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Effect of Spatial Characteristics of Farmland Plots on Transfer Patterns in China: A Supply and Demand Perspective

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Abstract: (1) Background: The tense relationship between man and land makes transferring farmland rights in the market critical for improving agricultural production efficiency and promoting large-scale agricultural management. (2) Methods: This study considers the impact of the spatial characteristics of farmland plots on the economies of scale of farmers in terms of farmland use and heterogeneity. The effect of plots' area and location on the directional flow of plots in the farmland transfer market from the perspective of matching supply and demand is also investigated. An empirical test is conducted on farmer actions and plot characteristics data based on surveys from 2015 and 2018 in the Chinese provinces of Heilongjiang, Henan, Zhejiang, and Sichuan. (3) Results: The plots' area and location affect economies of scale for different potential transfer plots. This leads to large plots and adjacent plots in the market transferring to large-scale households, while scattered small plots mainly transfer to ordinary households. (4) Conclusions: The fixed spatial characteristics of the plots determine the scattered circulation of farmland in the transfer market, hindering the centralized utilization of farmland and restricting efficiency in farmland transfer market allocation. The findings from the context of China are similar to what has been found elsewhere. This suggests the need for a unified trading platform for farmland transfer and strengthening the mutual transformation of land and agricultural machinery.

Keywords: plot spatial characteristics; farmland transfer patterns; resource allocation; scale economic; bivariate probit model

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1. Introduction

In China, as farmland is limited and the resources for its further development are insufficient, reallocating farmland through the transfer market is considered an important means of developing agricultural scale and improving agricultural production efficiency [1,2]. Therefore, since the 1980s, the Chinese government has issued a series of policies to encourage and support the transfer of farmland in the market to promote the development of large-scale agricultural operations. However, contrary to policy objectives, the amount of farmland transferred to large-scale farm operators is not as great as expected [3], even though the average rent paid by large operators is higher [4]. To help frame or amend the future land policy, a better understanding of the underlying reasons for this is worthy of study.

Many scholars have analyzed the influence of social and economic factors on farmers' decisions to reduce their farmland or switch to non-agriculture from the perspective of family characteristics, population migration, income structure, non-agricultural employment, rural social security, farmland tenure, and agricultural policy, among other aspects [5–11]. However, there have been few in-depth studies on the directional transfer pattern of farmland and the factors influencing this trend. Some scholars have compared the differences among households transferring land using different transfer methods and found that farmers with stronger management ability and better technology used more formal, well-paid methods of transferring farmland. Still, farmers with less per capita farmland, an aging labor force, less education, and a lack of non-agricultural employment experience were more likely to choose informal and unpaid means of transferring scattered farmland [12]. In addition, some scholars have found that farmlands in economically developed areas are concentrated in large-scale households, while in economically underdeveloped areas, they have been dispersed and transferred mainly among farmers in their own villages [13,14]. Although the above studies focus on the differences in the transfer of farmland in different markets, the causes and influencing mechanisms underlying these differences have not been analyzed systematically. From the perspective of the transfer-in farmland household, various farmer agricultural production factors will differ because of different factor endowments and production and management capacities. That is, the combination of different factors in production that affect the cost and profit of agricultural production [15,16] also determines the rent of farmland. However, in reality, the adjustment of factor combinations is often constrained by factor endowment conditions [17–19], which means not only that the land's features in the transfer market affect how the transferee households use the farmland but also that differences in factor endowments of the transferee households will lead to heterogeneity in their demand for farmland with different characteristics.

From the perspective of farmland distribution, fragmentation characteristics are affected by the inheritance system, land distribution system, conditions of land resources, and demand for planting diversification, among other factors. For example, a farmer in China usually operates multiple plots of different sizes and presents "fancy" distribution on different plots. At the same time, it is difficult for farmers to make collective decisions about transferring or replacing farmland. Thus, the distribution of the potential plots for transfer is random. Consequently, plots in the farmland transfer market are spatially divided into certain areas and locations.

Furthermore, in agricultural production, small and far-flung plots are inconvenient for mechanical operations, thus hindering the use of mechanical technology for labor [20]. As such, the plots increase the time spent and transportation costs of workers to the transfer location as well as the transportation of production means, restricting the substitution of factors and cost allocation in the production process. Therefore, the utilization of plots with different spatial characteristics differs; moreover, the same land has a different value for farmers with different factor endowments. In particular, with the expansion of operational areas, labor scarcity increases, increasing the demand for factor replacement and leading to the need for mechanical labor or labor-saving technology. Thus, the spatial characteristics of the transferred land may hinder the economies of scale achieved by scale expansion, resulting in a serious efficiency loss [21].

Previous studies have preliminarily discussed the impact of the spatial characteristics of land plots in the transfer market on agricultural production and the development of farmland scale management [18]. However, no studies have tested whether there are systematic differences in the characteristics of farmer demands for transferred farmland at different scales. Moreover, the expansion of operating areas and the development of agricultural scale in the transfer market have been gradual, and few studies have examined changes in household demand for transferred farmland. Combined with the natural attributes of the spatial characteristics of farmland, we investigate the impact of the spatial characteristics of the farmland on the transfer of land from the perspective of matching farmland supply and demand. Our study uses survey data on farmers and plots in the Chinese provinces of Heilongjiang, Henan, Zhejiang, and Sichuan to conduct an empirical analysis. We contribute to the literature as follows: First, by comparing and analyzing differences in farmers' preference for the characteristics of transferred farmland restricted by different factor endowments, we reveal the economic constraints from the perspective of natural resource endowment. Second, based on economies of scale and transaction cost theory, we construct a transaction cost analysis framework for land transfer to recognize contiguity, explain the logic and mechanism of the impact of this resource endowment constraint on farmland transfer and scale management, and expand and enrich the theory and research perspective of existing farmland transfer.

2. Framework and Hypotheses

In the competitive farmland market, the basis for transferring land is the rent received from the farmland transfer. From the perspective of the transferee households, and based on differences in factor endowment, production, and the management capacity of the farmers, differences in this combination of factors in the production process will lead to differences in farmer demand for land characteristics [22]. From the perspective of the plots, the area and location of the plots to be transferred will affect not only the adoption of agricultural technology and factor replacement but also the allocation of production costs at the plot level [23], leading to different rent values for plots in different areas and locations. Thus, the spatial characteristics of the transferring land and the matching factor endowment potential of the transferee households will affect the utilization and rent of the transferring farmland. Our study examined the impact of the area and location of land transfer on production and utilization, as well as the heterogeneity of farmer preferences for spatial land characteristics at different operation scales.

