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The Impact of Land Transfer-In on Crop Planting Structure and Its Heterogeneity among Farmers: Evidence from China

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Abstract: The crop planting structure in the world has shown a trend of "non-grain", which will shake the foundations of global food security in the long run. As a basic and important production factor, changes in land will have an impact on farmers' crop planting decisions. In this paper, we take China, a country that is experiencing land transfer, "non-grain" production, and farmer differentiation, as the research area, use the household survey data at the national level, and adopt the methods of Propensity Score Matching (PSM) and multiple regression models to reveal the impact of land transfer-in on the crop planting structure and its heterogeneity among farmers. The results showed that land transfer-in can drive the crop planting structure to tend to be "non-grain" in China. The research conclusion was still valid after the robustness tests of expanding the sample size, increasing the number of control variables, and introducing endogenous problem management. The heterogeneity analysis indicated that the negative impact of land transfer-in on the planting of grain crops mainly exists for large-scale farmers and farmers with agriculture as the main source of income. Based on these findings, the Chinese government should formulate targeted policies to prevent the "non-grain" tendency of crop planting structure after land transfer-in.

Keywords: land transfer-in; crop planting structure; food security; PSM; China

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1. Introduction

At present, world security is facing various challenges, such as local conflicts, trade frictions, and frequent extreme weather events [1–5]. In this context, the importance of food security is becoming more and more prominent [6–8]. Ensuring a stable supply of food rations is the key to ensuring food security [9,10]. However, with the development of the economy and urbanization, people's demand for high-value and high-quality food has increased, and the planting structure has shown a trend of "non-grain". According to the data from FAOSTAT, from 1980 to 2021, the global harvested area of oilseeds, vegetables, and fruits expanded by 108.4%, 68.1%, and 126.5%, respectively. However, the harvested area of the main ration crops (rice and wheat) expanded by only 1.1%, and its share of the total harvested area of crops decreased from 34.5% to 26.3% [11]. In the long term, this change in crop planting structure will affect the supply capacity of food rations and shake the foundations of global food security [12–15].

Essentially, whether to plant grain crops or cash crops is a behavioral decision made by the business entity to maximize production profit and labor productivity [16,17]. The principal basis for this decision is the factors of production such as land, labor, and capital owned by the business entity [18]. Of all the factors of production, land is the most basic and important [19,20]. The amount of land owned largely determines the mode of agricultural production and management [21,22]. Therefore, changes in the scale of land management, such as land transfer-in (farmers take over the transferred land, and the land management scale expands), will inevitably have an impact on the crop planting decisions of the business entities [23,24].

The impact of land transfer-in on cropping structure is still controversial among scholars. On the one hand, some scholars believe that land transfer-in will lead to the "non-grain" of planting structures. There are two main theoretical logics. Firstly, the business entity usually pays rent for the land that is transferred-in, thus increasing the land and total production cost. In order not to cut profits, business entities may prefer to plant cash crops with relatively higher returns [25–27]. Secondly, with the transfer-in of land and the expansion of the land operation scale, the cost of labor and land has gradually become apparent, and the objectives of business entities have become more and more profitable [28–30]. As a result, the tendency to plant cash crops with higher returns has become stronger.

On the other hand, there are many scholars who hold the opposite view, arguing that land transfer-in will drive the planting structure to be "grain-oriented" [31–35]. The main theoretical logic lies in the fact that compared with the cash crops that are labor-intensive, difficult to be replaced by machinery for manual operation, and have high mechanization application cost, grain crop planting has more mature mechanization technology and socialized service technology [25]. With the land transfer-in and the expansion of land scale, more labor force is required. Under the constraints of the decreasing amount and rising cost of agricultural labor, business entities tend to grow grain crops that make it easier to replace labor with machinery [36]. At the same time, with the expansion of the operation scale, the agricultural production activities such as cultivation, planting, and harvesting are usually outsourced when the operation scale exceeds the cultivation capacity of the farmer's labor. Grain crops are more likely to be involved in the socialized service system [33,37]. As a result, with the rapid development of the agricultural productive service market, grain crops are more likely to be the plant choice of most business entities [38].

