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How Do the Different Types of Land Costs Affect Agricultural Crop-Planting Selections in China?

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Abstract: Land costs in agricultural production are rapidly becoming apparent and increasing in light of the market's rapid development in rural China. This study examines how agricultural operators' farming decisions are affected by explicit and implicit costs associated with land transfers. This study first categorizes explicit and implicit land costs theoretically and demonstrates that both types of land costs affect farmers' crop-planting selections. The study then uses the most recent household survey data from the Chinese Family Database (CFD) and the China Household Finance Survey (CHFS), released in 2017, to empirically test the theoretical analysis and examine the mechanisms underlying the impact of land costs on crop-planting selections. This study makes the case that higher land costs, both explicit and implicit, cause agricultural operators to grow more crops for cash and less for food. The impact of land costs on planting selection can vary depending on the heterogeneity of production areas and geography. In terms of production area heterogeneity, the explicit cost of land has a greater influence on planting decisions in non-major food-producing areas, whereas the implicit cost of land has a greater influence on planting decisions in major food-producing areas. In terms of topographic heterogeneity, the less flat the terrain, the more growers would choose to grow cash crops. A complementary relationship between the two forms of costs is also suggested by this study's confirmation that explicit and implicit land costs can positively reduce each other's impact on cropping decisions. Additional mechanism research revealed that explicit and implicit land costs impact crop crop-planting selections. The explicit cost of land primarily affects the local land transfer market effect, whereas the implicit cost of land affects the land transfer service.

Keywords: land costs; crop-planting selections; explicit costs; implicit costs; land transfer

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1. Introduction

Food security is the foundation of social stability and sustainable national development [1]. Research by the United Nations World Food Program predicts that due to climate shocks, geopolitical unrest, new global illnesses, and rising energy prices, the world will experience an unparalleled food crisis [2–4]. The imbalance between food supply and demand in China is becoming increasingly prominent. Accordingly, in order to ensure national grain security, the Chinese government has emphasized farmland redlining, grain self-sufficiency, and the absolute security of staple foods in every published "Central No.1 Document" since 2013. Developing land rental markets is a commonly suggested method for increasing grain yields and farm productivity in China [5]. The argument is that land fragmentation is a major obstacle to increasing farm productivity [6]. There is also agreement that there is a positive relationship between land scale and farm productivity [7,8]. The Chinese government has developed its land rental markets by reforming the land system [9] and encouraging off-farm employment [10–12]. The land transfer rate in China increased from 4.51 percent in 2006 to 34.1 percent in 2020[1].

With the development of China's land transfer market, the cost of rural land has risen from 62.02 yuan/mu[2] in 2005 to 238.82 yuan/mu in 2020. The structure of agricultural cultivation in China has altered along with the sharp rise in land prices [13], but some researchers have argued that high land rents in agriculture may lead to a decline in food production [14]. According to the data, the percentage of land in China's Guangdong Province planted with grain crops decreased from 48% in 2004 to 40% in 2020. In the Guangxi Zhuang Autonomous Region, it decreased from 49% to 38% in the same year. In more than a dozen other provinces, including Chongqing, Sichuan, and Guizhou, the rate of decline varied[3]. Additionally, Qiu et al. and Liu et al. contend that the emergence of a market for land rentals may result in a rise in land rents, which would have a detrimental effect on rural China's ability to feed its people [15,16]. Wang et al. and Zhang et al. analyzed that lessees would prefer to grow higher-yielding cash crops to offset the financial pressure of rising costs and produce commodities that would fetch a higher price [17,18].

In the current literature, the cost of land in rural China is mostly defined simply as land transfer rent [16] Land transfer rent is not the same as the price of the land [10]; rather, it is an indication of land revenue obtained through land management rights [18]. However, in the current common perception, land transfer rent is, by default, characterized as the cost of land in rural China [17]. In fact, in the process of agricultural cultivation, operators spend on land includes not only the externally explicit land transfer rent but also other types of implicit costs, such as land searching [19,20], negotiating for renting the land [21,22], and finishing costs of the land after renting [23,24]. None of these costs are included in the cost of land, but they do represent actual costs associated with farmers' usage of the land.

Land transfer rents have recently increased as a result of China's market for rapid development of land transfers [25–27]. While concentrating on the function of transaction costs in agriculture, scholars have stated in the current study that growing land rents put cost pressure on cultivation agents [28,29]. Even though the fraction of farmers who experience hidden expenses is very small, its impact on the trend's steady evolution and land transfer rent cannot be understated. Chinese farmers spend money on their land during agricultural production on rent and other unreported expenditures [30], and these expenses critically impact the land costs for agricultural production. To date, the hidden costs of land have received little attention, and few academics have outlined them in detail.

This study aims to examine the different types of rural land costs and their effects on crop selection. The study, which focuses on the implicit costs of land, categorizes the many types of land costs in rural China and examines the influences of various types of land costs on agricultural operators' farming selections. This paper also attempts to confirm the relationship between various forms of costs because it is less explored in the current literature. Finally, we examine the mechanism by which different types of land costs affect the farming selections made by agricultural operators and look into the causes of this phenomenon. We focus on farm households that experience explicit value costs of using land, often known as land transfer households, in terms of the research population. We use nationally representative surveys from China, the latest 2017 household survey data released by the CFD and the CHFS jointly published by Zhejiang University and Southwest University of Finance and Economics.

Our study makes three main contributions to the literature. First, we examine how land costs, both explicit and implicit, affect the planting choices made by agricultural operators. Our study improves the categorization of land costs compared to earlier research and more thoroughly illustrates how land costs affect planting choices. Second, the relationship between implicit and explicit land costs is examined. These two forms of costs have an additive effect on farmers' crop-planting selections. Third, our study looks at how the two types of land costs affected farmers' planting choices and discovers that the degree of marketization of land transfer largely determined how effective explicit land costs were, whereas the number of land transfer agencies had a greater impact on implicit land costs.

2. Background and Theoretical Analysis

2.1. Background

The topic of land transfer has been included in China's official documents on rural land policy since the early 20th century [31]. The marketization of rural land is currently progressing quickly, and a significant quantity of urban capital is stationed in rural areas to create large-scale operations on the basis of land transfer [32,33]. The cost of rural land has steadily become obvious as its marketization progresses, and the cost of land use in agricultural operations can no longer be disregarded [34,35].