First, we analyzed the influence of the plot area when controlling for location. Compared with a large plot, a small plot has limited space for labor and mechanical activities that not only provides few advantages in terms of the cost allocation of factors, such as material transportation, labor, and machinery, but also limits the possibility of mechanical operations on the plot. Even if mechanical substitution can be achieved, mechanical efficiency is restricted. Therefore, for large plots, the stronger the operational capacity and the higher the mechanical level of the transferee household, the larger the profit generated by the transferred farmland and the higher the rent. For small plots, farmers with high mechanical levels are limited by land space, which restricts mechanical efficiency. As farmers with high labor costs need to spend more time on cross-plot operations, they often have no competitive advantage. In contrast, farmers with little mechanization and low labor costs will see only a small negative impact when renting transferred land and will have more competitive advantages.

Second, we analyzed the influence of plot location when controlling for the area. Plots adjacent to a farmer's original farmland can expand the effective farming space by means of adjacent borders and ridges. On the one hand, the effect can improve the constraints of the land area on mechanical replacement and efficiency. On the other hand, the time and transportation costs of cross-plot operations can be saved, which is particularly evident when the plot area is small. For large plots, due to economies of scale in the utilization of farmland, whether or not the location of the plot is adjacent to the transferee household has no obvious influence on production, and the rent payment ability depends on the operational ability of the transferee household. In other words, the location of the plot has a limited influence on large plots in the farmland transfer market. In the competition for adjacent small plots in the transfer market, farmers with stronger management ability and higher mechanical levels who rent small plots adjacent to their existing farmland can achieve greater profits by creating larger-scale management, as well as a competitive advantage. In nonadjacent small plots, their location restricts the farmland utilization efficiency of a transferee household with high mechanical levels and labor costs. By contrast, farmers with low mechanical levels and low labor costs have a competitive advantage.

Next, we analyzed the differences in farmer preferences regarding the spatial characteristics of the transferred plots. In terms of the potential transfer of farmland to households, the spatial characteristics of the farmland within a region fell into four categories: large plots with adjacent locations, large plots with nonadjacent locations, small plots with adjacent locations, and small plots with nonadjacent locations. The impacts of these different spatial plot characteristics on the production costs of the transferee households are shown in Table 1, rows two through five. The expansion of the household farmland scale changes the relative scarcity of agricultural production factors, and the constraints of household production gradually change from scarcity of arable land to scarcity of labor. The change in the marginal output of the labor force increases the demand for other factors to replace labor in agricultural production; thus, the degree of labor scarcity and factor replacement demand from large-scale households is generally higher than that of ordinary households. (Referring to the index interpretation of the National Agricultural Census in 2017, large-scale households are defined as farmers with "100 mu or more of open land planted with crops in the area of one cropping a year, and 50 mu or more of open land planted with crops in the area of two cropping a year," while all others are ordinary households). Plots with the first three characteristics directly or indirectly achieve economies of scale in farmland utilization, favored by large-scale households and ordinary households. However, for the nonadjacent small plots, large-scale households with high labor scarcity and demand for mechanical replacement are restricted from replacing factors with low marginal production value with high marginal ones and face restrictions in mechanical cross-plot operation and an increase in labor time. As a result, the marginal output of farmland input decreases; thus, large-scale households are not inclined to rent nonadjacent small plots. For ordinary households, the demand for mechanical replacement in production is not as strong as that for large-scale households, and the cost of labor is lower. However, there are differences in the utilization of scattered farmland plots, and the difference is not so large that it "excludes" the transfer of scattered small plots. The preferences of farmers of different scales for the spatial characteristics of transfer plots are shown in Table 1, rows six and seven.

Table 1. Influence of farmland characteristics on land use and the transfer preferences of different farmers.

Spatial Plot Characteristics	Large & Adjacent	Large & Non-Adjacent	Small & Adjacent	Small & Non-Adjacent
Cost allocation	+	+	+	−
Factor substitution	+	+	+	−
Mechanical operation	+	+	+	−
Cross-plot transportation	+	+	+	−
Large-Scale Households	Preference	Preference	Acceptability	Reject
Ordinary Households	Preference	Preference	Acceptability	Acceptability

Notes: "+" indicates positive impact, and "−" indicates negative impact.

Furthermore, plot area and location have different impacts on scale economies of potential transferees, leading to differences in tenants' willingness to pay rent for plots with different areas and locations. This mechanism leads to differences in the transfer pattern of plots with different spatial characteristics. Specifically, three types of plots, adjacent large plots, nonadjacent large plots, and adjacent small plots, can deliver economies of scale in the utilization of farmland. As large-scale households have advantages in terms of management ability and technology, they can obtain a higher marginal output than ordinary households, meaning that large-scale households can pay higher rents for these plots. Therefore, the plots are more likely to transfer to large households in market competition.

However, the spatial characteristics of nonadjacent small plots do not match the labor and technology choice of large-scale households, thus reducing their marginal output and affecting rent payments. As the marginal output of the plots may be negative, households would not choose these for transfer, even if there was no rent. However, for ordinary households, the negative impact on production is not significant for nonadjacent small plots, so they have an advantage in the competition for such scattered small plots. Therefore, most transfer to ordinary households.

Based on the above analysis, we formulated the following hypotheses: large-scale households prefer large plots in the transfer market and plots adjacent to their original land. Thus, large plots and adjacent plots in the farmland market are more inclined to transfer to large-scale households with stronger management ability. Nevertheless, scattered plots are more likely to transfer to ordinary households.