By combing through the literature of scholars, it can be found that most of the data sources for these studies were farmer surveys in one or several provinces. The natural, social, and economic conditions of different regions vary greatly, so the results of the research were regional and diverse. Moreover, the type of farmer household is not distinguished, so the ignorance of farmer differentiation may be an important reason for the controversy of the existing results. With the process of industrialization and urbanization, the differentiation of rural development has accelerated, and the differentiation of peasant households has also gradually emerged [39–41]. Some peasant households have more resources, higher production and management capacity, and gradually develop into large farmers or family farms. Some peasant households seek non-agricultural employment in the cities and return to the countryside to engage in agricultural production only when needed, thus becoming part-time farmers. There are also farmers who still maintain traditional agricultural production due to inertial thinking [29]. Different types of farmers have different resources, and the consideration of planting choices is correspondingly different. Based on this, we take the whole of China, a country that is experiencing farmer differentiation and land transfer, and where the phenomenon of "non-grain" production is intense, as the research area. Then, we adopt the data from the Chinese Family Database (CFD) of ZheJiang University and China Household Finance Survey (CHFS) conducted by the Survey and Research Center for China Household Finance at the Southwestern University of Finance and Economics (SWUFE) [42], to reveal the impact of land transfer-in on the crop planting structure and its heterogeneity among farmers through the methods of Propensity Score Matching (PSM) and constructing multiple econometric models.

There are two possible contributions to this article. Firstly, the data used in this paper are derived from a representative national database of farmer surveys covering almost all provinces, so this work can provide a nationwide and stable conclusion on the impact of land transfer on the crop planting structure in China. Secondly, although China's land transfer policy is relatively mature, there is still a lack of management policies for different types of farmers. Considering the reality of farmer differentiation, we divide farmers into four types according to their operation scale and income structure. By analyzing their differences in planting choices after the land transfer-in, this work can provide decision-making support for China's more targeted land transfer policies.

2. Materials and Methods

2.1. Variable Selection

The explained variable in this paper is the crop planting structure of farmers. Taking into account the availability of data, we measured this variable using the ratio of the planting area of grain crops to the total planting area of grain crops and cash crops (GR). According to the questionnaire, grain crops include six major types: rice, wheat, maize, potato, sweet potato, and pulses. Cash crops include four major types: peanuts, rape, cotton, and tobacco. An increase in the value indicates that the crop planting structure shows a trend of "grain-oriented", and a decrease in the value indicates that the crop planting structure shows a tendency of "non-grain".

The core explanatory variable in this paper is land transfer-in, which is measured by two indicators. One is the dummy variable, i.e., whether the farmer owns the cultivated land that transferred-in (Trans_in). The other is a continuous variable, i.e., the ratio of the area of cultivated land that transferred-in to the total area of cultivated land owned by farmers (Trans_rate).

Farmers' planting decisions will be affected by many factors, including natural conditions, agricultural production conditions, farmers' household characteristics, agricultural production costs and benefits, etc. [38]. In order to ensure the unbiased simulation results, this paper selects topographic conditions (Topography), the amount of agricultural labor (Labor), area of cultivated land (Land), agricultural machinery usage (Machine), cost and profit of grain production (Cost, Profit), and farmer's income level (Income) as control variables, considering the availability of data and referring to the existing literature [25,33,43–48].

The definitions of all variables are shown in Table 1.

Table 1. Definition of each variable.

Variables	Definition	Unit
GR	Proportion of the planting area of grain crops to the total planting area of grain crops and cash crops	%
Trans_in	A dummy equal to 1 if the farmer owns transferred-in land, and 0 otherwise	–
Trans_rate	The ratio of the area of cultivated land that transferred-in to the total area of cultivated land owned by farmers	%
Topography	A dummy equal to 1 if the farmer is located in a plain, and 0 otherwise	–
Labor	Amount of agricultural labor force per household	Person
Land	Area of cultivated land per labor force	Hectare/person
Machine	The proportion of the area of cultivated land with machinery use to the total area of cultivated area	%
Cost	Production cost per planting area of grain crops *	Thousand CNY/hectare
Profit	Net profit per planting area of grain crops *	Thousand CNY/hectare
Income	Disposable income per labor force	Thousand CNY/person

Note: * average value of rice, wheat, and maize.

2.2. Data Sources and Descriptive Statistics

2.2.1. Data Sources

The data used in this study came from the China Family Database (CFD) of Zhejiang University, and its data were obtained through the China Household Panel Survey (CHPS). The sample of the CHPS is distributed in 29 provinces (autonomous regions and municipalities directly under the central government; excluding Xinjiang, Tibet, Hong Kong, Macao, and Taiwan). The survey content includes the basic structure of urban and rural households, employment situation, income and expenditure structure, household wealth, agricultural production and operation, land use and transfer, population migration and urbanization, financial behavior, health and social security, education and training, etc. [49]. The survey has been conducted every two years since 2011 and has so far conducted 5 rounds. However, the 2019 data are only available to researchers at Zhejiang University, so we can only obtain data up to 2017. According to the data in 2017, the number of family samples was 40,011, including 127,012 individual samples and 608 community samples. Based on the purpose of the study, we screened the samples. Invalid samples, incomplete data samples, and extreme value samples were deleted. Finally, 2334 valid samples were obtained and 2% tail reduction was carried out. Among them, the number of households with land transfer-in was 295.