The FAO definition of grain crops includes three major cereal groups: wheat, rice, and coarse grains (i.e., grains often used as animal feed, including barley, corn, rye, oats, rye, and sorghum)[4]. Cash crops are often defined as crops that provide greater economic benefits in addition to basic grain crops. Different countries are suitable for growing different kinds of cash crops, such as spices, herbs, fruits, and vegetables in Nepal [36], cotton in northern Cameroon [37], cocoa in Ghana, and coffee in Ethiopia [38]. In China, according to the National Compilation of Agricultural Products' Cost and Income (NCAPCI), there are three main grain crops in agricultural production, namely rice, wheat, and corn; cash crops include fruits, vegetables, oil crops, cotton, flue-cured tobacco, and sugar crops. Among them, fruits and vegetables are the main cash crops produced, so in this section, we focus on the data on fruits and vegetables. According to NCAPCI statistics, land price in rural China has climbed over the previous 20 years for three grain crops (rice, wheat, and corn), rising from 62.02 yuan/mu in 2005 to 238.82 yuan/mu in 2020. From 2005 to 2020, the ratio of land costs to total costs increased from 14.59% to 21.33%. (Table 1). Evidently, land has become expensive in Chinese agriculture [26]. However, compared with cash crops, grain crops require more inputs from land. Grain crops require more area for production than cash crops because they are land-intensive crops [16]. Among the most important cash crops, the percentage of land costs is 5.44% for fruits and 8.24% for vegetables, as presented in Table 1. In grain crops, the share of land costs in total cost was 21.33% in 2020. Grain crops, therefore, require more land for cultivation than cash crops, and an increase in land price can have a higher impact on growing grain crops.

From the point of view of revenue, growing cash crops can be tens or even hundreds of times more profitable than growing grain crops. According to Table 1, the profit from cultivating grain crops was 122.58 yuan/mu in 2005, but by 2020, it dropped to 47.14 yuan/mu, with negative profits from 2016 to 2019. In terms of planting cash crops, the profit from planting fruits in 2020 was 1953.78 yuan/mu, and that from planting vegetables was 3802.39 yuan/mu (Table 1). These figures, which have a significant gain gap, are respectively 41 and 81 times the profits from planting grains in that year.

Table 1. Costs and profits of main crops in China unit: yuan/mu, percent.

Crop Type		Year	Total Costs	Land Costs	Proportion of Land Costs	Net Profit
Grain crop	Three main grains (rice, maize, and wheat)	2005	425.02	62.02	14.59%	122.58
		2010	672.67	133.28	19.81%	227.17
		2015	1090.04	217.76	19.98%	19.55
		2020	1119.59	238.82	21.33%	47.14
Cash crop	The average of fruits	2005	1373.87	103.72	7.55%	1865.05
		2010	2628.56	185.55	7.06%	2906.13
		2015	4189.20	252.92	6.04%	2405.70
		2020	4777.17	259.73	5.44%	1685.96
	Average of vegetables	2010	2698.52	231.13	8.57%	2776.89
		2015	4278.43	293.94	6.87%	2094.22
		2020	5071.67	417.76	8.24%	3802.39

Sources: Authors' calculations using NCAPCI (2021). The statistics of vegetable data started in 2010.

2.2. Theoretical Analysis

Based on a previous analysis, we divide land costs into two categories:

(1) Explicit land cost, i.e., land rent during the land transfer process. Farmers in rural China have the legal authority to administer their own land [39]. This authority may be sublicensed to other business entities [31]. According to the length of use, the transferring party is required to pay what is known as "land transfer rent," which is effectively rent paid to the transferring party [40]. Land transfer rent is not the same as land price; rather, it is the land revenue expression as a result of land management rights. However, in the current public impression, the transfer rent—the most direct manifestation of land costs—is assumed to be the land costs in rural China; therefore, we refer to it as a land explicit cost.

(2) Implicit land cost is a cost that is different from land transfer rent but actually exists during the land transfer process and use [41]. The costs incurred by operating agents in land usage have expanded with the growth of the land transfer market, including input costs, in addition to land transfer rent. Operating agents frequently need to go through multiple parties, including the local government, transfer agencies, and village collectives, and incur corresponding consultation, negotiation, and evaluation costs to acquire land in a village with higher quality and a more concentrated contiguous area. Furthermore, after the land is transferred, preparing the land to make it better suited for agricultural development or installing irrigation facilities is necessary, incurring land preparation expenditures. Although they are required for the operator to use land, these expenses are not covered by land rents [32]. We refer to the costs associated with land that are not related to land transfer rent, such as those associated with transactions, preparation, and other expenditures associated with land, as the implicit land costs.

In contrast to other variables, such as labor and capital, land is a fixed natural product with unique natural, economic, and social characteristics that make it indispensable for human production and usage [42]. Urban capital's engagement raises land transfer rents, and an underdeveloped land transfer market raises the cost of land transfers and coordination, driving up growers' land investment. According to the Cost–Benefit Model (CBM) [43], the corresponding land operation scale is optimal when the marginal cost of agricultural production is equal to the marginal benefit. If the marginal cost is higher than the marginal benefit, growers will decide to reduce the scale of cultivation [44], or worse, they will stop farming [45]. The marginal yield of the land or the output value of above-ground resources must be raised if growers want to continue farming on the property.

Only if the return from land operation exceeds the sum of output cost and land costs would farmers who cultivate the land opt to continue doing so [2]. As a result, they will base their production decisions on the market's demand and fluctuations in agricultural product pricing. To maximize their financial gains, they decide to plant crops with better returns [46]. Growing cash crops such as vegetables and fruits is several times more profitable from a revenue standpoint than growing food without a major increase in food prices. Operators can increase profits and the marginal product value of the land to offset the operating losses caused by the growing cost of land if they switch from the cultivation of grains to cash crops with greater returns (Figure 1).

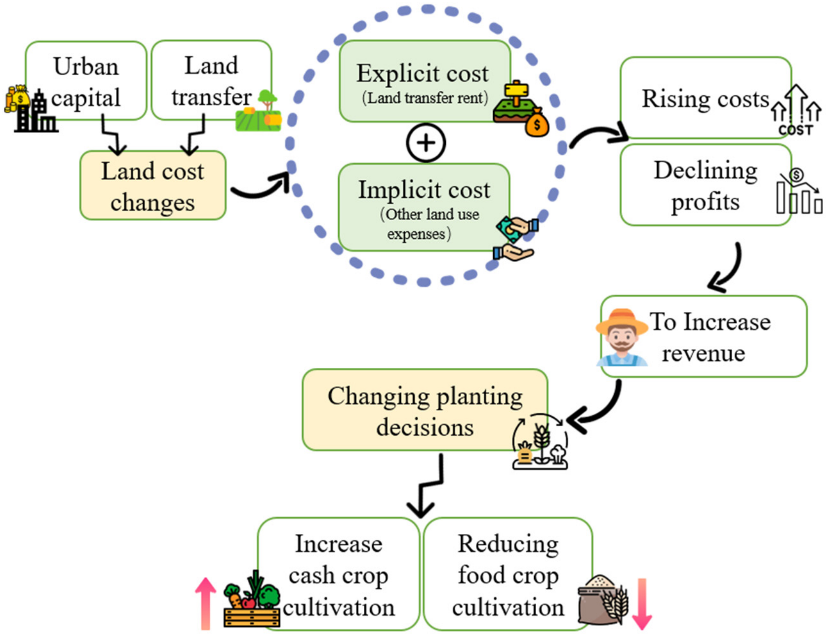

Figure 1. The framework of land costs and crop choice of farmers.