3. Methods

3.1. The Model

We examined the effect of the spatial characteristics of farmland on the transfer pattern by comparing the systematic differences in land characteristic preferences of large-scale households and ordinary households. As stated above, we considered four types of plots in terms of area and location characteristics in the transfer market: large plots with adjacent locations, large plots with nonadjacent locations, small plots with adjacent locations, and small plots with nonadjacent locations. We used a multivariate selection model for our estimation, expressed as follows:

$$\begin{cases} Y_i^{1*} = \alpha_1 + \beta_1 \cdot Scale_i + \gamma_1 \cdot X_i + \xi_1 \\ Y_i^{2*} = \alpha_2 + \beta_2 \cdot Scale_i + \gamma_2 \cdot X_i + \xi_2 \\ Y_i^{3*} = \alpha_3 + \beta_3 \cdot Scale_i + \gamma_3 \cdot X_i + \xi_3 \\ Y_i^{4*} = \alpha_4 + \beta_4 \cdot Scale_i + \gamma_4 \cdot X_i + \xi_4 \end{cases}, \quad Y_i = \begin{cases} 1 \; if \; Y_i^{1*} > Y_i^{2*}, Y_i^{3*}, Y_i^{4*} \\ 2 \; if \; Y_i^{2*} > Y_i^{1*}, Y_i^{3*}, Y_i^{4*} \\ 3 \; if \; Y_i^{3*} > Y_i^{1*}, Y_i^{2*}, Y_i^{4*} \\ 4 \; if \; Y_i^{4*} > Y_i^{1*}, Y_i^{2*}, Y_i^{3*} \end{cases} \tag{1}$$

The model analyzes the plot characteristics of farmers who have transferred-in farmland; the plot areas are divided using five mu (mu is a unit of measurement of farmland area, That is the commonly used in China. In unit conversion, 15 mu equals one hectare.) as the boundary. In Equation (1), Y_i^{1*}, Y_i^{2*}, Y_i^{3*}, and Y_i^{4*} represent the latent variables of net income of farmers choosing four types of transfer plots: (1) nonadjacent with an area less than five mu, (2) adjacent plots with an area less than five mu, (3) nonadjacent plots with an area greater than five mu, and (4) adjacent plots with an area greater than five mu, respectively. The first line of Equation (1) shows that farmers receive higher net income when they choose nonadjacent plots with an area less than five mu in the transfer market than other types, namely, $Y_i^{1*} > Y_i^{2*}, Y_i^{3*}, Y_i^{4*}$. The reality shows that farmer i chooses to transfer a nonadjacent plot with an area of less than five mu, namely $Y_i = 1$, and so on with the other lines of the Equation (1).

In Equation (1), $Scale_i$ is a dummy variable where, when $Scale_i = 1$ farmer i is a large-scale household or is otherwise an ordinary household. The X_i variables are the control variables of farmer i, including the number of family laborers, age of the household head, education level, agricultural experience, the number of planting plots, whether they belong to a cooperative, and whether they own agricultural machinery. These variables are used mainly to control the farmers' production and management capacities. Finally, ξ_i is the random disturbance term.

We then tested our hypotheses. The influence of the variable $Scale_i$ was not considered significant in the multivariate selection model if there was no difference between the spatial characteristics of the farmland transferred to ordinary households and large-scale households. In other words, there was no significant difference in the influence of the key explanatory variables in the model, indicating that the area and location characteristics of the plots did not affect the transfer direction of farmland in the market. By contrast, if the variable $Scale_i$ in the model had a significant impact on the explained variables, there were significant differences between the characteristics of the plots transferred to large-scale households and ordinary households. Through this, we could determine whether the area and location characteristics of the plots affected the transfer pattern of the farmland.

Additionally, we considered the impact of plot location in terms of large and small plots. For this, we constructed a bivariate probit model to test and compare whether there was heterogeneity in the influence of plot location characteristics on farmland transfer in different area groups.

$$\begin{cases} Y_5^* = \alpha_5 + \beta_5 \cdot Scale_i + \gamma_5 \cdot X_i + \xi_5;\ if\ Y_5^* > 0,\ \ Y_5 = 1,\ or\ Y_5 = 0 \\ Y_6^* = \alpha_6 + \beta_6 \cdot Scale_i + \gamma_6 \cdot X_i + \xi_6;\ if\ Y_6^* > 0,\ \ Y_6 = 1,\ or\ Y_6 = 0 \end{cases} \quad (2)$$

In Equation (2), Y_5^* and Y_6^* are the latent variables of the transferred farmland characteristics. If $Y_5 = 1$, it represents farmers who transferred-in nonadjacent plots with areas less than five mu; if $Y_5 = 0$, it represents all others; $Y_6 = 1$ represents farmers who transferred-in adjacent plots with areas less than five mu, and $Y_6 = 0$ represents all others. The explanatory variable $Scale_i$ indicates whether farmer i is a large-scale household. The other control variables are the same as those above.

$$\begin{cases} Y_7^* = \alpha_7 + \beta_7 \cdot Scale_i + \gamma_7 \cdot X_i + \xi_7;\ if\ Y_7^* > 0,\ \ Y_7 = 1,\ \ or\ Y_7 = 0 \\ Y_8^* = \alpha_8 + \beta_8 \cdot Scale_i + \gamma_8 \cdot X_i + \xi_8;\ if\ Y_8^* > 0,\ \ Y_8 = 1,\ \ or\ Y_8 = 0 \end{cases} \quad (3)$$

In Equation (3), Y_7^* and Y_8^* are the latent variables of the transferred farmland characteristics. Where $Y_7 = 1$, farmers who transferred-in nonadjacent plots with areas greater than five mu are represented; when $Y_7 = 0$ it represents all others; $Y_8 = 1$ represents farmers who transferred-in adjacent plots with areas greater than five mu, and $Y_8 = 0$ represents all others. The other variables are the same as described above.

Equations (2) and (3) were used to test the heterogeneity of the influence of plot location on the farmland transfer patterns of different area groups. The model investigated the following: if there was no difference in the influence of plot location on the transfer of small or large plots, there would be no significant difference in the two equations of the bivariate probit model, whether or not the variable $Scale_i$ had a significant impact on the explained variables. The model analysis focused on the significance and differences in the key variable coefficients of β_5 and β_6, and β_7 and β_8. The differences between the coefficients β_5 and β_6 would reflect the heterogeneity of the influence of plot location on the choices made by large-scale and ordinary households in the small plot group. The differences between coefficients β_7 and β_8 would reflect the heterogeneity in the bigger plot group. Furthermore, we tested the heterogeneity of the influence of plot location characteristics on the farmland transfer among different area groups by comparing the differences between the above two groups of coefficients.

