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Land Registration, Adjustment Experience, and Agricultural Machinery Adoption: Empirical Analysis from Rural China

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Abstract: Land property security and advanced factor inputs play critical roles in agricultural modernization in developing countries. However, there are unclear relationships between land property security and advanced factor inputs. This study aims to clarify these relationships from the perspective of the differentiation of the realization process of land property security. From the perspective of property rights theory and endowment effects, data from 2934 farming households in rural China are used to determine the quantitative impacts of land registration and adjustment experience on the adoption of agricultural machinery. The results are as follows: (i) Land registration does not affect the adoption of agricultural machinery. (ii) Adjustment experience has a negative impact on the adoption of agricultural machinery. (iii) The interaction of land registration and adjustment experience has a positive impact on the adoption of agricultural machinery. This study provides some policy references with which developing countries can achieve agricultural modernization and revitalize the countryside by improving property rights security.

Keywords: land property security; land registration; adjustment experience; advanced agricultural factor inputs; agricultural machinery; China

1. Introduction

Agricultural mechanization is an important factor in agricultural modernization in developing countries [1–3]. It matters not just because agricultural machinery helps to improve agricultural productivity [4–6], but because it is correlated with agricultural economic growth [7,8]. In developing countries, urbanization is developing rapidly and a large number of rural laborers leave home to work, seeking economic benefits [9–12]. A lack of agricultural laborers and serious aging of the remaining population have led to a desolate countryside [10]. Agricultural machinery is a labor-saving technology [13] that has gradually become the main way by which developing countries cope with agricultural labor shortages [14,15]. In addition, the adoption of agricultural machinery helps improve agricultural productivity [14,16,17]. For example, Paudel et al. [17] found that the adoption of agricultural machinery could improve rice productivity by 1110 kg/ha. Thus, agricultural mechanization is the key method for developing countries to realize agricultural modernization [18,19]. However, farmers often do not adopt it or take a long time to start adopting it [20]. Thus, it is important to explore the key drivers of the adoption of agricultural machinery.

Meanwhile, developing countries have paid special attention to the reform of their property rights systems in their modernization processes. China is the world's largest developing country and one of

the world's largest agricultural countries [21,22]. China feeds 20% of the world's population with 7% of the world's cropland [23], thus, agricultural modernization is important to China [24,25]. Thus, this study shows the reform of Chinese rural land property rights system as an example. In rural China, land rights are divided into ownership, contract rights, and management rights (ownership belongs to the village collective; contract and management rights belong to farmers) [26]. Chinese government vigorously promotes land registration program since 2009. Land registration program means the contract rights and management rights of farmers are officially registered by Chinese government. And the rights of farmers are protected by the law [27,28]. More specifically, (i) in 2009, the Chinese agricultural department selected eight villages for a trial of rural contracted land registration; (ii) in 2012, the Chinese government began trialing the registration of rural contracted land across the whole county (50 pilot counties); (iii) in 2013, the Chinese government expanded the number of pilot counties for rural contracted land registration to 55; (iv) at the end of 2018, most of China's rural contracted land had been officially registered.

Land registration program can help protect farmers' interests. Land registration gains official recognition and legal protection, which means that others who want to obtain the land management rights of farmers need to obtain authorization from farmers. Thus, the impacts of land registration on farmers are undoubtedly huge. In particular, there has been much discussion in the academic community about whether land registration motivates farmers to invest in agriculture [29]. Agricultural machinery plays an important role in sustainable agriculture [15,30]. Thus, this study aims to explore whether land registration motivates farmers to adopt agricultural machinery.

Previous studies disagree about whether land registration motivates farmers to increase their agricultural investment. While some say that it does [26,31–35], others suggest that the effect is not obvious [36–40]. In reality, the Chinese government is trying to stimulate agricultural investment by stabilizing land rights. As shown in Figure 1, the scale of the land registration pilot program has gradually expanded from 8 villages in 2009 to 28 provinces in 2017. However, Figure 1 also shows that the per capita power of agricultural machinery has not increased with the scale of land registration. Thus, the case of China seems to indicate that land registration is not a clear incentive to adopt agricultural machinery.