We further defend farmer actions using agricultural economics ideas. Land cost is depicted on the *x*-axis in Figure 2, and the return on farming is indicated on the *y*-axis, with the return on growing grain crops and the return on growing cash crops represented by straight line L_1 and straight line L_2, respectively. At a steady crop price, an increase in cost is expected to reduce the return on crops. In Figure 2, only the explicit land cost is displayed (a). It increases from point A to point B, corresponding to the crop point from point A′ to point B′. That is, when the explicit land cost rises, the low agricultural output forces farmers to switch from growing grain crops to cash crops.

Figure 2b illustrates the appearance of the implicit cost, which is represented by line II′. The original land cost increases from point A to point A_1 and from point B to point B_1 with the emergence of the implicit cost (where $AA_1 = BB_1 = OI$). As displayed, the producer still decides to grow grains when the land cost is at point A. However, after the emergence of the implicit cost, the crop choice of the grower passes intersection point P and shifts to the cash crop planting line (A_1′). Due to the limited benefit in this situation, the grower may give up and leave the farm. The inclusion of the hidden land cost exacerbates this situation.

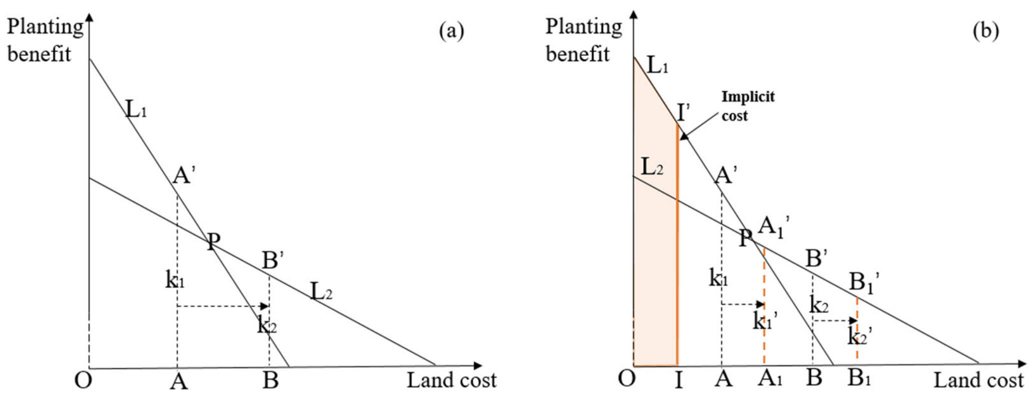

Figure 2. Land cost and crop selection in different situations. (**a**) The economic theory explanation of land cost on crop selection; (**b**) The economic theoretical explanation of land cost on crop choice after adding the implicit cost of land. The orange line represents the implicit cost of land.

Therefore, we hypothesize that the increase in land cost can make agricultural growers choose to plant more profitable cash crops and abandon planting less profitable grain crops; the inclusion of the hidden land cost aggravates this situation.

3. Methods and Data

3.1. Data

This study uses data from the CFD of Zhejiang University and the CHFS conducted by the Survey and Research Center for China Household Finance at the Southwestern University of Finance and Economics (SWUFE). This release was the latest of the 2017 annual household survey. The data include information on a sample of rural households' household structure, agricultural production and operation, land use, and land transfer, spanning 28 Chinese provinces. According to the report's content, only farm households relocated to land were chosen for analysis in this study. To obtain 1216 valid sample data from 28 Chinese provinces, we first matched all the values of land transfer households with the community (village) database and excluded outliers and missing value samples. The distribution of sample counts is shown in Figure 3. The quantity of the examined samples matches the national universality, and they are widely dispersed throughout China. More samples were found in China's northeast and southwest, and comparatively fewer in the northwest (Figure 3).

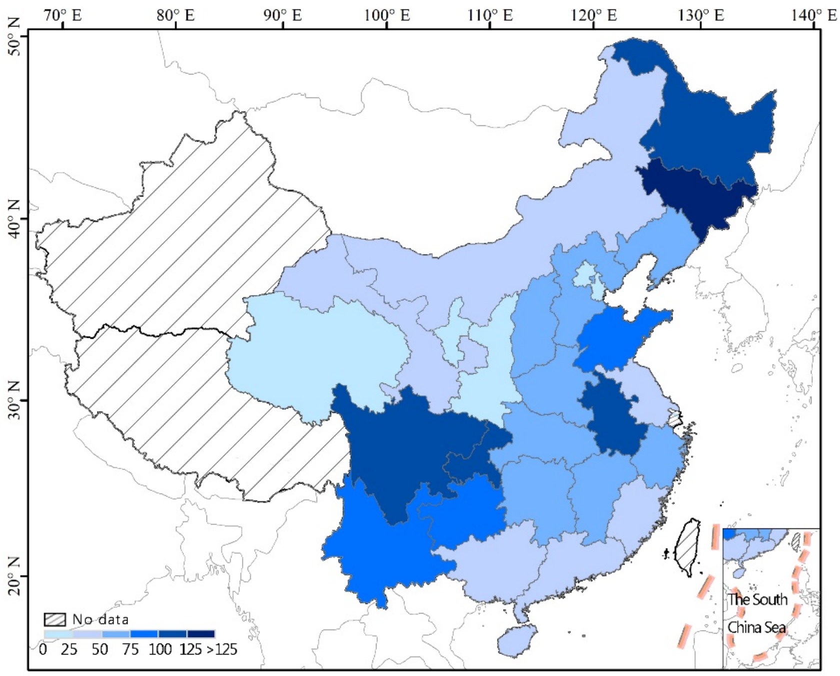

Figure 3. Sample size distribution.

3.2. Variables

(1) The explained variable is farmers' crop-planting selections. To reflect farmers' crop-planting selections, we utilize two indicators in this study: whether to plant food or cash crops. In the decision to plant crops for food, 1 means planting crops for food in the current year, and 0 means not planting crops for food in the current year. In the decision to plant crops for cash, 1 means to plant crops for cash in the current year and 0 means not to plant crops for cash in the current year. Planting food and cash crops are not always incompatible. In some instances, planting is appropriate.