3.2. Data and Variables

We obtained our data from a survey of farmers on "large-scale grain production" in the provinces of Heilongjiang, Henan, Zhejiang, and Sichuan in 2015 and 2018. The four provinces were selected according to their comprehensive regional distribution and economic and agricultural development in China. In 2015, the household survey adopted a multistage sampling method. Four cities were randomly selected from each province, two towns were randomly selected from each city, and 32 farmers were randomly selected from two villages within each town. In the survey sampling design, stratified sampling was carried out according to the multiple of the average area of operation of regional households to ensure sufficient large-scale farmers. Among the 32 households in each town, 20, 6, 4, and 2 households in the towns (townships) whose average farmland area is less than 3 times, 3~10 times, 10~20 times, and more than 20 times, respectively, were selected. The 2015 survey covered 1040 households in 16 cities in four provinces (The sample of cities are as follows: Ning 'an, Tangyuan, Zhaodong, and Longjiang are in Heilongjiang province; Xiayi, Anyang, Xiping, and Xuchang are in Henan province; Shengzhou, Wuyi, Wenling, and Xiuzhou are in Zhejiang province; Zhongjiang, Nanbu, Yanjiang, and Linshui are in Sichuan province).

A follow-up survey was conducted in 2018, and a total of 1033 households from the 2015 survey were located; some farmers were not found, thus, reducing the sample. We analyzed 1404 rural households that received transferred farmland, including 725 households in 2015 and 679 in 2018. The survey data included household details and plot data. Household data covered basic information, such as family personnel, arable land management, and agricultural machinery holdings. The plot data included plot characteristics and information on farmers who transferred-in plots. The variable assignments and descriptive statistics are presented in Table 2.

Table 2. Variable definitions and descriptive statistics.

Variable	Variable Assignment	Mean	Std.
Plots' spatial characteristics	The spatial characteristics of transferred plots, plots nonadjacent with area less than 5 mu = 0, adjacent plots with area less than 5 mu = 1, nonadjacent plots with area greater than 5 mu = 2, and adjacent plots with area greater than 5 mu = 3.	1.41	10.7
Nonadjacent and small	Household transferred plots nonadjacent with area less than 5 mu = 1, otherwise 0.	0.29	0.46
Adjacent and small	Household transferred plots adjacent with area less than 5 mu = 1, otherwise 0.	0.15	0.36
Nonadjacent and large	Household transferred plots nonadjacent with area greater than 5 mu = 1, otherwise 0.	0.40	0.49
Adjacent and large	Household transferred plots adjacent with area greater than 5 mu = 1, otherwise 0.	0.15	0.35
Scale	Household is large-scale management = 1, otherwise 0.	0.39	0.49
Labor	The amount of agriculture labor of household.	2.01	0.95
Age	The age of household head.	53.26	10.6
Education	The years of education of the household head.	6.96	3.14
Experience	The years of agriculture experience of the household head.	30.50	13.57
Plots	The number of plots cultivated by households.	12.72	12.53
Agr-cooperative	Household joined agricultural cooperatives = 1, otherwise 0.	0.19	0.39
Machine	Household has agricultural machinery worth more than 8000 yuan = 1, otherwise 0.	0.45	0.50
Year	The year 2015 = 0 and year 2018 =1.	0.48	0.50

Note: The table considers the information of farmers who have transferred to farmland in the sample only. Data source: The author sorted the statistics based on the survey data of households on "large-scale grain production" in 2015 and 2018.

3.3. Descriptive Statistics

Our study focused on how the spatial characteristics of farmland plots influenced farmland transfer patterns in the transfer market. As shown in Table 3, we used the household survey data from 2015 and 2018 to calculate the differences in farmland transfers for different sizes and locations at the plot level. The plots were divided into four groups according to size: 0–5, 5–20, 20–40, and more than 40 mu. Group statistics were calculated based on whether the plots were transferred to large-scale households and whether the plots were adjacent to the household's original land. As the data showed, in 2015, only 5.9% of plots with an area of less than five mu were transferred to large-scale households, and of these, 38.9% were adjacent to the household's original land. For greater plot areas, the proportion of land transferred to large-scale households increased significantly. In the group with areas of more than 40 mu, the proportion of land being transferred to large-scale households was as high as 95.8%, with only 25.2% of those plots adjacent to the household's original land. The data showed the same trend in 2018. The statistical analysis of the above two periods shows that, for a larger plot size, the possibility of the plot being transferred to a large-scale household gradually increases, and the requirements of large-scale households regarding whether the transferred plot is adjacent to their original land relaxes.

Table 3. Statistics of the flow direction of plots with different spatial characteristics in the survey.

Year	Area (mu)	Plots	Percentage (%)	Flow Direction of Plots					
				Ordinary Household			Large-Scale Household		
				Sample	Percentage (%)	Adjacent Ratio (%)	Sample	Percentage (%)	Adjacent Ratio (%)
2015	(0, 5]	305	42.1	287	94.1	31.4	18	5.9	38.9
	(5, 20]	186	25.7	118	63.4	28.8	68	36.6	30.9
	(20, 40]	114	15.7	33	28.9	24.2	81	71.1	28.4
	(40, ∞]	120	16.6	5	4.2	0	115	95.8	25.2
	Total	725	100	443	61.1	29.8	282	38.9	28.3
2018	(0, 5]	324	47.7	283	87.4	35.3	41	12.6	46.3
	(5, 20]	174	25.6	91	52.3	31.8	83	47.7	31.3
	(20, 40]	93	13.7	20	21.5	25.0	73	78.5	30.1
	(40, ∞]	88	13.0	5	5.7	20.0	83	94.3	21.7
	Total	679	100	399	58.8	33.8	288	41.2	30.4

We also examined the differences in the area and location of the plots transferred to large-scale households and those transferred to ordinary households. We analyzed the heterogeneity of the average area and location of the plots being transferred to different households using a *t*-test.

Table 4 shows that more plots in both survey years were transferred to ordinary households. In 2015, the proportion of plots transferred to large-scale households was 38.9%, and 61.1% were transferred to ordinary households. These percentages were 41.2% and 58.8% in 2018, respectively. However, the average area of the plots transferred to a large-scale household was significantly larger than that of an ordinary household. Beyond that, there was no significant difference in whether or not the plots transferred to either large-scale households or ordinary households were adjacent. One reason for this may be that the adjacency of land is relative; that is, the land adjacent to the original farm location transferred out by ordinary households was not necessarily adjacent to the large-scale household. We also tested and compared the heterogeneity of the spatial characteristics of land plots transferred to different farmers through empirical analysis.

Table 4. Heterogeneity test of spatial characteristics of plots with different flow directions.

Year	Flow Direction of Plots	Sample	Average Area of Plots (mu)	Adjacent Ratio (%)
2015	All plots	725	32.41	29.2
	Plot flow to large-scale household	282	72.05	28.3
	Plot flow to ordinary household	443	7.17	29.8
	T-value of the two-sample *t*-test	–	−8.61 ***	0.412
2018	All plots	679	24.88	32.4
	Plot flow to large-scale household	280	51.29	30.4
	Plot flow to ordinary household	399	6.36	33.8
	T-value of the two-sample *t*-test	–	−8.53 ***	0.952

Notes: *** $p < 0.01$.

