

Agricultural Product Marketization and the Expansion of Land Operation Scale among Grain Crop Farmers

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Abstract: Against the backdrop of insufficient demand in the farmland transfer market, agricultural product marketization has become a crucial channel through which smallholder farmers generate returns from agricultural production and, consequently, plays a pivotal role in their decisions regarding land operation scale. Using a sample of 1802 farm households from the 2020 China Rural Revitalization Survey (CRRS), this study empirically examines the impact of agricultural product marketization on large-scale land operation and explores the underlying mechanisms. The results show that, first, agricultural product marketization significantly increases smallholder farmers' propensity to expand their land operation scale. Second, this effect operates through two distinct channels: the income effect and the subsidy effect. Third, during the process of agricultural product marketization, farm households with a larger initial area of contracted farmland, as well as those located in major grain-producing regions or plain areas, are more likely to expand their land operation scale. These findings suggest that improving the level of agricultural product marketization is an effective means of stimulating farmers' demand for farmland and promoting large-scale land operation. Accordingly, policies should focus on strengthening smallholder farmers' market participation capacity and improving differentiated support and subsidy mechanisms to facilitate the effective integration of smallholder farmers into modern agricultural development.

Keywords: Smallholder Farmers; Agricultural Product Marketization; Large-Scale Land Operation; Chinese-Style Agricultural Modernization

1. Introduction

As China's economic landscape undergoes rapid transformation, the more efficient allocation of farmland resources has become increasingly important to address the growing problem of farmland underutilization and even abandonment [1]. Promoting farmland transfer and facilitating moderate-scale farming have therefore become central priorities of China's agricultural reform [2]. However, recent trends indicate that the expansion of farmland transfer has slowed considerably, and the development of large-scale land operation has fallen short of expectations. As shown in Figure 1, although the total area of transferred household-contracted farmland continued to increase between 2019 and 2023, the growth trend became increasingly volatile, with an average annual growth rate of only 1.62%. Moreover, despite the expansion of farmland transfer, most farm households continue to cultivate relatively small plots of land, suggesting substantial potential for further developing large-scale land operation in China. Against this backdrop, an important question arises: How can farmland transfer be further promoted to facilitate the steady development of moderate-scale farming while fostering the effective integration of smallholder farmers into modern agricultural development?

Existing studies have primarily explored feasible approaches to promoting large-scale land operation from the perspective of supply-side constraints in the farmland transfer market. However, some scholars argue that China's farmland transfer market has entered a new stage of development, in which the dominant factors affecting market equilibrium have shifted from the supply side to the demand side [3]. Against this background, this study investigates whether agricultural product marketization can promote large-scale land operation from the demand-side

perspective and examines the underlying mechanisms through which this effect operates. Doing so not only helps address the current demand constraints hindering the development of large-scale land operation in China but also provides a theoretical basis for accelerating the modernization of smallholder farmers.

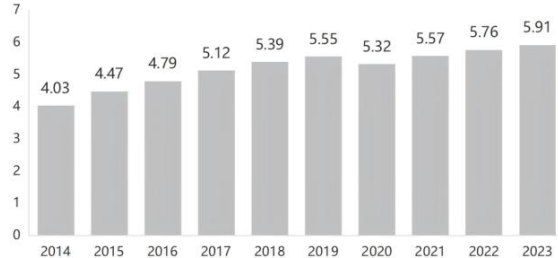


Figure 1. Changes in the Area of Transferred Household Contracted Farmland in China, 2014-2023 (100 Million Mu)

2. Literature Review

2.1 Studies on Large-Scale Land Operation from the Supply-Side Perspective

According to the theory of supply and demand, constraints on the development of large-scale land operation fundamentally arise from insufficient supply of or demand for farmland. From the supply-side perspective of the farmland transfer market, the existing literature has primarily focused on three aspects. First, studies have emphasized the role of land property rights. A substantial body of research argues that property rights and institutional arrangements are the key determinants of farmland transfer market development [4]. In particular, farmland tenure confirmation has been shown to significantly increase the likelihood of farmland transfer-out [5], thereby promoting the development of moderate-scale farming [6]. Second, researchers have examined the role of off-farm employment. The literature generally recognizes the development of the labor market as an important driver of the farmland transfer market, with expanded off-farm employment significantly promoting farmland transfer [7]. Third, existing studies have investigated a range of other micro-level determinants influencing farmers' willingness to transfer out farmland, including demographic characteristics, farmland characteristics, and household economic conditions [8-10].

However, as China has largely completed farmland tenure confirmation, agricultural income has gradually increased, and rural

population aging has intensified, supply-side approaches to promoting farmland transfer have become increasingly inadequate for advancing the development of large-scale land operation under the country's evolving socioeconomic conditions [11].

2.2 Studies on Large-Scale Land Operation from the Demand-Side Perspective

The development of large-scale land operation depends on the effective matching of farmland supply and demand. Consequently, exploring pathways from the demand-side perspective is equally important. Existing studies on farmland demand remain relatively limited and can be broadly categorized into two main strands. The first focuses on agricultural socialized services. Previous studies have shown that such services not only alleviate farmers' constraints arising from limited resource endowments [2], but also increase farmers' participation in the division of labor within the agricultural economy, thereby encouraging them to expand their operational scale [12]. The second strand examines the role of new agricultural business entities. Existing evidence suggests that family farms, agricultural cooperatives, and leading agribusiness enterprises, as emerging sources of farmland demand, contribute to accelerating farmland transfer and promoting large-scale land operation [13,14].

Nevertheless, relying solely on the development of agricultural socialized services and the cultivation of new agricultural business entities to stimulate farmland demand is both a slow process and one that may generate unintended consequences. Problems associated with non-family farming, such as low labor efficiency, rising supervision costs, and higher entry barriers, may undermine the interests of smallholder farmers and further compress their opportunities for agricultural development [15,16]. Therefore, from a demand-side perspective, greater attention should be devoted to the needs and constraints of smallholder household farming. Improving the profitability of smallholder farming can encourage farmers to generate endogenous demand for farmland, thereby facilitating their integration into the trajectory of modern agricultural development. This is also an essential requirement for advancing Chinese-style agricultural modernization.