(2) The core explanatory variable is land cost. The two indicators used to measure land cost in this study are the explicit and implicit costs of land. The current year's land transfer rent is the stated cost of the property. Using cost research methodology [41], the implicit cost of land is calculated from historical and prospective viewpoints, and

the database's two indicators, "other expenses in land transfer" and "land preparation costs," are selected to reflect the cost of land.

(3) Control variables. This study modifies the model of the impact of land costs on the crop-planting selections of operating agents by taking into account the control variables influencing farm families' crop-planting selections [25,47,48], such as household head qualities, household characteristics, and village features. Age, gender, and educational level are household characteristic factors. Operation scale, agricultural labor, equipment, inputs, subsidies, and cadre qualities are all household characteristic variables. Village characteristic variables include village economy and transportation. Table 1 lists the descriptive statistics of the variables (Table 2).

Table 2. Descriptive statistics of variables.

Variable Types	Variable Name	Variable Description	Symbolic	Mean	S.D.	Min	Max
Explained variables	Crop-planting selections	Whether the main entity was engaged in grain crop cultivation during the year (Yes = 1, No = 0)	Grain.	0.792	0.406	0	1
		Whether the main entity was engaged in cash crop cultivation during the year (Yes = 1, No = 0)	Cash	0.203	0.402	0	1
Core explanatory variables	Explicit cost of land	Current year's land transfer rent (yuan/mu); add 1, and take logarithmic processing	Ex_cost	3.069	2.833	0	8.412
	Implicit cost of land	Sum of other expenses in the land transfer process and land preparation input costs (yuan); add 1, and take logarithmic processing	Im_cost	2.285	2.972	0	14.221
Householder characteristics	Sex	Gender of the head of household (male = 1, female = 0)	Gen	0.936	0.244	0	1
	Age	Age of head of household (years)	Age	53.813	10.606	23	89
	Level of education	Educational attainment of the household head (no schooling = 1, primary school = 2, middle school = 3, high school = 4, secondary school/vocational high school = 5, college/higher education = 6, and undergraduate = 7)	Edu	2.515	0.911	1	7
Family characteristics	Scale of operations	Transferred acreage (mu); add 1, and take logarithmic processing	Area	1.677	1.374	0	8.006
	Agricultural labor force	Hired or not (yes = 1, no = 0)	Lab	0.223	0.416	0	1
	Agricultural machinery	Agricultural machinery inputs (yuan); add 1, and take logarithmic processing	Mac	6.622	3.537	0	16.013
	Agricultural inputs	Agricultural inputs (yuan); add 1, and take logarithmic processing	Cap	8.121	2.033	0	13.974
	Agricultural subsidies	Access to agricultural subsidies or not (yes = 1, no = 0)	Sub	0.722	0.448	0	1
	Cadre characteristics	Availability of village officials for household members (yes = 1, no = 0)	Cad	0.077	0.266	0	1
Village Features	Village Economy	Annual village income per capita (yuan), treated as the logarithm	Income	8.473	1.310	6.492	11.513
	Village transportation	Number of roads leading to the county	Road	2.593	0.847	0	5

3.3. Model

The probit model is the cumulative logistic used by academics because the dependent variable planting decision is a dichotomous dependent variable, and only two decisions can be made: "yes" or "no." Consequently, this study uses the cumulative distribution function to build the regression model. Researchers often employ the probit model, which is a cumulative logistic function computed by using a normal cumulative distribution function. The probit model was selected to confirm the impact of land costs on farmers' planting choices throughout their operations. Two models are used in this study to conduct an economic analysis of how each cost affects the decision to plant, and then to include all costs in one econometric model for calculation. Thus, the model's resilience is maintained while avoiding the interaction effects between costs as much as possible. Finally, we chose a logit model to validate the data results.

Set the underlying econometric model as follows:

$$Y_i = \alpha + \beta_1 X_i \sum\nolimits_{n=1} \beta_2 D_{ni} + \varepsilon_i \quad (1)$$

where Y_i is the planting decision of the dependent variable operator, X_i is the core independent variable of the land cost, and D_{ni} is another control variable, where α is the constant term, β_1 is the parameter to be estimated for the core explanatory variables, β_2 is the parameter to be estimated for the control variables, and ε_i is the random disturbance term.

4. Empirical Results and Analysis

4.1. Descriptive Statistics

The sample data included in the article span 28 provinces in China's east, center, and west, providing a good representation of the country's data. After extracting the essential variables from the sample and calculating the mean by province, the findings are presented in the Figure below. The current state of land costs in the sample data is depicted in Figure 4, where (a) is the provincial average of the explicit cost of land, and (b) is the provincial average of the implicit cost of land. The explicit cost of land is the highest in the Chinese province of Jilin, at over 400 yuan/mu, and moderately high in the provinces of Heilongjiang, Shandong, Ningxia, Zhejiang, and Gansu, at 250–400 yuan/mu. It is lower in Sichuan and Chongqing at 20–50 yuan/mu. The east has a greater overall national trend than the west. Shandong, Henan, Hebei, and other provinces are high-value locations for the implicit cost of land, with values of 350 yuan/mu or more. Sichuan, Guizhou, and Jiangxi are lower, with values of less than 50 yuan/mu. The central and eastern regions have a higher overall national trend than the southwest region, which has a lower overall trend.