4. Results

4.1. The Effects of the Spatial Characteristics of the Plots on Transfer Patterns

Table 5 presents the results of the multivariate probit model considering the heterogeneity of spatial characteristics of the plots transferred in terms of different households. In the model estimation, the nonadjacent plots with areas less than five mu were selected as the reference group. Columns (1) to (3) present the parameter estimation results of the farmers selecting adjacent plots with areas less than five mu, nonadjacent plots with areas greater than five mu, and adjacent plots with areas greater than five mu, respectively. Overall, the key explanatory variable *Scale* was positive and statistically significant at 5% or above, meaning that, compared with nonadjacent plots with areas of less than five mu, large-scale households were more inclined to receive plots with the other three characteristics. These results show obvious differences in the plot area and location characteristics selected by ordinary households and large-scale households in the farmland transfer market. That is, large-scale households preferred plots with large areas or adjacent locations. The above comparative analysis implies that as farmers expand their scale of operations, their demand for certain spatial characteristics of the plots change; namely, they tend to choose plots with larger areas or connected locations.

Table 5. The results of the multivariate probit model test on the spatial heterogeneity of different household transfer plots.

Variable	(1)	(2)	(3)
	Adjacent and Small	**Nonadjacent and Large**	**Adjacent and Large**
Scale	0.228 **	2.176 ***	2.114 ***
	(2.13)	(12.59)	(11.47)
Labor	0.048	0.096	0.115
	(0.65)	(1.39)	(1.53)
Age	0.010	−0.026 ***	−0.014
	(1.03)	(−2.74)	(−1.33)
Education	0.020	0.058 ***	0.078 ***
	(0.91)	(2.60)	(3.14)
Experience	−0.012 *	−0.013 **	−0.018 **
	(−1.78)	(−1.97)	(−2.46)
Plots	0.000	−0.053 ***	−0.046 ***
	(0.09)	(−9.39)	(−7.51)
Agr-cooperative	−0.147	0.254	0.267
	(−0.72)	(1.44)	(1.40)
Machine	0.159	1.001 ***	0.592 ***
	(0.97)	(6.92)	(3.69)
Year	0.087	−0.241 *	−0.220
	(0.64)	(−1.80)	(−1.50)
Constant	−0.987 *	1.095 **	−0.111
	(−1.90)	(2.21)	(−0.20)
Model statistical index	(Reference to the group of "Nonadjacent and small") Number of obs = 1404, Wald chi2 = 494.90, Prob > chi2 = 0.000		

Notes: The values between parentheses are the z value of the estimated parameters; * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

According to the results displayed in Table 5, households with a household head with more education, shorter farming experience, a larger number of farmland plots, and agricultural machinery worth more than 8000 yuan were more inclined to choose larger plots in the transfer market. This may be because farmers with more education were utilizing advanced technology and machinery. If the farmland plot was small, it is possible that the efficiency of new technology or machinery would be restricted; thus, the farmer would be more inclined to choose large transferred-in plots. The longer the years farming, the more experienced the farmers were in agricultural production; as such, they would have a greater ability and capacity to overcome any inconvenience caused by farmland fragmentation, which could explain why some still chose small and nonadjacent scattered plots. As the farmers expanded the scale of their operations, the negative impact of scattered plots on agricultural production increased in importance. Therefore, farmers with more plots (larger acreage) were inclined to choose large transfer-in plots. Large agricultural machinery operations also require more space, and therefore, farmers with agricultural machinery worth more than 8000 yuan were more inclined to choose large plots.

Notably, in our multiple probit model, the parameter values and significance of the key explained variables differed significantly in large-scale households that selected either adjacent plots with areas less than five mu, nonadjacent plots with areas greater than five mu, or adjacent plots with areas greater than five mu. Thus, the plot area and location characteristics had different impacts on the transfer pattern of the plots. The effect of the heterogeneity of location plot characteristics on the transfer pattern for different area groups was further tested and compared using Equations (2) and (3). The parameter estimation results are shown in Table 6, where columns (4) and (5) are the parameter estimated results of the two equations in the bivariable probit model (2), and column (6) is the coefficient difference test of the two equations. Columns (7) and (8) show the fitting results of the two equations in the bivariable probit model (3), and column (9) shows the coefficient difference test of the two equations.

Table 6. Estimated results of the bivariate probit model of the influence of location on plot flow direction with different areas.

Variable	(4)	(5)	(6)	(7)	(8)	(9)
	Non-Adjacent and Small	Adjacent and Small	Coefficient Difference Test	Non-Adjacent and Large	Adjacent and Large	Coefficient Difference Test
Scale	−1.185 *** (−11.36)	−0.808 *** (−7.09)	5.07 **	0.821 *** (9.38)	0.541 *** (4.38)	2.43
Labor	−0.070 (−1.64)	−0.010 (−0.21)	0.65	0.001 (0.03)	−0.007 (−0.16)	0.01
Age	0.003 (0.44)	0.013 ** (2.15)	1.10	−0.016 *** (−2.92)	−0.002 (−0.37)	1.81
Education	−0.025 * (−1.76)	0.003 (0.21)	1.17	0.019 (1.52)	0.029 ** (2.18)	0.20
Experience	0.012 *** (2.73)	−0.003 (−0.57)	3.65 *	−0.000 (−0.11)	−0.003 (−0.63)	0.09
Plots	0.018 *** (5.19)	0.013 *** (3.90)	0.68	−0.024 *** (−6.31)	−0.011 ** (−2.57)	4.03 **
Agr-cooperative	−0.082 (−0.72)	−0.227 * (−1.71)	0.52	0.087 (0.86)	0.066 (0.64)	0.01
Machine	−0.524 *** (−5.35)	−0.309 *** (−2.76)	1.60	−0.514 *** (6.01)	−0.111 (−0.99)	13.01 ***
Year	0.024 (0.87)	0.049 * (1.66)	0.27	−0.014 (−0.55)	0.010 (0.36)	0.28
Constant	−48.359 (−0.88)	−101.291 * (−1.69)	−1.94	−29.006 (0.56)	−22.227 (−0.38)	−3.15 *
Model statistical index	Number of obs = 1404, Wald chi2 = 747.9, Prob > chi2 = 0.000 Wald test of rho = 0: chi2(1) = 160.21, Prob > chi2 = 0.000			Number of obs = 1404, Wald chi2 = 895.0, Prob > chi2 = 0.000 Wald test of rho = 0: chi2(1) = 85.44, Prob > chi2 = 0.000		