2.2.2. Descriptive Statistical Analysis

Table 2 reports the average value of the main variables for the whole sample as well as for the grouped sample. According to the data, the average GR of all sample farmers was 91.51%, which is higher than that of the official statistics in China. This is partly due to the fact that the crop types in the CHPS questionnaire only include six main grain crop types and four major cash crop types. On the other hand, it may also be due to the fact that most of the samples selected by CHPS are farmers who grow grain crops. The average GR of farmers with land transfer-in was 89.16%, which was significantly lower than that of the whole sample and the farmers without land transfer-in. It indicates that land transfer-in may cause a decrease in GR. From the perspective of different types of farmers, the GR of small-scale farmers was significantly lower than that of large-scale farmers, while the GR of farmers with agriculture as their main income source is similar to that of farmers with a non-agricultural main income source.

Table 2. The average values of the main variables.

Variables	All Samples	Land Transfer-In		Operation Scale		Main Income Source	
		Yes	No	Small	Large	Agriculture	Non-Agriculture
GR	91.51	89.16	91.85	90.87	92.10	91.58	91.46
Trans_in	0.13	1.00	0.00	0.06	0.19	0.16	0.10
Trans_rate	5.02	38.78	0.00	2.38	7.47	6.43	4.04
Topography	0.44	0.43	0.47	0.32	0.56	0.49	0.41
Labor	1.94	2.04	1.92	1.85	2.03	1.98	1.92
Land	0.29	0.53	0.26	0.10	0.46	0.37	0.23
Machine	55.28	59.79	54.62	45.18	64.62	59.58	52.25
Cost	16.91	20.29	16.42	17.70	16.19	18.52	15.78
Profit	922.51	902.01	925.43	1062.26	796.75	970.51	890.65
Income	26.03	25.70	26.07	27.71	24.47	13.55	34.79

Note: Bounded by the median of the operation scale of all samples, if the operation scale of the farmer is larger than this value, they are considered a large-scale farmer. Otherwise, they are a small-scale farmer. If the agricultural income of a farmer accounts for more than 50% of their total income, they are considered to be a farmer with agriculture as their main source of income. Otherwise, they are considered to be a farmer with a non-agricultural main source of income.

The average Trans_rate of the whole sample of farmers was 5.02%, which is lower than that of the official statistics in China. This may be due to the fact that the sample size of households with land transfer-in surveyed by CHPS is not large. The average Trans_rate of farmers with land transfer-in was 38.78%, which is close to China's official statistics for the same period. From the perspective of different types of farmers, the average value of Trans_rate of small-scale farmers was significantly lower than that of large-scale farmers, while the average value of Trans_rate of farmers with agriculture as their main income source was significantly higher than that of farmers with a non-agricultural main income source.

2.3. Methods

2.3.1. Propensity Score Matching (PSM)

Farmers' planting behavior is affected by a variety of factors, so there may be a problem of selectivity bias in the sample data. In order to reduce the interference of sample selectivity bias and overcome the shortage of land transfer samples, the Propensity Score Matching (PSM) method proposed by Rosenbaum and Rubin [50] was used to process the samples. The PSM method makes the observations as close as possible to the random experimental data by matching and resampling [51]. Its analysis steps are as follows. First, the samples were divided into a treatment group (farmers with land transfer-in, D = 1) and untreated group (farmers without land transfer-in, D = 0). Secondly, considering the control variables, the propensity score of the sample farmer, i.e., the probability that a farmer is willing to accept land transfer-in, was calculated. In the third step, according to the propensity scores of each sample farmer, the methods of nearest neighbor matching, radius matching, and kernel matching were used to match the samples. Then, the balance and validity of the match results were checked. Finally, the Average Treatment Effect on Treated (ATT), that is, the change in the GR brought about by land transfer-in, was calculated.