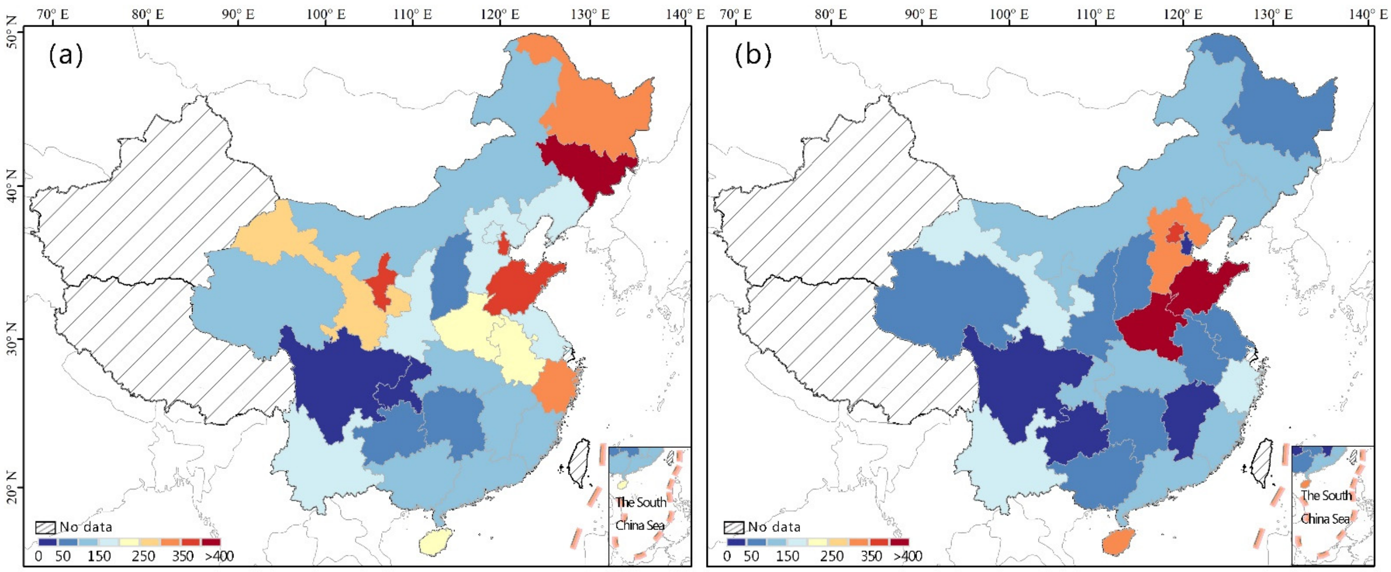

Figure 4. Current status of land costs by province in China. (**a**) Explicit cost of land (yuan/mu); (**b**) implicit cost of land (yuan/mu).

Figure 5 shows the current status of business agents' farming decisions in the sample data, characterized by the proportion of growers who grow grain crops (or cash crops) as a percentage of growers in the province's sample data. The percentage of farmers who cultivate grain crops is shown in (a), and the percentage of farmers who plant cash crops is shown in (b). Heilongjiang, Shaanxi, Inner Mongolia, and Hubei account for more than 40% of China's grain production, whereas Qinghai, Gansu, Sichuan, Chongqing, Guizhou, and Guangxi produce more than 40% of the country's cash crops. From a national perspective, planting cash crops is likely in the west and southwest and grain crops in the northeast, northwest, and central regions, demonstrating the accuracy of the sample data; it is consistent with the divide between China's main grain-producing regions and non-major grain-producing regions[5].

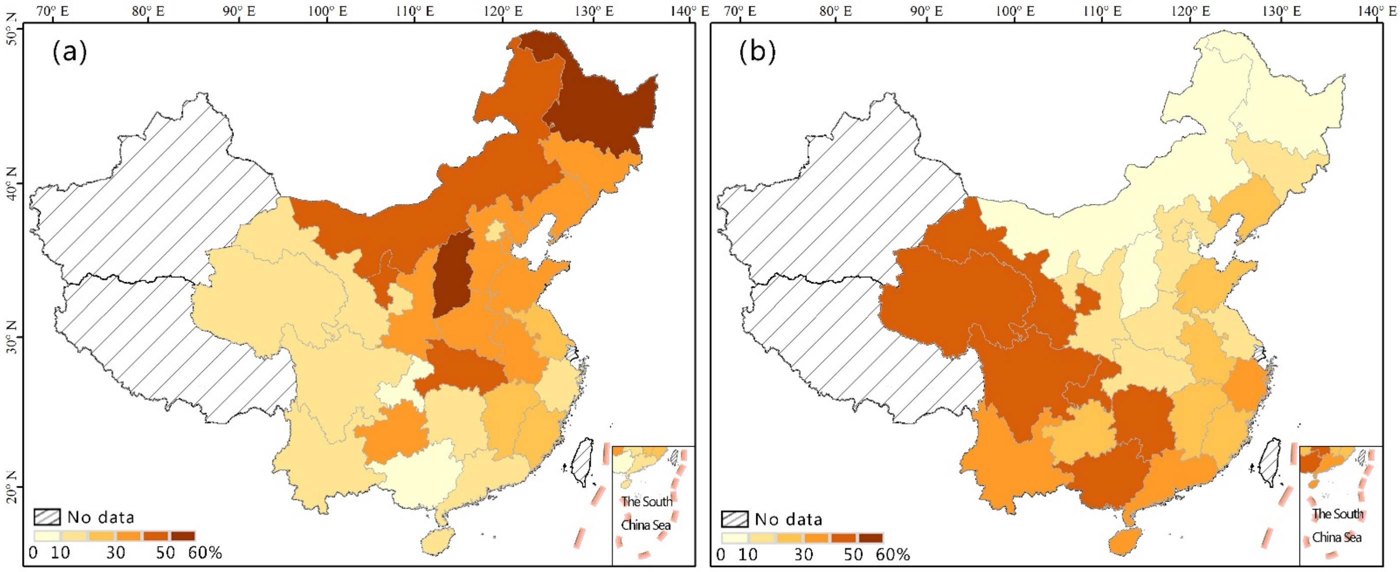

Figure 5. The current state of crop-planting selections by province in China. (**a**) Proportion of growing grain crops decisions (%); (**b**) proportion of growing cash crops decisions (%).

4.2. Regression Results

Before the formal regression analysis, a multiple collinearity test was conducted due to the possibility of internal correlation between variables. The test results showed that the VIF values were far less than 10, indicating that there was no serious collinearity problem between variables, and the degree of collinearity was within a reasonable range. Therefore, this study conducted a formal regression estimation to further explore the impact of land costs on farmers' crop selections. The overall fitting effect of the model was good, and it passed the significance tests at the 1% level. The specific results are shown in Table 3.

Table 3 shows the results of fitting the land costs effect to the operators' crop-planting selections. Regressions (1) and (3) include only the explicit and implicit costs of land, whereas regressions (2) and (4) also include control variables. The model's findings are less variable after the variables are accounted for, demonstrating the robustness of the model.

Table 3 shows the findings after adjusting for other factors, demonstrating that explicit and implicit land costs statistically impact the operators' planting choices at the 1% level. A one-unit increase in land explicit cost is linked to a 0.089 decrease in food growing decisions and a 0.087 increase in cash crop growing choice. That is, land explicit cost has a negative impact on food growing decisions and a positive impact on cash crop growing decisions. Decisions about growing food are adversely affected by the land implicit cost by 0.053. Comparatively, the impact of land explicit cost on the operator's decision to plant is bigger than that of land implicit cost.

