DID}$	Mean difference		$ATT_{PSM\text{-}DID}$
		Treatment group	Control Group		Treatment group	Control Group	
vul1	Radius matching	−0.240	−0.203	−0.037***	−0.192	−0.190	−0.002
	Local linear regression matching	−0.241	−0.199	−0.042***	−0.193	−0.189	−0.004
N		161	2571		486	2571	

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 5
Robustness test 2.

Explained variable	Farmland transfer-in			Farmland transfer-out		
	Mean difference		ATT$_{PSM-DID}$	Mean difference		ATT$_{PSM-DID}$
	Treatment group	Control group		Treatment group	Control group	
vul2	−0.246	−0.222	−0.024***	−0.195	−0.190	−0.005
vul3	−0.213	−0.175	−0.038***	−0.139	−0.132	−0.007
N	161	2571		486	2571	

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 6
The estimated results of PSM-DID according to different regions.

Explained variable	ATT$_{PSM-DID}$ (farmland transfer-in)				ATT$_{PSM-DID}$ (farmland transfer-out)			
	Eastern region	Central region	Western Region	Northeastern region	Eastern region	Central region	Western Region	Northeastern region
vul1	−0.016*	−0.014*	−0.007	−0.011	−0.000	−0.010	0.001	−0.013
vul2	−0.019**	−0.017*	−0.008	−0.003	0.000	−0.012	0.001	−0.011
vul3	−0.045***	−0.033*	−0.012	−0.063	0.003	−0.021	0.000	−0.016
N	990	834	791	126	1143	921	877	125

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 7
The empirical results of PSM-DID grouping by poverty vulnerability.

Explained Variable	ATT$_{PSM-DID}$ (farmland transfer-in)		ATT$_{PSM-DID}$ (farmland transfer-out)	
	vul<0.5	vul≥0.5	vul<0.5	vul≥0.5
vul1	−0.011*	−0.033**	0.005	−0.010
vul2	−0.019***	−0.036**	0.005	−0.018
vul3	−0.019**	−0.042**	−0.000	−0.015

Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

5. Discussion

The existing literature has conducted extensively on poverty issues, but most still used income as a single indicator to measure poverty. This study focused on the risk of farmers falling into poverty in the future after the transfer of farmland and introduced a forward-looking concept of vulnerability to poverty. The greatest contribution of this study is to add evidence on the impact of farmland transfer on the vulnerability to poverty among the rural population aged≥45 years and to compare the anti-poverty effects of farmland transfer-in and transfer-out. We found that farmland transfer-in could significantly reduce the vulnerability to poverty among rural households, while farmland transfer-out had no significant impact on vulnerability to poverty, which resonates with previous studies related to the income effect of farmland transfer [5,13]. We also found that farmland transfer-in effectively alleviated the vulnerability to poverty among the lessee households, which resulted from the increase in their agricultural operating income. Due to the release of more of the labor force, the wage income of the lessor households increased. Bojnec et al. [46] also revealed that supplementary farm activities and off-farm incomes are important sources of income for rural households' well-being in Slovenia. However, based on our results, one can infer that the increasing rate of the lessor households' wage income was much less than that of the agricultural operating income of the lessee households in China. The explanation for this may be that farmland transfer-in increases the input of agricultural factors, which can obtain a relatively large increase in income because of the rise in agricultural output. However, for the lessor households, since many members of the rural population might already work in the non-agricultural sector before farmland transfer-out, the labor force that is released through farmland transfer-out is limited. Meanwhile, these newly transferred labor forces may not be able to quickly obtain higher wage income in the market due to limited education, labor skills, etc., which also leads to a limited impact on income. This limited impact can also reflect that although farmland transfer-out can improve the current total household income level, it cannot play a substantive role in reducing the probability of families suffering impoverishment in the future.