Overall, the existing literature provides valuable

insights into the determinants of large-scale land operation, yet several important limitations remain. First, most previous studies have focused on identifying feasible pathways for promoting large-scale land operation from the supply-side perspective, while relatively little attention has been devoted to demand-side drivers. Second, although the level of agricultural product marketization has gradually emerged as a key factor influencing farmers' decisions regarding large-scale land operation, its underlying micro-level mechanisms particularly the pathways through which it affects farmers' decision-making have not been systematically examined. Finally, owing to limitations in sample coverage and empirical methodologies, existing studies provide limited evidence regarding the generalizability of their findings.

3. Theoretical Framework and Research Hypotheses

3.1 Definition of Core Concepts

3.1.1 Agricultural Product Marketization

Agricultural Product Marketization refers to the process through which agricultural products are marketed and traded as commodities, commonly referred to as supply-side marketization. In the existing literature, the commercialization rate of agricultural products is widely used to measure the degree of agricultural product marketization [17]. Building on the studies of Zhong and Kong [18] and Gao et al. [19], this study further extends this concept by proposing the notion of the level of agricultural product marketization, which reflects the extent to which farm households actively participate in agricultural product markets and the efficiency with which market transactions are conducted. A higher level of agricultural product marketization indicates that smallholder farmers are both more willing and more capable of realizing the commercial value of their agricultural products through market exchange.

It should be noted that, compared with cash crops, grain crops such as wheat, rice, and maize are characterized by greater dependence on mechanized production and stronger requirements for contiguous land cultivation. Consequently, market competition provides stronger incentives for grain producers to expand their land operation scale in order to reduce average production costs and increase output. As

a result, the relationship between agricultural product marketization and land operation scale is theoretically more direct and empirically more observable in grain production than in cash crop production. Therefore, this study focuses on grain crops as the representative agricultural products.

3.1.2 Large-Scale Land Operation

Expanding land operation through farmland transfer has become one of the principal approaches to promoting moderate-scale farming in China [20]. However, the average operational scale of smallholder farmers remains substantially below the generally recognized threshold for moderate-scale farming (approximately 100 mu) [21]. Therefore, rather than measuring the absolute size of land operation, this study conceptualizes large-scale land operation as farm households' propensity to expand their land operation scale. Specifically, it reflects the extent to which farmers are both willing and able to increase the area of land they operate, with the ultimate objective of achieving the scale associated with moderate-scale farming.

3.2 The Impact of Agricultural Product Marketization on Large-Scale Land Operation

For farm households, the decision to expand land operation is essentially a process of Pareto-improving resource allocation under constraints imposed by household factor endowments, with the objective of maximizing returns from the allocation of household production factors [22]. On the one hand, farm households can obtain returns from land operation only after their agricultural products are commercialized and successfully sold in the market. A higher level of agricultural product marketization enables farmers to realize greater economic returns from agricultural production, thereby strengthening their incentives to expand their land operation scale. On the other hand, agricultural product marketization also reflects farmers' market orientation. As the level of marketization increases, farmers become more inclined to expand their land operation in order to increase agricultural output, reduce production risks, and enhance their market competitiveness. Taken together, agricultural product marketization serves as an important driving force that stimulates farmers' endogenous demand for farmland and promotes

the sustainable development of large-scale land operation. Based on the above theoretical analysis, the following hypothesis is proposed:
H1: Agricultural Product Marketization promotes Large-Scale Land Operation.

3.3 Agricultural Product Marketization, the Income Effect, and Large-Scale Land Operation

Constrained by limited resource endowments, smallholder farmers generally exhibit a low capacity to bear production and market risks. Consequently, they are willing and able to expand their land operation only when existing farming activities generate sufficiently attractive returns, thereby improving their expectations regarding future agricultural income. First, as agricultural production shifts from subsistence-oriented production to market-oriented sales, farmers are able to generate market income from agricultural products, thereby relaxing their initial financial constraints. Second, the stable cash inflows generated by agricultural product marketization reshape farmers' perceptions of production and market risks. As agricultural income becomes more predictable, farmers' decision-making shifts from ensuring household subsistence toward maximizing economic returns, transforming land expansion from a high-risk undertaking into a calculable investment decision. In this study, the mechanism through which higher agricultural income encourages the expansion of land operation is referred to as the Income Effect. Based on the above analysis, the following hypothesis is proposed:

H2: Agricultural Product Marketization has a positive and significant effect on Large-Scale Land Operation through the Income Effect.

3.4 Agricultural Product Marketization, the Subsidy Effect, and Large-Scale Land Operation

Agricultural Product Marketization enables farm households to establish more stable production activities and marketing channels. As a result, farmers gradually accumulate standardized production and transaction records, including receipts for agricultural input purchases, agricultural product sales records, and farmland transfer contracts, which constitute essential documentation for applying for agricultural subsidies. These records reduce the information and verification costs associated with subsidy

applications and increase the likelihood that farm households will successfully obtain government support. Moreover, farm households are often eligible for multiple types of agricultural subsidies. Access to different subsidy programs may generate complementary effects, facilitating the accumulation of production factors and creating a virtuous cycle of agricultural investment and scale expansion [23]. Therefore, agricultural product marketization can indirectly promote large-scale land operation by enhancing farm households' ability to obtain agricultural subsidies. In this study, this transmission mechanism is referred to as the Subsidy Effect. Based on the above analysis, the following hypothesis is proposed:
H3: Agricultural Product Marketization has a positive and significant effect on Large-Scale Land Operation through the Subsidy Effect.

4. Data, Variables, and Empirical Strategy

4.1 Data Source

The data used in this study are drawn from the 2020 China Rural Revitalization Survey (CRRS), a large-scale household and village survey conducted under the Major Program of Economic and Social Surveys of the Chinese Academy of Social Sciences. The CRRS provides nationally representative micro-level data and serves as a reliable empirical foundation for this study.

To construct the analytical sample, three screening criteria were applied. First, only observations in which the respondent was identified as the household head were retained. Second, the sample was restricted to farm households that continued to cultivate farmland in 2019. Finally, observations with missing values or obvious outliers were excluded. After data cleaning, the final sample consists of 1802 valid farm households.