Among the control variables, the individual endowment of the operating agent has a weak effect on the planting decision. Gender, age, and educational level are not significant in the model. The size of the land operation is one of the household variables that significantly influence whether or not to cultivate food, while negatively impacting cash crops. Whether hiring labor has a significant negative impact on food production and a positive impact on producing cash crops, the opposite is true for the use of agricultural machinery, which is consistent with the fact that producing grain crops requires large machinery, while producing cash crops requires more labor. The disincentive effect of agricultural inputs suggests that the more money invested, the more inclined the subjects are to cultivate cash crops. Agricultural subsidies significantly facilitate food production, and the presence of village cadres facilitates cash crop production. According to village characteristics, food production is more common in villages with a higher yearly per capita incomes. This might be the case because few agricultural laborers still live in these villages and the majority of the inhabitants of these villages work in the towns [48]. Growing grain crops needs less labor and is better suited to extensive mechanization than farming cash crops [26,49]. Grain crops are, therefore, more likely to be planted in villages with a smaller labor force [15,50]. In contrast, the village transportation variable has no appreciable impact on either food or cash crop production, demonstrating that the development of transportation has a minimal impact on whether food or cash crops are produced. The regression findings for the control variables will not be given in the following pages because of space restrictions.

Table 3. Regression results.

Variable	Planting Grain Crops (1)	Planting Grain Crops (2)	Planting Cash Crops (3)	Planting Cash Crops (4)
Ex_cost	−0.070 *** (0.014)	−0.089 *** (0.018)	0.068 *** (−0.014)	0.087 *** (0.018)
Im_cost	−0.044 *** (0.013)	−0.053 *** (0.015)	0.046 *** (0.013)	0.055 *** (0.015)
Gen	—	0.157 (0.171)	—	−0.126 (0.173)
Age	—	0.004 (0.004)	—	−0.003 (0.004)
Edu	—	−0.068 (0.048)	—	0.075 (0.048)
Area	—	0.206 *** (0.043)	—	−0.215 *** (0.044)
Lab	—	−0.458 *** (0.107)	—	0.450 *** (0.107)
Mac	—	0.046 *** (0.015)	—	−0.044 *** (0.015)
Cap	—	−0.078 ** (0.034)	—	0.089 *** (0.034)
Sub	—	0.312 *** (0.096)	—	−0.306 *** (0.096)
Cad	—	−0.323 ** (0.154)	—	0.327 ** (0.154)
Income	—	0.113 *** (0.031)	—	−0.114 *** (0.031)
Road	—	−0.050 (0.052)	—	0.037 (0.053)
_cons	1.155 *** (0.068)	0.186 (0.480)	−1.170 *** (0.069)	−0.325 (0.485)
LR chi^2	41.61 ***	120.31 ***	40.25 ***	120.93 ***
Pseudo R^2	0.032	0.097	0.031	0.099
N	1216	1216	1216	1216

Note: *** and ** indicate significance levels of 1% and 5%, respectively, and the standard errors are in parentheses.

4.3. Robustness Tests

4.3.1. Modifying Estimation Methods

The logit model, which tests whether the dependent variable is a binary variable or not, is a cumulative logistic function. The assumptions made regarding the distribution of the sample are the major distinction between the logistic model and the probit model. The conditional probabilities in the logit model converge to 0 or 1 a little more slowly than they do in the probit model. We used the logit model to retest the data in the robustness test. With marginal effects of −0.156 and −0.091 for the grain planting decision and marginal effects of 0.153 and 0.095 for the planting of cash crops, the results in columns (1) and (2) of Table 4 demonstrate that the explicit and implicit costs of land are significant at the 1% level for the planting decision under the Tobit model estimation. These findings are solid because the outcomes align with those of the research described above.

4.3.2. Excluding Special Samples

The explicit cost of land, or land transfer rent, serves as the main explanatory variable in this study. The sample data on transfer household rent for the entire sample are preserved during data processing. However, the zero-rent phenomenon, in which the party transferring land voluntarily gives it to another party for cultivation without demanding a fee, occurs frequently in real life. The article decided to exclude the zero-rent data from the sample and keep 690 samples for robustness testing because the existence of the zero-rent phenomena will have a stronger impact on agricultural operators' farming operations. Following the exclusion of the zero-rent sample, the findings in columns (3) and (4) of Table 4 demonstrate that the impact of explicit and implicit land costs on crop-planting selections remains substantial. The coefficients for the explicit and implicit land costs, which are −0.237 and −0.040 for food planting selections and 0.226 and 0.042 for cash crop planting selections, respectively, are higher than those in the full sample analysis above, demonstrating that the impact of land costs on crop-planting selections is more pronounced in the non-zero rent case.

4.3.3. Replacing Key Variables

The implicit cost, which is a monetary representation of the implicit cost in the preceding study, is expressed as the sum of other land transfer and land preparation costs. In the robustness test, the implicit cost of the land is swapped out with a binary variable with the symbol *Ser* that represents "if the service is received in the process of transfer." According to the findings in Table 4 (5) and (6), which are consistent with the study above, more operators who employ land transfer services cultivate more grain crops and fewer cash crops. The findings of this analysis agree with those presented above. This shows that, even though land transfer service providers can take the place of farmers to complete the process of searching for, negotiating, and transferring land and can reduce transaction costs, such as time, consultation, and decision-making costs for households transferring land, the providers still have to pay for it. As a result, operators are more eager to plant more lucrative cash crops to compensate for this increase in the implied cost of the property.

Table 4. Robustness test results.

Variable	**Logit Model**		**Special Samples Exclusion**		**Replacement Variables**	
	(1) Grain	**(2) Cash**	**(3) Grain**	**(4) Cash**	**(5) Grain**	**(6) Cash**
Ex_cost	−0.156 *** (0.032)	0.153 *** (0.032)	−0.237 *** (0.063)	0.226 *** (0.063)	−0.080 *** (0.018)	0.079 *** (0.018)
Im_cost	−0.091 *** (0.025)	0.095 *** (0.025)	−0.040 ** (0.018)	0.042 ** (0.018)	—	—
Ser	—	—	—	—	−0.411 *** (0.131)	0.393 *** (0.132)
Control variables	controlled	controlled	controlled	controlled	controlled	controlled
_cons	0.465 (0.850)	0.727 (0.863)	1.509 ** (0.738)	−1.421 * (0.737)	0.098 (0.479)	−0.241 (0.485)
LR chi^2	121.83 ***	122.83 ***	114.84 ***	112.48 ***	117.11 ***	115.90 ***
Pseudo R^2	0.099	0.100	0.150	0.148	0.095	0.095
N	1216	1216	1216	1216	1216	1216

Note: ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively, and the standard errors are in parentheses.