Notes: The values in parentheses are the z values of the estimated parameters; * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

In Table 6, the results in columns (4) to (6) show that the variables influencing a farmer's choice of a small nonadjacent plot also influence the farmer's choice of a small adjacent plot in the same direction. However, the coefficients of the estimated parameters reflected different degrees of influence. According to the estimation coefficient of the key explanatory variable "Scale," the probability of heads of large-scale households choosing small plots was significantly lower than that of ordinary households, indicating that large-scale households "rejected" small plots in the transfer market, regardless of whether the location of the small plot was adjacent. At the same time, we tested the difference between the estimation coefficients of the two equations of the bivariable probit model, as shown in column (6). The results indicate a systematic difference in the selection of small plots with nonadjacent locations and small plots with adjacent locations by large-scale households, implying that the situation changes when the location of the small plot is adjacent to the original land of the large-scale household, although large-scale households generally "reject" small plots. In other words, for small plots, adjacent plots significantly affect the probability of a large-scale household transfer. The results in columns (7) to (9) show that the variables influencing farmers' choice of large nonadjacent plots also affect the farmers' choice of adjacent large plots in the same direction. However, the coefficients of the estimated parameters reflected different degrees of influence. According to the estimation coefficient of the key explanatory variable "Scale," the probability of large-scale households choosing large plots was significantly higher than that of ordinary households, regardless of whether the transfer location was adjacent, suggesting that, in the transfer market, large-scale households preferred large plots. At the same time, we tested the difference between the estimation coefficients of the two equations of the bivariable probit model, as shown in column (9). The results indicate no systematic difference between large nonadjacent plots and large adjacent plots. This finding implies that the location of the plots did not significantly affect the land transfer pattern for large plots. Further, a comparative analysis of models (2) and (3) shows that the adjacency of plots only affected the transfer demand for small plots and did not significantly affect the transfer demand for large plots. The implication is that the requirements of large-scale households for adjacent plots gradually relaxed with the expansion of the transferred plot area.

In the above empirical analysis, we used the standard of five mu to divide large and small plots. To test the reliability of our results, we conducted the same regression analysis using three mu as the dividing standard, which is presented in Table A1. The symbol of the estimated coefficient of the model was the same as above. However, the absolute value of the *Scale* coefficient became larger, and the difference test of the coefficient was significant, which is fully consistent with the above conclusion; that is, the smaller the plot area, the lower the possibility of a large-scale household choosing to transfer it in. Nevertheless, when the location of the plot was adjacent to the household's existing land, the possibility of a large-scale household transferring it significantly increased. This result confirmed the robustness of our analysis results. The results indicate that moderate plot integration in the transfer market is helpful for the expansion of farmland scale by farmers.

4.2. The Influence of Resource Allocation on Farmland Spatial Characteristics

Our study applies theory and empirical methods to investigate the differences in the spatial land characteristics chosen by farmers of different scales when transferring in farmland [17]. The characteristics of households of different scales directly affect farmland utilization efficiency and the allocation of resources. Therefore, the heterogeneity of the characteristics of farmers of different scales was tested further. We conducted a *t*-test based on household heterogeneity using a selection of household indices in terms of human capital, operation and management ability, production technology adoption, and the value of agricultural machinery holdings. The results are presented in Table 7.

Table 7. *T*-test of the difference between household characteristics with a different scale.

Year	Household Type	Sample	Agriculture Labors	Age	Education (Year)	Value of Agr-Machine (Yuan)	Joined Agr-Cooperatives (%)
2015	Total	1040	1.89	52.2	6.8	32,851.9	23.65
	Ordinary	749	1.80	54.8	6.3	13,520.1	17.76
	Large-Scale	291	2.02	48.0	7.8	82,609.6	38.83
	T-value	–	−2.93 ***	9.05 ***	−6.65 ***	−10.69 ***	−6.43 ***
2018	Total	1033	1.93	57.0	6.8	36,294.6	9.10
	Ordinary	751	1.81	59.7	6.5	16,100.6	5.92
	Large-Scale	282	2.27	50.0	7.7	90,073.6	17.38
	T-value	–	−6.99 ***	13.85 ***	−5.68 ***	−10.95 ***	−5.85 ***

Notes: *** $p < 0.01$.

The data comparison in Table 7 shows that characteristics clearly differ between ordinary and large-scale households. The average number of family agricultural laborers in ordinary households was 1.80 in 2015, which was lower than the average of 2.02 for large-scale households, which suggests that the number of agricultural laborers was an important factor affecting the expansion of farmers' management areas. In terms of the household head, in the large-scale household, the average age of the head of the household was 6.8 years younger than the head of the ordinary household and had 1.5 more years of education. The implication is that younger household heads with more education were more likely to choose to scale up their operations, possibly because younger and more educated farmers have advantages in terms of labor ability, technical learning, access to information, and risk management. In addition, the original value of agricultural machinery held by large-scale households was about 6.1 times that of ordinary households, statistically significant at 1%. Regardless of whether households had agricultural machinery before expanding their scale or purchased agricultural machinery after expanding their scale due to production demand, the significant difference between the agricultural machinery holdings of large-scale households and ordinary households reflected the significant difference between their production and management capacity and agricultural production mode. In terms of participation in cooperatives, 38.8% of large-scale households in the survey sample were participating in cooperatives, whereas only 17.8% of the ordinary households in the survey participated. These findings imply that farmers increased their willingness to join and their demand for cooperatives to reduce their costs of production and marketing, risk control, and other aspects after expanding their business.

From a resource allocation perspective, in a fully competitive market, farmland is allocated to operators with higher marginal output values [24,25]. However, for each plot, the marginal output of the potential transferee is different, not only because of differences in management ability, factor endowment, and technology adopted by different farmers [26], but also because plots with the same spatial characteristics have different impacts on different transferees. Generally, large-scale households have advantages in terms of operational and management ability, technology, and resource endowment. Therefore, large-scale households have higher marginal output, compared with ordinary households, on the premise that the land transferred does not limit their normal production efficiency. According to the above analysis, large-scale households can obtain economies of scale in the utilization of farmland by transferring plots with large areas or plots adjacent to their original land, and they receive greater benefits from these than those obtained by ordinary households. Therefore, large-scale households can pay higher rents to obtain the plots in market competition. Nonetheless, scattered small plots hinder the economies of scale of the transferees; as such, it is difficult to create "scale" management at the operator level or achieve the "scale" operators' prefer. Therefore, more plots with large areas adjacent to the original plots were transferred to large-scale households, while scattered small plots were transferred mainly to ordinary households.