This study found that the anti-poverty effect of farmland transfer-in the eastern and central regions of China was significantly higher than that in the western and northeastern regions. We further found that the average area of farmland transferred-in by rural households in the western and northeastern regions was only 0.59 acres and 1.16 acres, which was much lower than that in the eastern and central regions (3.00 acres and 9.47 acres, respectively). Our findings also indicate that the farmland marketization in the western and northeastern regions was still small. The transfer of a small area of land was not enough to form a scale effect and could not

substantially increase agricultural operating income, so as to reduce their risk of poverty.

In addition, we also found that farmland transfer-in had a more obvious anti-poverty effect among the rural households with higher vulnerability to poverty. The results align with previous studies uncovering that the lower income groups obtained the greatest total income from farmland transfer-in based on samples from one province [13] and from the labor force in China [47]. Our results might be because farmland transfer is more important to the rural households with high vulnerability to poverty. The middle-aged and elderly with high vulnerability often lack non-agricultural employability. Farmland transfer-in provides them with livelihood capital for sustainable development and exerts a more crucial part in poverty reduction and prevention.

Our study has the following policy implications. First, the local government should improve the land rental market and further promote the participation of more farmers in farmland transfer. From the data of this study, the farmland transfer rate of the middle-aged and elderly rural households was only 20.1 %, which is not high, thus limiting the poverty reduction effect of farmland transfer to some extent. Therefore, local governments should standardize the farmland transfer procedures, give full play to the market and legal guarantee, reduce the land transaction cost, and make the marketization and standardization of farmland transfer more market-oriented. Second, for poor rural households with production capacity, the local government should provide financial and technical support and increase the amount of agricultural subsidies and other means of support to encourage them to choose farmland transfer-in, thus obtaining sustainable livelihoods. Third, the finding that farmland transfer-out failed to improve the vulnerability to poverty of the lessor households suggests that the local government should continue to improve the non-agricultural employment ability of the rural population, to carry out relevant non-agricultural vocational training for them, and to build efficient employment information circulation channels, aiming at providing farmers with more non-agricultural employment and entrepreneurship opportunities.

Due to data limitations, it is impossible to determine whether the lessee of farmland transfer is individuals or enterprises, relatives or other farmers. The lessee affects the effect of farmland transfer on anti-poverty. Although this study investigated the 3218 middle-aged and elderly rural households, in a country like China, future research should further expand the sample size and examine the robustness of the research results. As to methodology, this study still has limitations. Limited by our data, we only used a VEP method to measure vulnerability to poverty and failed to compare the results measured by VEP with the results of other methods, such as VER and VEU. Future study is needed in this regard. Another limitation is that our study period was from 2015 to 2018, which may not be sufficient to effectively reveal the poverty reduction effect of farmland transfer. Future research can use other data to further examine the farmland transfer effect.

6. Conclusions

We found that the anti-poverty effect of farmland transfer was "asymmetric". Farmland transfer-in could effectively alleviate the vulnerability to poverty of the middle-aged and elderly rural households, which was mainly caused by the increase in the agricultural operating income. Although farmland transfer-out could significantly improve the wage income of the lessor households, it had no significant impact on the vulnerability to poverty. Second, we also found that the anti-poverty effect of farmland transfer-in was more obvious in eastern and central China and among the rural households with higher vulnerability to poverty. Based on the results of this study, we suggest that China ought to strengthen the farmland rental market and encourage rural households to transfer farmland. It should be noted that encouraging rural households to transfer land is not to let them give up agricultural production but to concentrate agricultural resources.

Ethics statement

This study used open data. Ethical approval for this type of study is not required by our institute. The CHARLS survey was approved by the Ethical Review Committee of Peking University.

Data availability statement

The data used in this study can be found on the official website of CHARLS: https://charls.charlsdata.com/pages/data/111/zh-cn.html.

CRediT authorship contribution statement

Xiaojun Lu: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Qun Wang:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Yunan Wang:** Methodology, Investigation, Formal analysis.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Xiaojun Lu reports article publishing charges was provided by Dalian University of Technology. Qun Wang reports a relationship with Dalian University of Technology that includes: employment. No has patent No pending to No. None.

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Appendix A. Supplementary data

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