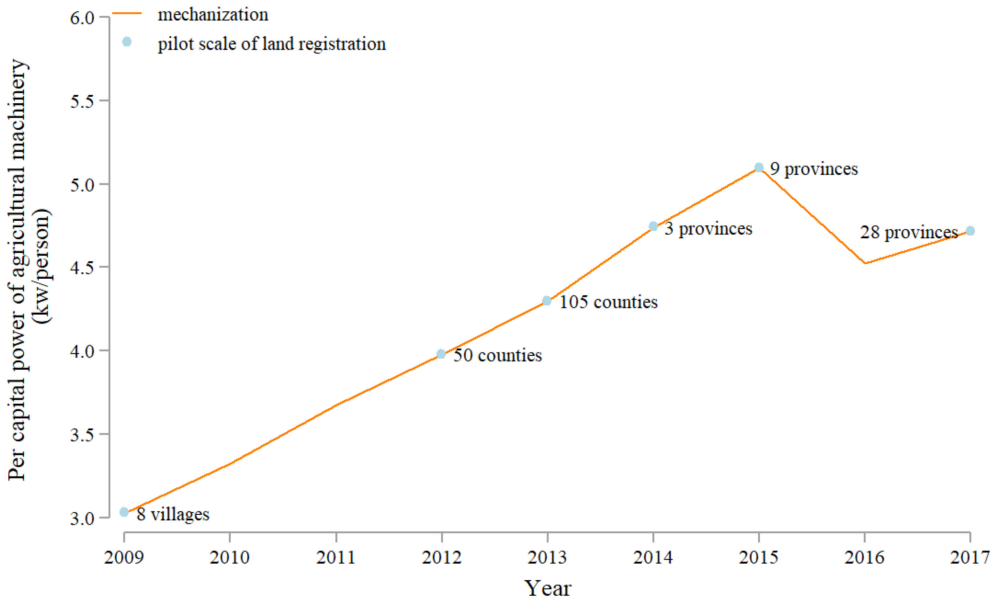

Figure 1. The relationship between land registration and agricultural machinery in China. Source: National Bureau of Statistics of China 2009–2017

Perhaps, the above dispute originates from insufficient consideration of differences in initial property rights distribution [41]. For example, under the premise of ensuring that the duration of land contracts remains unchanged, China's land management law allows appropriate adjustment of ownership of land contract rights among some farmers. Thaler [42] believed that the initial allocation of property rights plays a decisive role in the final allocation of resources. In rural China, the adjustment of the ownership of land contract rights must be approved at a villagers' meeting, and its goal is to optimize the allocation of resources. Thus, land registration may be better with appropriate adjustment of the ownership of land contract rights than without it. However, in previous studies, when discussing whether land registration stimulates agricultural investment, little consideration has been given to whether the land has been undergone appropriate adjustments before registration. Meanwhile, experience may leave long-term effects [43–45], and Ren et al. [27] and Hong et al. [41] found that farmer's experience of land adjustment may affect land investment. Thus, this study focuses on the combined impacts of land registration and adjustment experiences on the adoption of agricultural machinery.

In addition, the Chinese government has proposed a "Village Revitalization Strategy" [46–50], which aims to improve agricultural productivity and enhance rural vitality [51,52]. However, at present, the world is facing difficulties in revitalizing the countryside [10]. Thus, this study explores the combined impacts of land registration and adjustment experiences on the adoption of agricultural machinery from the perspective of Chinese farmers. The results may provide policy references for developing countries to realize agricultural modernization and revitalize the countryside.

2. Theoretical Analysis

In general, land fragmentation hinders the adoption of technologies such as agricultural machinery [53–55]. Governors hope farmers will expand the scale of land management by land registration [26,56]; this, in return, will also help to facilitate the adoption of agricultural machinery by farmers. However, differences in initial property rights may lead to different economic outcomes [57]. Empirical studies show an unclear relationship between land registration and the scale of land management [58,59]. Therefore, the impacts of land registration on the adoption of agricultural machinery require further investigation.

Differences in land registration may lead to different levels of adoption of agricultural machinery. Coase [60] believed that if the market transaction cost is zero, no matter how the initial property rights are arranged, resource allocation will automatically achieve Pareto optimality under the market mechanism. However, Thaler [42] believed that there is an "endowment effect", which does not change an individual's preferences but strengthens their motivation to maintain the status quo [61,62]. Thus, improper land registration will increase the endowment effect in farmers, which may hinder the transfer of land. As a consequence, it may be disadvantageous for farmers to adopt agricultural machinery. Hence, when we discuss the relationship between land registration and agricultural machinery adoption, we should identify the differences in land registration involved.