2.3.2. Regression Model

In order to systematically reveal the relationship between land transfer-in and crop planting structure, we constructed the following multiple linear regression model after matching the samples.

$$GR_i = \beta_0 + \beta_1 Landtransfer_i + \sum \beta_k Control_i^k + \varepsilon_i \tag{1}$$

where GR_i is the explained variable, i.e., the proportion of the planting area of grain crops to the total planting area of grain crops and cash crops of farmer *i*. The $Landtransfer_i$ is the core explanatory variable, representing the situation of the land transfer of farmer *i*, and is measured by either the land transfer-in dummy or the rate of land transfer-in. $Control_i^k$ represents each control variable, as shown in Table 1. β_0 is the constant term. β_1 is the coefficient of the core explanatory variable. β_k is the coefficient of the control variable *k*. ε_i is the random error term. At the same time, in order to clarify the heterogeneity of farmers in the impact of land transfer-in on crop planting structure in China, we also constructed a corresponding regression model based on the data of each farmer type, and the model form was the same as that of Equation (1).

3. Results

3.1. PSM Estimation Result

Table 3 reports the results of the balance test for the explanatory variables. It can be seen that from pre-matching to post-matching, Pseudo R^2 decreased significantly from 0.075 to 0.001~0.005, the LR statistic decreased significantly from 126.01 to 0.86~4.01, and the significance test result shown by the *p* value changed from highly significant to non-significant. It indicates that the null hypothesis was rejected, that is, there was no significant difference in the influencing factors between the treatment group and the untreated group after matching. Moreover, the mean bias decreased dramatically from 15% to 3.3~5.9%, and the median bias decreased from 8.2% to 3.1~6.2%. The test results showed that the overall bias of the samples was greatly reduced after matching, the characteristics of the samples were similar between the two groups, and the matching results were ideal.

Table 3. Equilibrium test results of explanatory variables before and after matching.

Matching Method	Pseudo R^2	LR	p	Mean Bias	Med Bias
Before matching	0.075	126.01	0.000	15.0	8.2
Nearest neighbor matching	0.005	3.60	0.825	5.4	5.6
Radius matching	0.002	1.52	0.982	4.0	3.8
Kernel matching	0.001	0.86	0.997	3.3	3.1

Table 4 reports the GR of farmers in the treatment group and untreated group, as well as the difference between the two groups. It can be noted that the results obtained by the three matching methods are relatively similar, indicating that the matching results are robust. The results show that for farmers with land transfer-in, the average GR is 89.53%. However, if these farmers do not accept land transfer-in, the average GR will rise to 92.59%. That is, due to the land transfer-in, the GR of these farmers decreased by 3.06%. This suggests that the land transfer-in can promote the "non-grain" of farmers' crop planting structure.

Table 4. The overall effect of land transfer-in on GR.

Matching Method	Treatment Group	Untreated Group	ATT
Nearest neighbor matching	90.47	93.60	−3.13 **
Radius matching	88.90	92.08	−3.18 **
Kernel matching	89.21	92.09	−2.88 **
Mean value	89.53	92.59	−3.06

Note: ** $p < 0.05$.

3.2. The Impact of Land Transfer-In on Crop Planting Structure

In order to further confirm the impact of land transfer-in on crop planting structure, we constructed multiple regression models and estimated the regression coefficients using Stata software version 15.1. The results are presented in Table 5. In Model 1 and Model 2, we simulated only the effects of the core explanatory variables Trans_in and Trans_rate on the explained variable GR, respectively. Then, we added all the control variables to Model 1 and Model 2 and obtained Model 3 and Model 4, respectively. The results show that the coefficients of the core explanatory variables Trans_in and Trans_rate change little with or without control variables, and both of them are significantly negative at the 1% level. This indicates that the proportion of the planting area of grain crops to the total planting area will decline with the land transfer-in. That is, land transfer-in can drive the crop planting structure to tend to be "non-grain". On average, the occurrence of land transfer-in can lead to a decrease of 3.47% in the proportion of the planting area of grain crops to the total planting area of grain and cash crops. For every 1% increase in the ratio of the land transfer area to the total land area, the proportion of the planting area of grain crops to the total planting area decreased by 0.1%.

3.3. Robustness Test

In order to verify the validity and robustness of the estimation results, a number of robustness tests are performed in this paper.

3.3.1. Expand the Sample Size

The samples in the model are farmers who grow only grain crops and cash crops. To test the robustness of the models, we expanded the sample size to farmers who grow all types of crops. After that, the samples were screened by the PSM method, and the regression model was simulated again. The results showed that the coefficients of Trans_in and Trans_rate were significantly negative at the 1% level (Table 6, Model 5 and Model 6), which was consistent with the previous conclusion.

Table 5. Simulation results of the regression models.