Admittedly, among the transferees of plots with different spatial characteristics, there were differences in how farmland was used, its operating ability, and the use of technology. However, this does not mean resource allocation was inefficient in the market. Although some farmland resources were transferred to ordinary households with weak management ability, inadequate technology adoption levels, and low production efficiency, this was mainly restricted by the farmland's characteristics. If large-scale households with strong management ability and high technology adoption levels transferred in farmland, their production efficiency and economic benefits were not necessarily stronger than that of ordinary households, which is part of effective market allocation behavior and reflects the general law of the market allocation of resources.

5. Conclusions

Under the tense relationship between man and land, the transfer of farmland in the market in China is a significant means of improving agricultural production efficiency and promoting the development of agricultural scale management. This study discusses the differences among farm plots considering spatial characteristics and how these affect the transfer of farmland in the market from the perspective of matching supply and demand. To that end, a multivariate probit model and a bivariate probit model were constructed for empirical analysis. Data from farmers and plots surveyed in the provinces of Heilongjiang, Henan, Zhejiang, and Sichuan were used for analysis. The analysis explains the influence of plot spatial characteristics on the allocation of resources in the transfer market. We can draw the following conclusions from our analysis.

First, the resource endowment conditions of farmers determine their farmland use and factor combinations. Thus, the area and location of the potential transfer plots will have different impacts on the economies of scale of different potential transfer households. As a result, large plots and adjacent plots in the market tended to transfer to large-scale households, whereas scattered small plots tended to transfer to ordinary households. Second, due to differences in farmland utilization, management ability, and technology adoption of households of different scales, there were differences in the utilization efficiency of the farmland, which affected resource allocation efficiency in the transfer market.

Based on the endowment of farmland, we assessed the impact of the spatial characteristics of the plots on the farmland transfer patterns in the market and the implications of such resource allocation. The policy implications are as follows. First, there is a need to build a unified transactional platform for transferring farmland management rights. Because the spatial characteristics of the plots are important factors that affect the transfer pattern and utilization of land, adjacent land needs to be packaged and transferred on the trading platform. To a certain extent, this action could lessen the adverse effects brought about by the fixed locations of the plots in the transfer market. In addition, this could improve the transfer and utilization efficiency of farmland. Second, the mutual suitability of land and agricultural machinery should be strengthened. On the one hand, this means supporting and encouraging the research and development and improvement of machinery technology to promote the development of small and efficient agricultural machinery; on the other hand, it means improving and strengthening land integration and mechanical transformation. Moreover, such transformation should apply to fragmented land that is small or large and short or long, while slopes should be leveled to be suitable for mechanized operation. This approach will help lessen the constraints of a plot's spatial location on the diseconomies of scale of agricultural machinery operations. Third, the impact of the farmland ownership confirmation policy on the efficiency of resource allocation in the transfer market should be scientifically evaluated. In China, the farmland policy of "clear four boundaries" in the confirmation and registration of contracted land management rights undoubtedly strengthens the natural property of spatial land characteristics at the institutional level. However, the policy restricts the possibility of breaking ridges and integrating plots in the process of farmland transfer and, thus, may have adverse effects on improving the efficiency of resource allocation and utilization of farmland in the transfer market.

It is worth noting that there are some limitations in this study. When analyzing the influencing factors of farmland flow direction, we only focused on the economic exchange between the transferer and ignored the influence of non-economic factors, such as social relations, which are frequently included in the farmland transfer. Furthermore, only the area and location of plots are considered in analyzing the spatial land characteristics while ignoring the distance between plots, the shape of plots, infrastructure, and other related factors. In fact, the characteristics of plots in the transfer market are far more complicated than the analysis. Finally, the simplified setting in this study only controls the influence of some factors.

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Appendix A

Table A1. Estimated results of the bivariate probit model of the influence of location on plot flow direction with different areas.

Variable	Non-Adjacent and Small	Adjacent and Small	Coefficient Difference Test	Non-Adjacent and Large	Adjacent and Large	Coefficient Difference Test
Scale	−1.236 *** (−9.90)	−0.858 *** (−6.28)	6.43 ***	0.578 *** (6.81)	0.372 *** (3.90)	3.69 *
Labor	−0.137 *** (−2.85)	0.016 (0.29)	3.47 *	0.031 (0.86)	−0.002 (−0.07)	0.23
Age	0.013 ** (2.12)	0.011 (1.54)	0.05	−0.017 *** (−3.08)	0.006 (0.99)	5.46**
Education	−0.025 (−1.63)	−0.007 (−0.38)	0.42	0.009 (0.77)	0.028 ** (2.16)	0.70
Experience	0.005 (1.11)	−0.002 (−0.40)	0.82	0.002 (0.56)	−0.004 (−0.85)	0.72
Plots	0.020 *** (5.65)	0.009 ** (2.56)	3.42 *	−0.019 *** (−6.17)	−0.002 (−0.60)	11.09 ***
Agr-cooperative	−0.124 (−0.93)	−0.212 (−1.28)	0.14	0.071 (0.75)	−0.048 (−0.49)	0.46
Machine	−0.423 *** (−3.85)	−0.448 *** (−3.26)	0.02	0.330 *** (3.96)	−0.079 (−0.88)	6.84 ***
Year	0.020 (0.67)	0.062 * (1.82)	0.67	−0.015 (−0.59)	−0.005 (−0.19)	0.05
Constant	−41.139 (−0.69)	−127.032 * (−1.84)	−1.04	30.451 (0.60)	8.919 (0.16)	−1.06
Model statistical index	Number of obs = 1404, Wald chi2 = 449.6, Prob > chi2 = 0.000 Wald test of rho = 0: chi2(1) = 181.60, Prob > chi2 = 0.000			Number of obs = 1404, Wald chi2 = 678.6, Prob > chi2 = 0.000 Wald test of rho = 0: chi2(1) = 91.6, Prob > chi2 = 0.000		

Notes: The values between parentheses are the z value of the estimated parameters; * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. We used three mu as the divisor.