4.2 Variables

4.2.1 Dependent Variables

Following Xiao and Luo [3], this study employs two dependent variables to capture farmers' propensity to expand their land operation scale: land rental-in participation (1 = yes; 0 = no) and the area of land rented in (mu). The former measures farmers' willingness to expand their land operation scale, whereas the latter reflects the extent of such expansion.

4.2.2 Independent Variables

Following Xiao et al. [24], this study uses two core independent variables to measure the level of agricultural product marketization: the agricultural product commercialization rate and the share of the largest sales batch. The agricultural product commercialization rate is measured as the ratio of agricultural products sold to total agricultural output. A higher commercialization rate indicates greater market participation by agricultural producers and a stronger integration of farmers' production and business activities with the market system [19]. The share of the largest sales batch is measured as the proportion of the largest single sales batch relative to annual agricultural product sales. A higher value indicates a greater concentration of product sales and reflects higher marketing efficiency. It also suggests that farmers hold relatively stable expectations regarding future grain market conditions, thereby reducing incentives to delay sales or store grain [25]. Furthermore, a higher concentration ratio implies closer integration with the market, more stable marketing channels, and a greater capacity to market agricultural products in large quantities through a single transaction.

4.2.3 Control Variables

To account for other factors that may influence large-scale land operation, this study includes three groups of control variables: household head characteristics, household characteristics, and village characteristics. Household head characteristics include age, educational attainment, and village cadre status. Household characteristics comprise the area of contracted farmland, farmland fragmentation, off-farm employment experience of the household head or family members in the previous year, and participation in new agricultural business entities. Village characteristics include natural disaster exposure during the previous three years, distance from the village committee to the county government, total village farmland area, and the degree of village aging.

4.2.4 Mediating Variables

This study employs the income effect and the subsidy effect as the mediating variables. The income effect is measured by the household's annual net income from crop production, while the subsidy effect is measured by the amount of government crop production subsidies received by the household in 2019. Table 1 presents the descriptive statistics of all variables.

4.3 Model Specification

4.3.1 Baseline Regression

Because land rental-in participation and the area of land rented in are used as proxy variables for large-scale land operation, two baseline models are specified. The first model employs a Logit model to examine the effect of agricultural product marketization on farmers' participation in renting in farmland. The model is specified as follows:

$$Y_{li} = \alpha_0 + \alpha_m \text{Marketization}_i + \alpha_i X_i + \varepsilon_i \quad (1)$$

(1) where Y_{li} is a binary indicator denoting whether farm household i transferred in farmland, Marketization_i represents the level of agricultural product marketization of household i , which is the key independent variable; X_i denotes a vector of control variables affecting the household's land transfer decision; ε_i is the error term; α_0 is the intercept and α_m and α_i are parameters to be estimated.

The second model adopts an ordinary least Squares (OLS) model to estimate the effect of agricultural product marketization on the amount of farmland transferred in. The empirical specification is given by:

$$Y_{2i} = \beta_0 + \beta_m \text{Marketization}_i + \beta_i X_i + \mu_i \quad (2)$$

(2) where Y_{2i} denotes the amount of farmland transferred in by farm household, μ_i is the error term; β_0 is the intercept and β_m and β_i denote the coefficients to be estimated. All other variables are defined in the same way as in Equation (1).

4.3.2 Mechanism Analysis

To examine whether agricultural product marketization promotes large-scale land operation through the Income Effect and the Subsidy Effect, this study follows the mechanism analysis framework proposed by Jiang [26]. Consistent with this framework, the empirical analysis focuses primarily on the effect of the key independent variable on the mechanism variables, while the effect of the mechanism variables on the dependent variable is established through theoretical reasoning. The following mechanism models are specified:

$$y = \alpha_0 + \alpha_m \text{Marketization}_i + \alpha_i x_i + \varepsilon_{i2} \quad (3)$$

$$\text{Mediation}_i = \beta_0 + \beta_m \text{Marketization}_i + \beta_i x_i + \varepsilon_{i3} \quad (4)$$

(3) (4) where Mediation_i denotes the two mechanism variables, namely the Income Effect and the Subsidy Effect, and y represents large-scale land operation. The coefficient α_m captures the effect of agricultural product

marketization on large-scale land operation, whereas β_m measures its effect on the mechanism variables. A statistically significant

β_m indicates the existence of the proposed mechanism. All other variables are defined in the same way as in Equation (1).

Table 1. Definitions of Variables and Descriptive Statistics

Variable	Definition	Mean	Std. Dev.
Dependent Variables			
Land Rental-in Participation	Dummy variable: 1 = Yes; 0 = No	0.346	0.476
Area of Land rented in	Amount of farmland transferred in (measured in mu)	17.805	79.807
Key Independent Variables			
Agricultural Product Commercialization Rate	Sales volume of agricultural products/Total agricultural production	0.510	0.450
Share of the Largest Sales batch	Largest single sales transaction/ Total annual agricultural product sales	0.565	0.481
Control Variables			
Household-head Characteristics			
Age	Age of the household head (2020.07-Date of birth)	54.897	10.468
Educational Attainment	Years of schooling of the household head: No formal education = 0; Primary school = 6; Junior high school = 9; Senior high school/Technical secondary school/Vocational high school/Technical school = 12; Junior college = 15; Bachelor's degree = 16; Master's degree or above = 19	7.743	3.101
Village Cadre Experience	Dummy variable: 1 = The household head has served as a village leader (e.g., village director, village committee member, village group leader, or member of the supervisory board or governing board of a cooperative or collective economic organization); 0 = Ordinary villager	0.178	0.382
Household Characteristics			
Area of Contracted Farmland	Area of contracted farmland operated by the household (measured in mu)	13.432	25.966
Farmland Fragmentation	Number of cultivated land plots operated by the household	7.338	8.195
Off-farm Employment Experience	Dummy variable: 1 = The household head or other household members engaged in wage employment or self-employment outside agriculture during the previous year; 0 = No	0.520	0.500
Participation in New Agricultural Business Entities	Dummy variable: 1 = The household joined a cooperative or was registered as a family farm; 0 = No	0.255	0.436
Village Characteristics			
Natural Disaster Exposure	Dummy variable: 1 = The village experienced natural disasters during the past three years; 0 = No	0.592	0.492
Distance to the County Government	Distance between the village committee and the county government (km)	24.134	16.546
Total Village Farmland Area	Total cultivated land area of the village (measured in mu)	6600.795	7094.229
Degree of Village Aging	Population aged 60 and above/Resident population	0.291	0.156
Mediating Variables			
Income Effect	Annual net income from agricultural production of the household in 2019 (thousand yuan)	12.564	30.564
Subsidy Effect	Government subsidies related to crop production received by the household in 2019 (thousand yuan)	2.114	7.431