4.4. Heterogeneity Analysis

4.4.1. Regulating the Role of Production Regions

China has been classified into main grain-producing and non-major food-producing regions, with comparative advantages based on geographical, soil, meteorological, and technical circumstances. Given that the primary crops cultivated in the main grain-producing regions are primarily grain crops caused by objective conditions, examining the heterogeneity between the main grain-producing regions and non-major food-producing regions is important. Ex_cost×pro and Im_cost×pro, two interaction terms, were created, with pro serving as a dummy variable for the primary production areas (1 for non-major food-producing regions and 0 for main grain-producing regions). Table 5 shows the regression results. The regression results demonstrate that the coefficients of the independent variables in the main effect are the same for land explicit cost and land implicit cost with production area, indicating that the interaction terms of both types of land costs with production area enhance the main effect. Among these, the impact of explicit land costs on crop-planting selections is greater in non-major grain-producing regions. In contrast, the impact of implicit land costs is greater in the main grain-producing regions.

Table 5. Analysis of heterogeneity.

Variable	Planting Grain Crops				Planting Cash Crops			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ex_cost	−0.042 ** (0.020)	−0.092 *** (0.018)	−0.067 *** (0.020)	−0.091 *** (0.018)	0.038 * (0.020)	0.090 *** (0.178)	0.064 *** (0.020)	0.089 *** (0.018)
Im_cost	−0.053 *** (0.015)	−0.196 *** (0.409)	−0.054 *** (0.015)	−0.045 ** (0.018)	0.055 *** (0.148)	0.201 *** (0.041)	0.056 *** (0.015)	0.047 *** (0.018)
Ex_cost×pro	−0.115 *** (0.022)	—	—	—	0.121 *** (0.022)	—	—	—
Im_cost×pro	—	0.088 *** (0.024)	—	—	—	−0.090 *** (0.024)	—	—
Ex_cost×geo	—	—	−0.026 ** (0.012)	—	—	—	0.028 ** (0.012)	—
Im_cost×geo	—	—	—	−0.009 (0.012)	—	—	—	0.010 (0.012)
Control variables	controlled	controlled	controlled	controlled	controlled	controlled	controlled	controlled
_cons	0.221 (0.483)	0.225 (0.481)	0.295 (0.482)	0.218 (0.482)	−0.364 (0.489)	−0.370 (0.487)	0.444 (0.487)	−0.360 (0.487)
LR chi^2	148.20	134.30	125.02	120.87	151.21	135.63	126.38	121.58
Pseudo R^2	0.120 ***	0.109 ***	0.101 ***	0.098 ***	0.124 ***	0.111 ***	0.103 ***	0.099 ***
N	1216	1216	1216	1216	1216	1216	1216	1216

Note: ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively, and the standard errors are in parentheses.

4.4.2. Moderating Role of Topography

Studies have shown that topography may affect farmers' planting choices [51,52]. Flatter topography has a higher land concentration and contiguity, which is better for expanding grain crop production. In contrast, farmers choose to grow labor-intensive income crops because uneven terrain makes it difficult to use agricultural equipment and is unsuitable for large-field cultivation. This research studies the moderating effect of topographic parameters in order to determine the moderating effect of topography on the link between land costs and operator crop-planting selections. Table 5 presents the study outcomes. The interaction term of explicit costs of land passes the significance test, and the coefficients of the interaction terms of explicit and implicit costs of land and terrain are negative for grain-growing behavior, indicating that the terrain factor exhibits a negative moderating effect on both types of costs. The fact that both forms of expenses interact positively with the topography element in the behavior of planting cash crops suggests that terrain has a positive moderating effect on the decision to plant cash crops. In other words, operational agents are more likely to plant cash crops if the terrain is uneven.

4.5. Further Analysis: Interaction of the Two Types of Land Costs

The cost of land has gradually become apparent in the process of agricultural cultivation in recent years because of the exodus of rural labor and the growth of the land transfer market [18,31], and land rent has progressively become one of the major expenses that farmers must consider when growing crops [16,26]. Furthermore, farmers pay for the use of land to acquire transfer services [25], and governments at all levels, village collectives, and various social organizations have all stepped in to help construct bridges between the two sides of the transfer and aid in better and faster transfers [22]. Land rent and additional land use costs are input to the land by operators in the cultivation process. Existing literature has not thoroughly investigated whether a relationship exists between these two costs and whether they are mutually constraining or mutually facilitating. The interaction factors of the two types of costs were incorporated into the model to examine whether the explicit and implicit costs of land were complementary or substituted. The results are presented in Table 6. The variables in this study are centered on preventing the potential issue of multicollinearity that could arise with the inclusion of the interaction term.

Table 6 demonstrates that the interaction factors between the explicit and implicit costs of land in grain growth have negative signs and pass the significance tests. This shows that the interaction term of both has a significant negative moderating effect on the negative influence of land costs on grain cultivation decisions. The explicit and implicit costs of land are positive in the case of cash crops, indicating that the cost of land has a positive moderating influence on the cultivation of cash crops, with the explicit cost of the land's moderating effect being more substantial. In other words, operators choose to cultivate cash crops rather than grain crops when balancing costs. Additionally, the two types of costs function in unison, meaning that raising one cost will raise the other, and the two are mutually reinforcing.

Table 6. Interaction of the two types of land costs.

Variable	Planting Grain Crops		Planting Cash Crops	
	(1)	**(2)**	**(3)**	**(4)**
Ex_cost	−0.074 *** (0.019)	—	0.072 *** (0.019)	—
Im_cost	—	−0.023 (0.023)	—	0.026 (0.023)
Ex_cost×Im_cost	−0.006 ** (0.003)	−0.007 * (0.004)	0.007 ** (0.003)	0.007 (0.004)
Control variables	controlled	controlled	controlled	controlled
_cons	0.119 (0.479)	0.106 (0.478)	−0.256 (0.485)	−0.246 (0.484)
LR chi^2	112.06 ***	97.30 ***	112.26 ***	98.89 ***
Pseudo R^2	0.091	0.079	0.092	0.081
N	1216	1216	1216	1216

Note: ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively, and the standard errors are in parentheses.

5. Mechanism of Action: Degree of Land Transfer Market Development

The available research mainly explains the effect of land costs on operators' crop-planting selections in terms of the factor substitution drive of land and labor [53,54] or the substitution of agricultural machinery services [47]. However, the level of development of the agricultural land transfer market is significantly correlated with the establishment of explicit land costs and formation of implicit land costs [23,40]. The pricing of land costs is more developed and the transaction procedure is clearer in countries where the land transfer market is more developed [21]. This study shows the interaction effect of the degree of land transfer market development on whether it influences the behavior of the two types of land costs on the planting decision of operators. The land transfer market index and the land transfer market services were chosen as the two indicators in this study to describe the level of market development.