Variables	Model 1	Model 2	Model 3	Model 4
Trans_in	−3.1994 ***	–	−3.4667 ***	–
	(−2.62)	–	(−2.90)	–
Trans_rate	–	−0.0928 ***	–	−0.0986 ***
	–	(−3.51)	–	(−3.82)
Topography	–	–	4.8277 ***	4.8027 ***
	–	–	(3.95)	(3.94)
Labor	–	–	−0.3319	−0.4420
	–	–	(−0.41)	(−0.55)
Land	–	–	0.0161	0.0836
	–	–	(0.01)	(−0.07)
Machine	–	–	0.0157	0.0164
	–	–	(0.98)	(1.02)
Cost	–	–	−0.0309 ***	−0.0320 ***
	–	–	(2.82)	(2.92)
Profit	–	–	−0.0014 ***	−0.0014 ***
	–	–	(−4.09)	(−4.15)
Income	–	–	0.0011	0.0011
	–	–	(0.06)	(0.07)
Cons	93.6580 ***	93.8224 ***	92.3138 ***	92.7082 ***
	(123.79)	(131.73)	(40.81)	(41.25)
N	698	698	698	698
R^2	0.106	0.170	0.266	0.274

Note: *** $p < 0.01$.

Table 6. Results of robustness test.

Variables	Model 5	Model 6	Model 7	Model 8	Model 9
Trans_in	−2.5116 ***	–	−2.8279 **	–	–
	(−2.88)	–	(−2.32)	–	–
Trans_rate	–	−4.0530 **	–	−0.0857 ***	−2.6021 ***
	–	(−2.07)	–	(−3.29)	(−2.77)
Control Variables	Yes	Yes	Yes	Yes	Yes
N	2254	2254	659	659	698
R^2	0.195	0.193	0.269	0.276	0.167

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

3.3.2. Increase the Number of Control Variables

When farmers choose whether to plant grain crops, their decisions are usually affected by the cost and profit of cash crops in addition the cost and profit of grain crops. Therefore, we bring the cost and net profit of cash crops into the model for re-simulation. The regression results show that the coefficients of land Trans_in and Trans_rate (Table 6, Model 7 and Model 8) change little compared with Model 3 and Model 4, which indicates that the previous conclusion is robust.

3.3.3. Endogenous Problem Management

Although the PSM method can solve the endogeneity problem of selectivity bias to a certain extent, the model may also have the endogeneity problem of reverse causality, as farmers' planting situations may also affect their willingness to transfer land [38]. For example, the cultivation of cash crops requires more human input, and it is difficult for left-behind farmers to accept land transfer-in under the existing technical conditions [52]. In this paper, the instrumental variable (IV) method is used to solve the endogeneity problem. Referring to the practice of Luo et al. [53], the average rate of the land transfer area to the total land area of each province was chosen as the instrumental variable. On the one hand, the rate of the land transfer area to the total land area of each farmer is closely related to the average rate of the land transfer area to the total land area of the province where the farm is located. On the other hand, the planting behavior of farmers is not affected by the average rate of the land transfer area to the total land area at the provincial level. Using this instrumental variable, the two-stage least squares (2SLS) method is adopted to re-simulate the model. The result shows that the estimation coefficient of the instrumental variable in the first stage passes the significance test, and the F-value of the weak-instrumental variable test is 19.56. The value is largely greater than 10, indicating that the instrumental variable is valid [38]. The coefficient of Trans_rate is significantly negative at the level of 1% (Table 6, Model 9), which is consistent with the previous result. It indicates that after considering the possible endogeneity, the land transfer-in still significantly promotes the crop planting structure to have a "non-grain" trend, which verifies the robustness of the conclusion again.

3.4. The Heterogeneity of the Impact among the Farmers

Table 7 reports the estimate results for different types of farmers. For small-scale farmers, the coefficients of Trans_in and Trans_rate did not pass the significance test (Model 10 and Model 11), indicating that land transfer-in does not have any significant impact on the crop planting structure of small-scale farmers. For large-scale farmers, the coefficient of Trans_in and Trans_rate was significantly negative at the 5% and 10% level, respectively (Model 12 and Model 13). It indicates that land transfer-in had a negative impact on their tendency to grow grain crops, i.e., driving the "non-grain" cropping structures. For farmers with agriculture as their main source of income, the coefficient of Trans_in and Trans_rate was significantly negative at the 5% level (Model 14 and Model 15), indicating that land transfer-in had a negative impact on their tendency to plant grain crops, that is, driving the "non-grain" planting structure. For farmers with a non-agricultural main source of income, the coefficients of Trans_in and Trans_rate both failed the significance test (Model 16 and Model 17), implying that land transfer-in did not have a significant impact on the planting structure of these farmers.