5. Empirical Results

5.1 Baseline Regression Results

Table 2 reports the estimation results of the baseline models. Models (1) and (2) employ the logit model, with land rental-in participation as the dependent variable. The estimated coefficients indicate that both the agricultural

product commercialization rate and the share of the largest sales batch significantly increase the probability that farmers rent in farmland at the 1% significance level. This finding suggests that a higher level of agricultural product marketization strengthens smallholder farmers' willingness to expand their land operation scale. Models (3) and (4) present the ordinary least squares (OLS) estimation results, using the area

of land rented in as the dependent variable. The coefficients of both core explanatory variables remain positive and statistically significant at the 1% level, indicating that improvements in agricultural product marketization significantly increase the amount of farmland rented in by farm households. Taken together, the baseline regression results consistently demonstrate that agricultural product marketization provides strong incentives for smallholder farmers to engage in large-scale land operation, as reflected in a significantly stronger propensity to expand their operational scale. Therefore, Hypothesis 1 is supported.

With respect to the control variables, among household characteristics, farmland fragmentation and participation in new agricultural business entities exhibit positive and statistically significant effects on both land rental-in participation and the area of land rented in. Regarding village characteristics, natural disaster exposure during the previous three years, total village farmland area, and the degree of village aging are all positively associated with large-scale land operation, whereas the distance from the village committee to the county government has a significantly negative effect.

Table 2. Baseline Regression Results: The Effect of Agricultural Product Marketization on Large-Scale Land Operation

Variables	Land Rental-in Participation		Area of Land rented in	
	(1)	(2)	(3)	(4)
Agricultural Product Commercialization Rate	1.033*** (0.127)		26.829*** (2.779)	
Share of the Largest Sales batch		0.768*** (0.118)		18.745*** (2.540)
Age	-0.029*** (0.005)	-0.029*** (0.006)	-0.284 (0.181)	-0.286 (0.181)
Educational Attainment	-0.016 (0.018)	-0.013 (0.018)	-0.166 (0.109)	-0.071 (0.104)
Village Cadre Experience	0.049 (0.146)	0.067 (0.145)	8.128 (5.166)	8.505 (5.172)
Area of Contracted Farmland	0.000 (0.002)	0.001 (0.002)	0.237 (0.225)	0.256 (0.233)
Farmland Fragmentation	0.105*** (0.013)	0.101*** (0.013)	1.897*** (0.382)	1.873*** (0.388)
Off-farm Employment Experience	-0.109 (0.109)	-0.121 (0.108)	-7.254* (3.702)	-7.630** (3.721)
Participation in New Agricultural Business Entities	0.506*** (0.121)	0.517*** (0.121)	21.905*** (6.975)	22.419*** (7.032)
Natural Disaster Exposure	0.483*** (0.114)	0.483*** (0.114)	6.041** (3.040)	6.119** (3.081)
Distance to the County Government	-0.009** (0.004)	-0.009*** (0.003)	-0.313*** (0.109)	-0.336*** (0.111)
Total Village Farmland Area	0.000*** (0.000)	0.000*** (0.000)	0.002*** (0.001)	0.002*** (0.001)
Degree of Village Aging	0.898** (0.369)	0.922** (0.366)	34.908* (20.137)	35.291* (20.240)
Constant	-0.929** (0.418)	-0.827** (0.415)	-20.701 (15.342)	-18.248 (15.521)
Pseudo R ² /R ²	0.143	0.132	0.164	0.154
Observations	1802	1802	1802	1802

Notes: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in parentheses. The same notation applies to the following tables.

5.2 Robustness Checks

5.2.1 Propensity Score Matching (PSM)

Farm households may choose to sell agricultural products because large-scale land operation generates surplus output available for market sales. In this case, the expansion of large-scale land operation may, in turn, influence farmers' decisions regarding agricultural product marketization, giving rise to potential reverse causality. Moreover, farmers' decisions to commercialize agricultural products are not randomly assigned but are likely affected by a range of observable household characteristics, resulting in potential self-selection bias. To mitigate these concerns, this study introduces a

binary treatment variable, whether agricultural products are sold (1 = commercialization rate > 0; 0 = commercialization rate = 0), and employs Propensity Score Matching (PSM) to estimate the effect of agricultural product sales on large-scale land operation. Before implementing the PSM procedure, the common support assumption and the covariate balance assumption are examined.

First, Common Support Test. As shown in Figure 2, the matching results for the 1802 sample households indicate substantial overlap in the propensity score distributions of the treatment and control groups within the central region of the distribution, with only a small number of observations at the tails being

excluded. After matching, 1663 observations remain within the region of common support, accounting for 92.3% of the original sample. These results suggest that the PSM procedure achieves satisfactory comparability between households that sold agricultural products and those that did not, thereby satisfying the common support assumption.