(1) To assess the development of the rural land transfer market, as shown in Table 7, we chose six evaluation dimensions: land transfer market participation, transfer object liberalization, transfer object marketization, transfer market sinking degree, transfer market stability, and transfer market effect. We set weights for the evaluation indicators based on the entropy weight method[6]. (2) The land transfer market services indicator is characterized by the number of rural land transfer trading agencies in each province. These two indicators are employed in conjunction with two types of land costs to determine the moderating influence of the degree of land transfer market development on the impact of land costs and crop-planting selections.

Table 7. Indicators of calculating the land transfer market index.

Evaluation Dimension	Meaning of the Indicator	Min	Max	Mean	S.D.
Rotating market participation	Percentage of arable land transferred under a family contract	0.09	0.91	0.38	0.18
Liberalization of the objects of circulation	Percentage of space leased to population or units outside the township	0.02	0.33	0.12	0.06
Marketization of the objects of circulation	Percentage of area transferred to new agricultural operators	0.35	0.91	0.59	0.15
Degree of sinkage in the circulation market	Number of land transfer markets/number of district and county administrative divisions	0.09	1.13	0.55	0.29
Stability of the circulation market	Number of disputes per unit area	1.01	66.89	14.14	14.32
Effectiveness of marketization of transfers	Percentage of farms above medium size	0.02	0.64	0.20	0.13

The regression results are presented in Table 8. The findings demonstrate that the explicit cost interaction term passes the significance test, and that the coefficients of the interaction term between the land transfer marketability index and the explicit cost of land and the implicit cost of land in the choice to grow food are negative. The interaction term of implicit costs passed the significance test. The coefficients of the interaction term between land transfer market services and both types of costs are negative. Therefore, the development of the land transfer market has a detrimental moderating impact on the effects of both forms of land costs on decisions related to food production. The explicit cost of transferring land is significantly influenced by its marketability index, whereas the implicit cost is significantly influenced by its market service. The degree of market development of agricultural land has a positive moderating effect on the impact of land costs on cash crops, as shown by the positive interaction coefficients of the land transfer marketability index, land transfer market services, and explicit and implicit land costs for cash crops. In other words, when land costs rise, the more the market has developed, the more operators will choose to cultivate cash crops.

Table 8. Moderating effects of the degree of market development.

Variable	Planting Grain Crops				Planting Cash Crops			
	Market Index		Market Services		Market Index		Market Services	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ex_cost	−0.023 (0.040)	−0.090 *** (0.018)	−0.048 (0.032)	−0.090 *** (0.018)	0.016 (0.041)	0.089 *** (0.018)	0.044 (0.032)	0.088 *** (0.018)
Im_cost	−0.055 *** (0.147)	−0.009 (0.039)	−0.052 *** (0.015)	−0.006 (0.032)	0.057 *** (0.015)	0.010 (0.039)	0.054 *** (0.147)	0.007 (0.032)
Ex_cost×mar	−0.024 * (0.013)	—	—	—	0.025 * (0.013)	—	—	—
Im_cost×mar	—	−0.017 (0.014)	—	—	—	0.017 (0.014)	—	—
Ex_cost×agen	—	—	−0.024 (0.016)	—	—	—	0.025 (0.016)	—
Im_cost×agen	—	—	—	−0.027 * (0.016)	—	—	—	0.027 * (0.016)
Control variables	controlled	controlled	controlled	controlled	controlled	controlled	controlled	controlled
_cons	0.138 (0.481)	0.174 (0.480)	0.140 (0.480)	0.147 (0.479)	−0.276 (0.487)	−0.314 (0.486)	−0.279 (0.485)	−0.286 (0.485)
LR chi^2	123.63 ***	121.78 ***	122.64 ***	123.04 ***	124.74 ***	122.44 ***	123.59 ***	123.81 ***
Pseudo R^2	0.100	0.099	0.010	0.010	0.102	0.100	0.101	0.101
N	1216	1216	1216	1216	1216	1216	1216	1216

Note: *** and * indicate significance levels of 1% and 10%, respectively, and the standard errors are in parentheses.

6. Conclusions and Implications

The importance of land costs in agricultural output has gained increasing attention as the land factor market has developed. This study examines the effects of explicit and implicit land costs on farmers' crop-planting selections using the most recent CFD and CHFS 2017 data from Zhejiang University. Both forms of land costs are found to impact how agricultural planting is structured, with a considerable negative impact on the planting of grain crops and a significant positive effect on planting cash crops. The impact of explicit and implicit land costs on planting structure is equal within the division of land costs framework, showing that when land costs rise, planting subjects are more likely to plant more lucrative cash crops than less lucrative ones. Conversely, the explicit cost of land influences crop-planting selections more than the implicit cost of land does. These conclusions hold true even after special variables are eliminated, explanatory variables are replaced, and the models are replaced. We also examine the diverse impacts of topography and production areas on the outcomes. These findings support the notion that different production locations are affected differently by the two forms of land cost. The lower the level of the terrain, the more probable it is that the operator will grow cash crops.

The relationship between the two types of land costs for crop-planting selections is further explored in this study, which supports the idea that explicit and implicit land costs play complementary roles in crop-planting selections for planting subjects. We also examine the mechanism by which market development for agricultural land affects planting choices for both types of land costs. Although the implicit cost of land operates mostly through the land transfer service effect, the explicit cost of land primarily operates through the impact of the local land transfer market.

Our findings have several significant policy implications. (1) Although the current increase in land prices in rural China has not led to a significant drop in food cultivation, the findings of this study indicate that it increases the probability of a drop in crop yields. Thus, China should implement controls on land transfer and use pricing at the national level to keep land costs from rising over the means of cultivation. (2) Given the recent involvement of urban capital in rural agricultural production, land costs have dramatically increased. Cash crops are preferred because of their profit-seeking tendencies. Controlling the disorderly expansion of capital and the proper utilization of industrial and commercial capital in agricultural production are important to maintain the development of grain crops and ensure national food security.

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Notes

1 Data source: China Rural Policy and Reform Statistics Annual Report, 2021.
2 Mu, Chinese unit of land measurement that is commonly 666.7 square meters.
3 Data source: China Rural Statistical Yearbook, 2021.
4 https://www.fao.org/markets-and-trade/commodities/grains/en/, accessed on 20 September 2022.
5 China's main grain-producing regions are key grain-producing regions with geographical, soil, climatic and technological conditions suitable for growing grain crops and with certain comparative advantages such as resource advantages, technological advantages and economic benefits, including 13 provinces of Heilongjiang, Jilin, Liaoning, Inner Mongolia, Hebei, Henan, Shandong, Jiangsu, Anhui, Jiangxi, Hubei, Hunan and Sichuan. The remaining provinces are non-major grain-producing regions.
6 For space reasons, the exact calculation process is omitted; please ask the authors for a copy if needed.

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