Table 7. The estimation results of different types of framers.

Variables	Small-Scale Farmers		Large-Scale Farmers		Farmers with Agriculture as Their Main Income Source		Farmers with a Non-Agricultural Main Income Source	
	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16	Model 17
Trans_in	−1.2508	–	−2.6495 **	–	−5.3423 **	–	0.9094	–
	(−0.46)	–	(−1.97)	–	(−2.55)	–	(0.45)	–
Trans_rate	–	−0.0997	–	−0.0551 *	–	−0.0975 **	–	−0.0575
	–	(−1.40)	–	(−1.82)	–	(−2.57)	–	(−1.50)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	512	512	171	171	346	336	352	344
R^2	0.183	0.182	0.063	0.082	0.109	0.178	0.072	0.082

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

4. Discussion

4.1. Comparison with Previous Studies

Based on data of the China Household Panel Survey at the national level, this paper analyzed the impact of land transfer-in on farmers' crop planting structure. The results show that land transfer-in can drive the crop planting structure of farmers to tend to be "non-grain". The conclusions of this study are partially consistent with those drawn by Zeng et al. [25], Bi et al. [28], and Luo et al. [53]. These studies are based on the survey of rural households in different provinces, and the results show that when the labor force is sufficient and the land area does not reach a moderate scale of operation, the more land transfer-in, the greater the tendency of a "non-grain" cropping structure. However, these scholars believe that there is a threshold effect on the impact of land transfer or operation scale on the "non-grain" cropping structure. When the operation scale exceeds the moderate scale, it is difficult for household labor to complete the production of cash crops. With the high cost of agricultural labor and the moral hazard, farmers will tend to plant grain crops that are more convenient for machinery use [54,55]. That is, when the scale of operation reaches or exceeds the moderate scale, farmers will rationally choose to plant more grain crops, and the planting structure will tend to be "grain-oriented".

However, how large is the moderate operation scale? There is still no unified understanding. Many scholars provide diverse results based on different evaluation standards [56–58], and the moderate scale of different business entities in different regions should also be different. A representative view is that "the scale of land operation is equivalent to 10 to 15 times the average contracted land area of local households, and the income from agriculture is equivalent to the income of local workers in the secondary and tertiary industry", as proposed in a Chinese government document. According to the data from the Annual Statistical Report of China's Rural Policy and Reform [59], the number of farmers with an operating scale of more than 3.33 hectares (50 mu) accounted for only 1.65%, and the number of farmers with an operation scale of more than 6.67 hectares (100 mu) accounted for only 0.59% in 2020. The average operating scale of the samples selected for this study is 0.3 hectares (Table 1). This indicates that the current scale of land management in China is far from reaching a moderate operation scale. Therefore, at this stage, land transfer will drive the planting structure to tend to be "non-grain", and the conclusion of this paper also confirms this.

4.2. Explanation of the Results of This Study

There are many explanations for this conclusion, but the most critical crux is the high cost of land transfer, and the root cause is the low comparative returns of grain crops [60]. According to the data of the National Compilation of Costs and Benefits of Agricultural Products [61], from 2003 to 2020, the average land rent of the three main grain crops (paddy, wheat, and maize) in China increased from 56.1 CNY/hectare to 660.15 CNY/hectare, an increase of 10.8 times. At the same time, the proportion of land rent to the total production cost of the three main grain crops has risen from 0.99% to 3.93%. In addition, there are also costs in collecting transaction information [26,62], negotiating, and rights protection in the process of land transfer [63–65]. With the increase in land transfer costs, the average cost of grain crops continues to increase, and the net profit is further compressed. From 2016 to 2019, the net profit was even negative. That is, farmers would lose money when growing grain. In 2020, the net profit of grain crops turned positive, but it was only 707.10 CNY/hectare. As a comparison, the average net profit of the two main oil crops (peanut and rapeseed), sugarcane, tobacco, and vegetables was 2378.25, 3976.5, 1176.9, and 61,965 CNY/hectare, respectively, which was 3.4, 5.6, 1.7, and 87.6 times that of grain crops, respectively. Farmers are economically rational people who will make rational decisions by comparing various factors including input, profit, risk, etc. [66,67], and the results of the decisions are ultimately reflected in the planting structure. Motivated by economic interests, farmers are more willing to plant cash crops, resulting in a trend of "non-grain" in the crop planting structure.