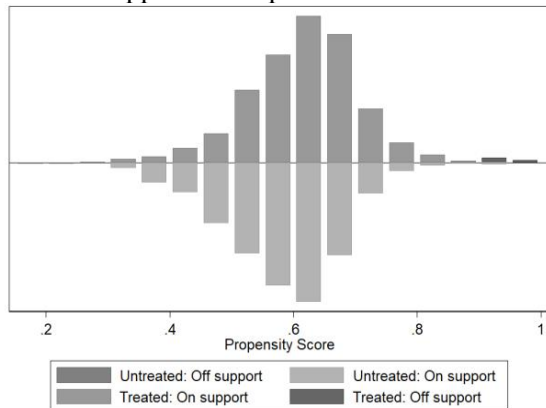


Figure 2. Distribution of Sample Matching (1:2 Nearest-Neighbor Matching)

Second, Covariate Balance Test. As shown in Figure 3, the standardized biases for all covariates are substantially reduced after matching, with the standardized bias of each covariate falling below the 10% threshold commonly used to assess covariate balance. This indicates that the treatment and control groups become well balanced in terms of their observed covariates after matching. Therefore, the PSM procedure successfully satisfies the covariate balance assumption.

Third, Estimation Results of the PSM Analysis. The Average Treatment Effect on the Treated (ATT) is the primary parameter of interest in the PSM analysis, measuring the average treatment effect for households in the treatment group. The estimation results are reported in Table 3. First, the ATT estimate for whether farmland was

transferred in remains largely unchanged after matching, suggesting that selection bias has only a limited effect on this outcome and that the PSM procedure mainly corrects for the imbalance in observed covariates. By contrast, the ATT estimates for the area of land rented in all decline noticeably after matching, indicating that the unmatched estimates are subject to upward bias and confirming the appropriateness of applying the PSM approach. Second, both the average probability of land rental-in participation and the average area of land rented in are substantially higher for the treatment group than for the control group. Moreover, the estimated ATT coefficients are positive and statistically significant, indicating that households selling agricultural products are more likely to expand their land operation scale than they would have been under the counterfactual scenario in which they did not sell agricultural products. This finding suggests that participation in agricultural product sales significantly promotes large-scale land operation. Third, the estimated ATT values obtained using 1:2 nearest-neighbor matching, radius matching, and kernel matching are highly consistent, indicating that the estimation results are robust to alternative matching algorithms.

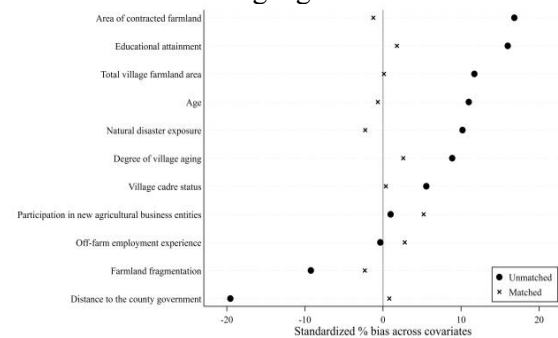


Figure 3. Standardized Biases of Covariates (1:2 Nearest-Neighbor Matching)

Table 3. PSM Estimation Results: The Effect of Agricultural Product Marketization on Large-Scale Land Operation

Dependent Variable/Matching Method	Land Transfer-In			Transferred-In Land Area		
	Treatment Group	Control Group	ATT	Treatment Group	Control Group	ATT
Before Matching	0.417	0.249	0.168*** (0.023)	27.857	3.766	24.091*** (3.872)
Nearest-Neighbor Matching (K = 2)	0.414	0.236	0.178*** (0.027)	25.049	3.401	21.648*** (2.565)
Radius Matching (R = 0.02)	0.413	0.241	0.172*** (0.023)	25.038	3.934	21.105*** (2.520)
Kernel Matching	0.414	0.246	0.168*** (0.023)	25.049	3.879	21.171*** (2.510)
Observations	1077	586	-	1077	586	-

Table 4. Heckman Two-Step Estimation Results: The Effect of Agricultural Product Marketization on Large-Scale Land Operation

Variables	Land Transfer-In		Transferred-In Land Area	
	(1)	(2)	(3)	(4)
Agricultural Product Commercialization Rate	0.607*** (0.074)		58.173*** (14.107)	
Share of the Largest Sales Batch		0.451*** (0.069)		42.622*** (11.787)
Control Variables	Yes	Yes	Yes	Yes
IMR	-	-	77.698** (32.881)	78.214** (36.809)
Constant	-0.529** (0.251)	-0.475* (0.250)	-106.108*** (42.918)	-101.507** (45.805)
Pseudo R ² /R ²	0.141	0.131	0.175	0.164
Observations	1802	1802	1802	1802

5.2.2 Heckman Two-Step Model

Farm households' decisions regarding large-scale land operation involve two sequential stages: first, deciding whether to transfer in farmland, and second, determining the amount of farmland transferred in. If a household chooses not to transfer in farmland, the observed value of the amount of farmland transferred in is zero. Estimating the outcome equation using only households that transferred in farmland may therefore lead to sample selection bias. To address this issue, this study employs the Heckman two-step model to further examine the effect of agricultural product marketization on large-scale land operation.

The results reported in Table 4 lead to two main findings. First, the Inverse Mills Ratio (IMR) in Models (3) and (4) is statistically significant at the 5% level, indicating the presence of sample selection bias in farmers' decisions to transfer in farmland. This finding justifies the use of the Heckman two-step model to correct for potential selection bias. Second, the estimated coefficients on both the Commercialization Rate of Agricultural Products and the Proportion of the Largest Single Sales Transaction remain positive and statistically significant, consistent with the baseline regression results. Overall, although

sample selection bias is present, correcting for this bias does not alter the direction or statistical significance of the estimated effects of the core explanatory variables. These findings further confirm the robustness of the baseline regression results.

5.3 Endogeneity Test

To address potential endogeneity associated with the core explanatory variables, this study employs the Two-Stage Least Squares (2SLS) estimator. Farm households' production and marketing decisions are often characterized by herding behavior [27], implying that the degree of agricultural product marketization among neighboring households within the same village may influence the marketization decisions of the surveyed household. Following Yang et al. [28], this study uses the average agricultural product commercialization rate of neighboring households and the average share of the largest sales batch among neighboring households as instrumental variables for the two key explanatory variables, respectively. Specifically, these variables are measured as the corresponding village-level averages calculated excluding the surveyed household. The estimation results are reported below.