References

1. Huang, J.; Tao, R.; Xu, Z.; Liu, M. *Institutional Change and Sustainable Development: China's Countryside and Agriculture in 30 Years*; Gezhi Publishing House: Shanghai, China, 2008.
2. Yangchen, D.C.; Hong, M.; Yang, Q. The Effect of Farmland Transfer on the Technical Efficiency of Farm Households in China: An Empirical Result of External Environmental Factors. *Land* **2023**, *12*, 64. [CrossRef]
3. Guo, Y.; Xu, Z. Market development of cultivated land transfer, resource endowment and agricultural land scale management development. *Chin. Rural Econ.* **2021**, *6*, 60–75. (In Chinese)
4. Yang, A.; Wang, Y. Spatiotemporal Variations in Farmland Rents and Its Drivers in Rural China: Evidence from Plot-Level Transactions. *Land* **2022**, *11*, 229. [CrossRef]
5. Li, C.; Li, X.; Wang, J.; Feng, T. Impacts of Aging Agricultural Labor Force on Land Transfer: An Empirical Analysis Based on the China Family Panel Studies. *Land* **2023**, *12*, 295. [CrossRef]
6. Zhang, F.; Bao, X.; Deng, X.; Xu, D. Rural Land Transfer in the Information Age: Can Internet Use Affect Farmers' Land Transfer-In? *Land* **2022**, *11*, 1761. [CrossRef]
7. Su, B.; Li, Y.; Li, L.; Wang, Y. How does nonfarm employment stability influence farmers' farmland transfer decisions? Implications for China's land use policy. *Land Use Policy* **2018**, *74*, 66–72. [CrossRef]
8. Deng, X.; Xu, D.; Zeng, M.; Qi, Y. Does early-life famine experience impact rural land transfer? Evidence from China. *Land Use Policy* **2019**, *81*, 58–67. [CrossRef]
9. Qian, L.; Lu, H.; Gao, Q.; Lu, H. Household-owned farm machinery vs. outsourced machinery services: The impact of agricultural mechanization on the land leasing behavior of relatively large-scale farmers in China. *Land Use Policy* **2022**, *115*, 106008. [CrossRef]
10. Gao, J.; Song, G.; Sun, X. Does labor migration affect rural land transfer? Evidence from China. *Land Use Policy* **2020**, *99*, 105096. [CrossRef]
11. Li, X.; Liu, J.; Huo, X. Impacts of tenure security and market-oriented allocation of farmland on agricultural productivity: Evidence from China's apple growers. *Land Use Policy* **2021**, *102*, 105233. [CrossRef]
12. Chen, Y.; Zhong, F.; Ji, Y. Paid vs. unpaid: Heterogeneity of farmland transfer to households and implications of resource allocation. *J. Nanjing Agric. Univ. (Soc. Sci. Ed.)* **2019**, *6*, 94–106 + 159. [CrossRef]
13. Bao, Z.; Xu, Z.; Gao, S.; Zhou, X. Regional differences and influencing factors of rural land transfer: A case study of Jiangsu Province. *Chin. Rural Econ.* **2009**, *4*, 23–30 + 47. (In Chinese)
14. Han, H.; Zhong, F. The Effect of Surplus Land Flow on the income distribution of Local farmers. *Chin. Rural Econ.* **2011**, *4*, 18–25. (In Chinese)
15. Pacini, C.; Wossink, A.; Giesen, G.; Vazzana, C.; Huirne, R. Evaluation of sustainability of organic, integrated and conventional farming systems: A farm and field-scale analysis. *Agric. Ecosyst. Environ.* **2003**, *95*, 273–288. [CrossRef]
16. Petersen, E.H.; Pannell, D.J.; Nordblom, T.L.; Shomo, F. Potential benefits from alternative areas of agricultural research for dryland farming in Northern Syria. *Agric. Syst.* **2002**, *72*, 93–108. [CrossRef]
17. Yu, P.; Fennell, S.; Chen, Y.; Liu, H.; Xu, L.; Pan, J.; Bai, S.; Gu, S. Positive impacts of farmland fragmentation on agricultural production efficiency in Qilu Lake watershed: Implications for appropriate scale management. *Land Use Policy* **2022**, *117*, 106108. [CrossRef]
18. Yu, C.A.O.; Zou, J.; Fang, X.; Wang, J.; Cao, Y.; Li, G. Effect of land tenure fragmentation on the decision-making and scale of agricultural land transfer in China. *Land Use Policy* **2020**, *99*, 104996. [CrossRef]
19. Tarolli, P.; Straffelini, E. Agriculture in hilly and mountainous landscapes: Threats, monitoring and sustainable management. *Geogr. Sustain.* **2020**, *1*, 70–76. [CrossRef]
20. Lu, H.; Xie, H.; He, Y.; Wu, Z.; Zhang, X. Assessing the impacts of land fragmentation and plot size on yields and costs: A translog production model and cost function approach. *Agric. Syst.* **2018**, *161*, 81–88. [CrossRef]
21. Ye, X.; Wen, N. Agricultural land concentration delayed for half a century—The difficult course and Enlightenment of the transformation from small-scale farmers' production to large-scale management in Japan. *Chin. Rural Econ.* **2018**, *1*, 124–137. (In Chinese)
22. Ma, Z.; Ran, R.; Xu, D. The Effect of Peasants Differentiation on Peasants' Willingness and Behavior Transformation of Land Transfer: Evidence from Sichuan Province, China. *Land* **2023**, *12*, 338. [CrossRef]
23. Bentley, J.W. Economic and ecological approaches to land fragmentation: In defense of a much-maligned phenomenon. *Annu. Rev. Anthropol.* **1987**, *16*, 31–67. [CrossRef]
24. Deininger, K.; Jin, S. The Potential of Land Rental Markets in the Process of Economic Development: Evidence from China. *J. Dev. Econ.* **2005**, *78*, 241–270. [CrossRef]
25. Chamberlin, J.; Ricker-Gilbert, J. Participation in Rural Land Rental Markets in Sub-Saharan Africa: Who Benefits and by How Much? Evidence from Malawi and Zambia. *Am. J. Agric. Econ.* **2016**, *98*, 1507–1528. [CrossRef]
26. Lin, J.Y. Endowments, technology, and factor markets: A natural experiment of induced institutional innovation from China's rural reform. *Am. J. Agric. Econ.* **1995**, *77*, 231–242. [CrossRef]