At the same time, the results of this paper also show that the negative impact of land transfer-in on the rate of grain crop planting area mainly exists for large-scale farmers and farmers with agriculture as their main source of income. This is mainly due to the fact that small-scale farmers often cultivate the land to meet their needs for grain rations [68]. Through rational comparison, smallholder farmers are more inclined to grow grain crops to obtain grain rations. With the transfer-in of land and the expansion of operation scale, the operation model will transition from self-sufficiency to commercialization and marketization. Farmers will pay more attention to the commercial attributes of land products and the economic benefits they bring, and profit has become the principal pursuit of their business activities [18,28]. As a result, they are more inclined to grow cash crops with higher economic returns. Farmers with a non-agricultural main source of income usually allocate most of their labor force to the non-agricultural work, and their dependence on agriculture is low. However, they still maintain small-scale agricultural operations because there is still agricultural labor in the family, or to protect against the risk of unemployment.

Such farmers have less labor allocated to agriculture and are therefore more disposed to grow grain crops that require less labor force. Farmers with agriculture as their main source of income are more dependent on agricultural income and allocate more labor to agriculture in pursuit of maximizing agricultural returns. Therefore, when other factors were controlled, they prefer to grow cash crops with higher profits.

4.3. Dialectical Understanding of the "Non-Grain" Planting Structure

From the perspective of farmers, choosing to grow more cash crops is understandable. They are rational economic beings, and their fundamental behavioral orientation is to pursue profit maximization under the condition of given resource endowment. Taking into account factors such as land, labor, policy, market, risk, and profit, they will make the choice of growing grain crops or cash crops. In fact, the "non-grain" planting structure is not a constant trend in China. For example, according to official statistics, the proportion of the planting area of grain crops to the total planting area of agricultural crops in China increased from 65.22% to 71.42% during 2003–2016 (Figure 1). The expansion of the grain planting area has benefited from many factors, such as the abolition of agricultural taxes, the introduction of agricultural subsidies, the establishment of a minimum procurement price policy, and the increase in agricultural infrastructure construction and scientific and technological services [69,70]. These measures have greatly enhanced the enthusiasm of farmers to grow grain crops. Moreover, from an international perspective, the "non-grain" planting structure is not unique to China. It also occurs in many agricultural countries, such as India, Bangladesh, and Myanmar. According to the FAOSTAT, from 1978 to 2021, the proportion of the planting area of grain crops to the total planting area of agricultural crops in India, Bangladesh, and Myanmar showed a downward trend, decreasing by 5.83%, 5.54%, and 5.18%, respectively (Figure 1). Agricultural production in these three countries is also dominated by smallholder farming, and farmers are also profit-oriented [71,72]. As these three countries are undergoing a shift in diets [73], the increasing demand for non-grain foods such as vegetables and fruits has also contributed to the change in the crop planting structure.

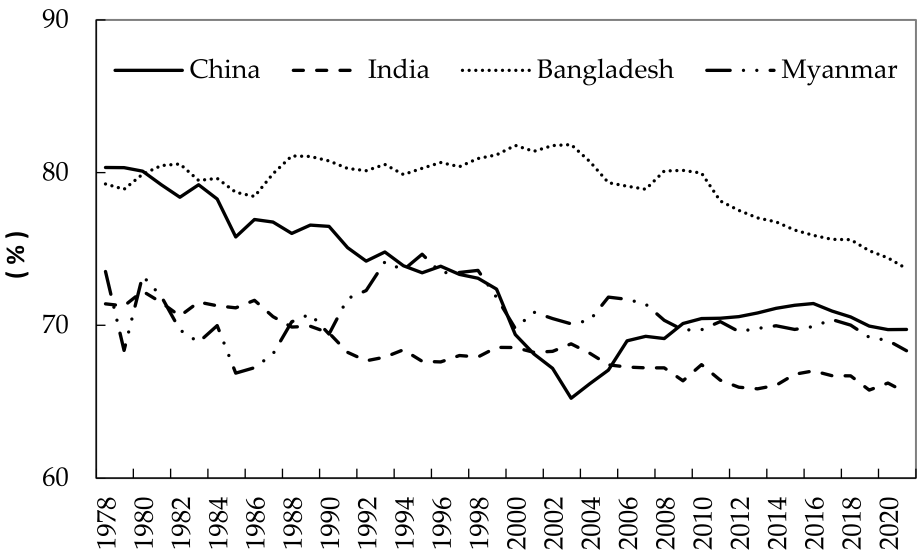

Figure 1. Proportion of planting area of grain crops to total planting area of agricultural crops in China, India, Bangladesh, and Myanmar during 1978–2021.