Table 5. 2SLS Estimation Results: The Effect of the Commercialization Rate of Agricultural Products on Large-Scale Land Operation

Variables	Land Transfer-In		Transferred-In Land Area	
	First Stage	Second Stage	First Stage	Second Stage
Average Agricultural Product Commercialization Rate of Neighboring Households	0.882*** (0.019)		0.882*** (0.019)	
Agricultural Product Commercialization Rate		0.300*** (0.035)		36.738*** (5.032)
Control Variables	Yes	Yes	Yes	Yes
Constant	-0.022 (0.060)	0.304*** (0.080)	-0.022 (0.060)	-23.184 (15.166)

First-Stage F Statistic	209.66	-	209.66	-
Weak Instrument Test (F Statistic)	2064.25***		2064.25***	
Hausman Test (F Statistic)	16.766***		7.425***	
R ²	0.477	0.152	0.477	0.161
Observations	1802	1802	1802	1802

Table 6. 2SLS Estimation Results: The Effect of the Proportion of the Largest Single Sales Transaction on Large-Scale Land Operation

Variables	Land Transfer-In		Transferred-In Land Area	
	First Stage	Second Stage	First Stage	Second Stage
Average Share of the Largest Sales Batch among Neighboring Households	0.846*** (0.022)		0.846*** (0.022)	
Share of the Largest Sales Batch		0.284*** (0.035)		31.744*** (4.610)
Control Variables	Yes	Yes	Yes	Yes
Constant	-0.043 (0.069)	0.315*** (0.082)	-0.043 (0.069)	-21.208 (15.365)
First-Stage F Statistic	144.87	-	144.87	-
Weak Instrument Test (F Statistic)	1440.74***		1440.74***	
Hausman Test (F Statistic)	24.093***		9.750***	
R ²	0.408	0.132	0.408	0.149
Observations	1802	1802	1802	1802

The results reported in Tables 5 and 6 yield three main findings. First, the Hausman test rejects the null hypothesis at the 1% significance level in all specifications, indicating the presence of endogeneity in the relationship between agricultural product marketization and large-scale land operation. This finding confirms the appropriateness of using the Two-Stage Least Squares (2SLS) estimator. Second, the estimated coefficients on both instrumental variables in the first-stage regressions are positive and statistically significant. Moreover, both the first-stage F statistics and the weak instrument test statistics exceed the conventional threshold of 10, suggesting that the instrumental variables are strongly correlated with their corresponding endogenous regressors and do not suffer from the weak instrument problem. Third, the second-stage coefficients of both endogenous

variables remain positive and statistically significant, indicating that agricultural product marketization significantly promotes large-scale land operation. This finding is consistent with the baseline regression results. Overall, the 2SLS estimation confirms that the baseline findings remain robust after accounting for potential endogeneity.

5.4 Mechanism Analysis

The theoretical analysis suggests that agricultural product marketization promotes large-scale land operation by increasing farm households' agricultural income and enhancing their ability to obtain agricultural subsidies. Following the mechanism identification framework proposed by Jiang [26], this study empirically examines these two transmission channels.

Table 7. Mechanism Analysis: Income Effect

Variables	Land Transfer-In		Transferred-In Land Area		Income Effect	
	(1)	(2)	(3)	(4)	(5)	(6)
Agricultural Product Commercialization Rate	1.033*** (0.127)		26.829*** (2.779)		14.742*** (1.503)	
Share of the Largest Sales Batch		0.768*** (0.118)		18.745*** (2.540)		9.359*** (1.525)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.929** (0.418)	-0.827** (0.415)	-20.701 (15.342)	-18.248 (15.521)	15.026*** (5.666)	16.683*** (5.891)

Pseudo R ² /R ²	0.143	0.132	0.164	0.154	0.143	0.119
Observations	1802	1802	1802	1802	1773	1773

Table 8. Mechanism Analysis: Subsidy Effect

Variables	Land Transfer-In		Transferred-In Land Area		Subsidy Effect	
	(1)	(2)	(3)	(4)	(5)	(6)
Agricultural Product Commercialization Rate	1.033*** (0.127)		26.829*** (2.779)		1.778*** (0.255)	
Share of the Largest Sales Batch		0.768*** (0.118)		18.745*** (2.540)		1.153*** (0.194)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.929** (0.418)	-0.827** (0.415)	-20.701 (15.342)	-18.248 (15.521)	-2.117* (1.107)	-1.934* (1.110)
R ²	0.143	0.132	0.164	0.154	0.214	0.206
Observations	1802	1802	1802	1802	1671	1671

(1) Agricultural Product Marketization, the Income Effect, and large-scale land operation Models (1)-(4) in Table 7 report the effects of agricultural product marketization on large-scale land operation, and the estimation results are consistent with those of the baseline regressions. Models (5) and (6) present the OLS estimates using the Income Effect as the dependent variable. The results indicate that both the Commercialization Rate of Agricultural Products and the Proportion of the Largest Single Sales Transaction have a positive and statistically significant effect on the Income Effect at the 1% significance level. These findings support Hypothesis 2.

(2) Agricultural Product Marketization, the Subsidy Effect, and Large-Scale Land Operation Models (1)-(4) in Table 8 correspond to those reported in Table 7. Models (5) and (6) estimate the Subsidy Effect using the OLS model. The results show that both the Commercialization Rate of Agricultural Products and the Proportion of the Largest Single Sales Transaction significantly increase the amount of agricultural

subsidies received by farm households at the 1% significance level. These findings support Hypothesis 3.

5.5 Heterogeneity Analysis

The heterogeneity analysis focuses on the amount of farmland transferred in as the outcome variable. Subgroup regressions are estimated using the OLS model.

5.5.1 Heterogeneity by Initial Farm Size

Following Luo et al. [29], farm households are classified into four groups according to the quartiles of contracted farmland area (measured in mu): small-scale, lower-medium-scale, upper-medium-scale, and large-scale households (25th percentile = 4 mu; 50th percentile = 7 mu; 75th percentile = 15 mu). The results reported in Table 9 indicate that, compared with small-scale and lower-medium-scale households, upper-medium-scale and large-scale households exhibit a stronger positive response to agricultural product marketization in terms of expanding their operational land scale.

Table 9. Heterogeneous Effects of Agricultural Product Marketization on Large-Scale Land Operation: By Initial Farm Size

Variables	Transferred-In Land Area			
	Small-Scale Households ($\leq q_{25}$)	Lower-Medium-Scale Households ($q_{25} \sim q_{50}$)	Upper-Medium-Scale Households ($q_{50} \sim q_{75}$)	Large-Scale Households ($> q_{75}$)
	(1)	(2)	(3)	(4)
Agricultural Product Commercialization Rate	22.768*** (5.119)	20.732*** (6.293)	24.484*** (4.470)	44.324*** (8.510)
Control Variables	Yes	Yes	Yes	Yes
R ²	0.201	0.173	0.362	0.147
	(5)	(6)	(7)	(8)
Share of the Largest Sales Batch	14.477*** (3.851)	11.422*** (3.503)	17.969*** (3.976)	33.569*** (9.065)
Control Variables	Yes	Yes	Yes	Yes
R ²	0.168	0.143	0.347	0.142

Observations	517	401	463	421
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Note: q25, q50 and q75 denote the 25th, 50th, and 75th percentiles, respectively.

Table 10. Heterogeneous Effects of Agricultural Product Marketization on Large-Scale Land Operation: By Major Grain-Producing Region

Variables	Transferred-In Land Area			
	Non-Major Grain-Producing Regions		Major Grain-Producing Regions	
	(1)	(2)	(3)	(4)
Agricultural Product Commercialization Rate	11.813** (5.589)		23.394*** (3.572)	
Share of the Largest Sales Batch		9.301 (6.785)		14.489*** (3.197)
Control Variables	Yes	Yes	Yes	Yes
R ²	0.075	0.074	0.229	0.223
Observations	709	709	1093	1093

5.5.2 Heterogeneity by Major Grain-Producing Region

Following Deng et al. [30], this study classifies the sample into two groups according to the functional roles of different regions in grain production. The major grain-producing regions include Shandong, Henan, Sichuan, Heilongjiang, and Anhui, while the non-major grain-producing regions include Ningxia, Guizhou, Shaanxi, Zhejiang, and Guangdong. As reported in Table 10, the positive effect of agricultural product marketization on large-scale land operation is substantially stronger in major

grain-producing regions than in non-major grain-producing regions.

5.5.3 Heterogeneity by Terrain Type

Agricultural production efficiency and the opportunity cost of farming differ substantially between plain and non-plain areas because of differences in terrain conditions [31,32]. As reported in Table 11, the positive effect of agricultural product marketization on large-scale land operation is significantly stronger in plain areas than in non-plain areas, which is consistent with the characteristics of agricultural production in China.

Table 11. Heterogeneous Effects of Agricultural Product Marketization on Large-Scale Land Operation: By Terrain Type

Variables	Transferred-In Land Area			
	Non-Plain Areas		Plain Areas	
	(1)	(2)	(3)	(4)
Agricultural Product Commercialization Rate	21.128*** (3.565)		31.057*** (7.671)	
Share of the Largest Sales Batch		10.216*** (2.083)		25.685*** (7.060)
Control Variables	Yes	Yes	Yes	Yes
R ²	0.191	0.156	0.205	0.202
Observations	962	962	840	840

6. Conclusions and Policy Implications

6.1 Conclusions

As an important channel through which smallholders obtain returns from agricultural production, agricultural product marketization plays a critical role in smallholders' decisions regarding farmland scale management. This study investigates its impact on smallholders' farmland scale management and reaches the following conclusions. First, agricultural product marketization significantly encourages smallholders to engage in farmland scale management, as evidenced by a substantially

stronger propensity to expand their operational land scale. Second, the mechanism analysis reveals that agricultural product marketization indirectly promotes the expansion of farmland operational scale by increasing smallholders' agricultural production income (Income Effect) and enhancing their ability to obtain government agricultural subsidies (Subsidy Effect). Third, the heterogeneity analysis shows that households with larger initial contracted farmland holdings are more likely to expand their operational land scale in response to agricultural product marketization. Moreover, the promoting effect of agricultural product marketization on farmland scale management is considerably stronger in

major grain-producing regions and plain areas.

6.2 Policy Implications

The coexistence of a large country with numerous smallholders will remain a defining feature of China's agricultural sector for the foreseeable future. A central challenge of Chinese agricultural modernization is how to improve smallholder welfare while transforming traditional agriculture, and how to balance the development of appropriately scaled farming with continued support for smallholder households. The findings of this study demonstrate that improving the level of agricultural product marketization is of considerable practical importance for promoting farmland scale management among smallholders. However, agricultural product marketization among China's smallholders continues to face a number of constraints, including information asymmetry, inefficient marketing channels, inconsistent quality standards, low value-added agricultural products, and limited market experience among smallholders. These challenges substantially hinder the development of smallholders' capacity to participate in modern agriculture.

Accordingly, several policy implications emerge. First, policymakers should place greater emphasis on improving the level of agricultural product marketization among smallholder households, thereby unlocking their potential to develop into operators of appropriately scaled farms. Second, because the effects of agricultural product marketization on farmland scale management vary across different types of farm households, regions, and topographical conditions, policy support should be tailored to local conditions and household characteristics while encouraging greater participation in agricultural product marketization. Third, to maximize the positive role of agricultural product marketization in promoting farmland scale management, governments should fully leverage the subsidy mechanism by refining and implementing differentiated agricultural subsidy policies, thereby improving the efficiency and effectiveness of subsidy allocation.