However, from the perspective of national food security, the trend of "non-grain" production must be prevented. Over the past two decades, China's self-sufficiency rate in grain rations has remained above 100% and the self-sufficiency rate in cereals has remained above 95%. The relatively high and stable grain self-sufficiency rate is due to the tremendous achievements in grain production. However, the growth rate of China's grain yield has been declining, with an average growth rate of less than 1% in the past decade. In the face of numerous challenges such as such as land and water resource constraints and climate change, it is becoming more and more difficult to further improve grain yields in the future. For example, the wheat yield has stagnated or decreased in more than 20% of counties in the North China Plain, while the maize yield has stagnated or decreased in more than 80% of counties [74,75]. In this context, it is becoming increasingly important to maintain the planting area of grain crops, and it is urgent to take measures to prevent the "non-grain" tendency of crop planting structures.

4.4. Policy Recommendations

Based on the above discussion, the Chinese government should formulate targeted policies to prevent the "non-grain" trend of crop planting structures after land transfer-in, and we put forward the following policy recommendations.

Firstly, improve the land transfer market and curb the excessively rapid rise in land rents. On the one hand, it is necessary to speed up the improvement of the construction of the land transfer service platform. This measure can provide more convenient information release and access services for both the supply and demand sides of land transfer, and thus reduce the cost of information transmission and promote the transfer of land. On the other hand, it is necessary to formulate a more reasonable guidance price for land transfer and explore the establishment of a reasonable rent formation mechanism for land transfer. Government intervention should be associated with market regulation to curb the excessively rapid rise in land transfer rents and promote the rationalization of land transfer rents.

In addition, improve the grain subsidy system and increase farmers' income from growing grain. On the one hand, it is necessary to make it clear that grain subsidies are linked to the actual grain planting area, so that grain subsidies will be tilted in favor of those who cultivate more grain, and increase the income and enthusiasm of the land operators. On the other hand, it is necessary to strengthen education and technical training for business entities, popularize advanced technology and management experience among them, and improve their operational and management standards. Through these measures, they can reduce the production costs and increase the income from growing grain. As a result, the profit gap between grain crops and cash crops may be narrowed, and the problem of "non-grain" production will be fundamentally alleviated.

Lastly, enhance the quality of land transfer and promote moderate-scale operation. On the one hand, local governments should actively explore forms such as land shareholding, land trusteeship, land exchange and mergers, and other innovative forms of transfer. For the purpose of centralizing and connecting land, the government should promote the transformation of land transfer from "decentralized transfer" to "large-scale transfer", so as to effectively promote the expansion of the land management scale. On the other hand, according to the local actual situations, local governments should actively cultivate new agricultural business entities, develop new agricultural business models, and promote moderate-scale operation. When the land scale reaches a moderate range, farmers will rationally choose to grow grain crops [53].

4.5. Research Limitations and Future Directions

In addition to the possible contributions, this research also has some limitations. For example, due to data usage limitations, we are unable to obtain the most recent data for 2019, which are only available to researchers at Zhejiang University. Probably due to the impact of the COVID-19 epidemics, the data for 2021 have not been released. Long-term series studies are of great significance to draw a more comprehensive and reliable conclusion. Therefore, we will conduct more updated farmer surveys in the future and systematically reveal the influence mechanism and results of land transfer-in on farmers' crop planting structure.

Moreover, based on data statistics and theoretical analysis, we deduced that the increase in land transfer rent is an important reason for the "non-grain" production after land transfer-in. However, we did not systematically explore the driving forces of the increase in the land transfer rent due to the unavailability of the data. Identifying this problem is helpful to optimize the rent of land transfer and prevent the "non-grain" production after land transfer. Therefore, it is necessary to conduct more systematic research on the land transfer rent in the future, such as its change characteristics, driving factors, and optimization countermeasures.

5. Conclusions

In this paper, we take China as the research area, use the household survey data at the national level, and adopt the methods of Propensity Score Matching (PSM) and multiple regression models to reveal the impact of land transfer-in on the crop planting structure and its heterogeneity among farmers. The results showed that land transfer-in can drive the crop planting structure to tend to be "non-grain". The research conclusion was still valid after the robustness tests of expanding the sample size, increasing the number of control variables, and introducing endogenous problem management. The heterogeneity analysis indicated that the negative impact of land transfer-in on the planting of grain crops mainly exists for large-scale farmers and farmers with agriculture as their main source of income. Based on these research results, the Chinese government should formulate targeted policies to prevent the "non-grain" trend of crop planting structures after land transfer-in.

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