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References

- [1] Li JY, Qin F. How can the demand dilemma of farmland transfer be solved? Evidence from the development of new agricultural business entities. *Management World*, 2022, 38(2): 84-99.
- [2] Yang Z, Rao FP, Zhu PX. The impact of agricultural socialized services on large-scale farmland management: Empirical evidence from the perspective of farmers' farmland transfer-in. *Chinese Rural Economy*, 2019(3): 82-95.
- [3] Xiao J, Luo BL. The core proposition of Chinese-style agricultural modernization: How can smallholders achieve large-scale farmland management? Evidence from returned migrant households. *Rural Economy*, 2023(2): 10-22.
- [4] Ye JP, Jiang Y, Feng L. An investigation of China's rural land transfer market: Analysis and policy recommendations based on a survey of 17 provinces in 2005. *China Rural Survey*, 2006(4): 48-55.
- [5] Wen L, Paudel KP, Chen YH, et al. The power of securing property rights: Evidence from China's land titling policy. *Economic Development and Cultural Change*, 2024, 72(4): 1829-1861.
- [6] Kuang YP, Peng Y. Historical evolution, driving mechanisms, and future pathways of China's farmland transfer institution. *Rural Economy*, 2024(4): 34-47.
- [7] Xu C, Wang Q, Fahad S, et al. Impact of off-farm employment on farmland transfer: Insight into the mediating role of agricultural production service outsourcing. *Agriculture*, 2022, 12(10): 16.
- [8] Jiang M, Li J, Paudel KP, et al. Factors affecting agricultural land transfer-out in China: A semiparametric instrumental variable model. *Applied Economics Letters*, 2019, 26(20): 1729-1733.
- [9] Zhu X, Wei C, Zhang F, et al. Influencing factors of farmers' farmland transfer in mountainous Chongqing, China: Evidence from a multiclass logistic model. *Sustainability*, 2022, 14(12): 16.
- [10] Wang LY, Li GC. The impact of digital finance use on farmers' farmland transfer behavior. *Journal of China Agricultural University*, 2025, 30(1): 293-304.
- [11] Luo BL, Zhang L. Farmland titling in China: A policy with potentially overestimated expectations. *Economic Issues in China*,

- 2020(5): 17-31.
- [12] Zhang Y, Zhang J, Liu Y, et al. Agricultural machinery service adoption and farmland transfer-in decisions: Evidence from rural China. *Frontiers in Environmental Science*, 2023, 11: 15.
- [13] Hong MY, Gong LJ. Cultivating new demand-side business entities to promote farmland transfer. *Agricultural Economy*, 2016(2): 18-20.
- [14] Peng WH, Li HN, Fu LL, et al. The impact mechanism of the development of new agricultural business entities on compensated farmland transfer: Evidence from the China Rural Household Panel Survey. *China Land Science*, 2022, 36(12): 58-68.
- [15] Zhao XF, Zhao XY. Capacity building of agricultural socialized services by new agricultural business entities and the development prospects of the smallholder economy. *Issues in Agricultural Economy*, 2018(4): 99-107.
- [16] Shang XD, Zhu SY. "Non-family management" of large-scale farmland by family farms and specialized farm households: Behavioral logic, operational performance, and policy deviation. *Chinese Rural Economy*, 2015(12): 4-13.
- [17] Peng JQ, Wu HT, Tan C, et al. The impact of agricultural mechanization on farmers' degree of market participation: A threshold effect analysis based on per capita basic farmland demand. *Journal of China Agricultural University*, 2019, 24(7): 167-180.
- [18] Zhong Z, Kong XZ. Market signals, farmer types, and the logic of agricultural production and management behavior: Evidence from a survey of more than 1000 farm households in Shandong, Shanxi, and Ningxia. *Journal of Renmin University of China*, 2013, 27(5): 62-75.
- [19] Gao S, Huang XJ, Zhong TY, et al. The impact of agricultural marketization on farmers' crop production performance: Empirical evidence from farm household surveys in Shanghai, Jiangsu, and Anhui. *Geographical Research*, 2013, 32(6): 1103-1112.
- [20] Mei FC, Ma KX. The debate over pathways to moderate-scale agricultural management: Land scale or service scale? *Economic Survey*, 2022, 39(2): 46-56.
- [21] Luo Y. Exploring the standards for moderate-scale agricultural management in contemporary China: An analysis from the perspective of costs and returns. *Price: Theory & Practice*, 2024(12): 91-98.
- [22] Xiong H, Jiang P, Ju C, et al. Mechanisms of farmers' voluntary farmland transfer behavior: Simulation, validation, and application. *Management World*, 2023, 39(6): 71-85.
- [23] Wang W, Wang Y, Shen Y, et al. The role of multi-category subsidies in cultivated land transfer decision-making of rural households in China: Synergy or trade-off? *Applied Geography*, 2023, 160: 12.
- [24] Xiao FW, Yang GQ, Guo JY. The impact of agricultural product marketization on farmers' farmland transfer-in behavior: Evidence from a survey of farm households in Jiangxi Province. *Chinese Journal of Agricultural Resources and Regional Planning*, 2016, 37(2): 45-51.
- [25] Wei HK. *China Rural Revitalization Comprehensive Survey Report 2021*. Beijing: China Social Sciences Press, 2022.
- [26] Jiang T. Mediation and moderation effects in empirical causal inference research. *China Industrial Economics*, 2022(5): 100-120.
- [27] Gao J, Zhao R, Lyu X. Is there a herd effect in farmers' land transfer behavior? *Land*, 2022, 11(12): 15.
- [28] Yang LL, Li XZ, Liu RF, et al. How can smallholders integrate into large markets? A perspective from the herd effect. *Rural Areas, Agriculture and Farmers*, 2025(2): 16-22.
- [29] Luo WY, Rong MQ, Guo SH. Differences and influencing factors of cultivated land use efficiency among farm households in desertification regions from the perspective of resource dependence: Evidence from household survey data in four prefectures of southern Xinjiang. *Journal of Desert Research*, 2024, 44(5): 105-115.
- [30] Deng H, Su LL, Sun TQ. Does integrating smallholders into modern agriculture enhance household resilience? Evidence from the China Rural Revitalization Comprehensive Survey. *Research on Economics and Management*, 2024, 45(9): 78-99.
- [31] Chen ZW, Zhao GS, Zhang XY. Factors influencing farm households' willingness to

participate in the service-scale agricultural management model: Evidence from a survey of 632 farm households in Henan Province. Journal of Harbin University of Commerce (Social Science Edition),

2022(5): 109-119.

- [32] Wang LL. The role of agricultural product marketization in agricultural economic development: A brief analysis. Marketing Circle, 2023(8): 77-79.