Differences in land registration may stem from the property rights experiences of farmers. In rural China, with the consent of two-thirds of the farmers, a village collective can adjust the land between farmers on a small scale. Land adjustment is a coherent collective action that aims to optimize land allocation. Samuelson and Zeckhauser [62] indicated that adjustment may enable individuals to form new endowment effects and make new choices. Adjustment experiences may impact the status quo and weaken endowment effects. That is, land registration with adjustment makes it possible for farmers to rationalize land valuations and investments. In return, it can help to enhance land transfer and improve the scale of land management, which may facilitate the adoption of agricultural machinery.

In summary, under the background of the reform of China's rural property rights system, and based on property rights theory and endowment effects, this study intends to provide empirical evidence for the following two issues:

1. How do the land registration and adjustment experiences affect farmers' adoption of agricultural machinery?
2. Can land registration with adjustment encourage farmers to adopt agricultural machinery?

3. Data Source, Variable Definition, and Empirical Approach

3.1. Data Source

The farmers' households play an essential role in the agricultural and rural studies [52,63–65]. According to the previous studies, this study uses the household-level data of Chinese famers belonging to the China Labor-force Dynamics Survey in 2014 (Hereinafter, CLDS2014). More specifically, the CLDS2014 was implemented by the Center for Social Science Survey at Sun Yat-sen University (Guangzhou, China) in 2014, which collected the details about the social and economic development in China, such as, rural land use, rural land registration, and agricultural production (more details can be found on the Web site http://css.sysu.edu.cn). CLDS2014 can help us to understand Chinese reality by the scientific sampling. And the sampling method employed the multistage cluster, stratified, probability-proportional-to-size (PPS) sampling to cover 29 Chinese mainland provinces (excluding Tibet and Hainan). Firstly, CLDS2014 sampled 209 counties from 29 provinces; secondly, CLDS2014 sampled 401 villages/communities from 209 counties; finally, CLDS2014 sampled 14,214 households from 401 villages/communities. In addition, the CLDS2014 is the latest open access data from the survey institutions.

This study aims to explore the relationship among land registration, adjustment experience, and agricultural machinery adoption. Thus, we clean the data of CLDS2014, and the cleaning processes are as follows: (1) the households living in urban area are not directly engaged in agriculture; thus, this study only retains the households living in rural area; and (2) this study also excludes the households living in rural areas but not engaged in agricultural production. In summary, through the above cleaning process, this study employs 2934 valid household-level questionnaires to perform empirical analysis. In addition, grain plays an important role in China with a large population, and China has a long history of planting grain. Meanwhile, CLDS2014 collected the details of planting grain. However, it did not provide the details that process farmer-adopted-agricultural machinery. Thus, the term "planting grain" used in this study is not just about planting, and may also involve cultivation and harvesting.

3.2. Variable Definition

3.2.1. Dependent Variable

At present, the Chinese government is committed to improving the level of mechanization of grain planting. Thus, this study assumes that if farmers have adopted machinery for this, they are considered to adopt agricultural machinery. Therefore, the dependent variable is binary. More specifically, 1 if a farming household adopts agricultural machinery in any planting grain processes (planting, cultivation and harvesting) or 0 otherwise.

3.2.2. Predicator Variables

Land registration is defined as whether the land contract and management rights of farmers are officially registered. Thus, it is defined as a binary variable. More specifically, 1 if the land right of the farming household has been officially registered or 0 otherwise.

Meanwhile, in rural China, with the consent of two-thirds of the farmers, a village collective can adjust land between farmers on a small scale. Hence, land adjustment is a coherent collective action that aims to optimize land allocation. In general, land adjustment occurs before land registration. Thus, an adjustment experience occurs when a farming household experiences land adjustment before the

land rights are officially registered. It is defined as a binary variable: 1 if the farming household had an adjustment experience or 0 otherwise.

3.2.3. Control Variables

To improve the accuracy of empirical estimates, referencing to the studies of Ji et al. [66], Ma et al. [15], Adu-Baffour et al. [16], Belton and Filipski [14], Deng et al. [67], and Hong et al. [41], this study controls householder-level variables, household-level variables, and location-level variables. Table 1 shows the definitions and descriptive statistics of all variables for empirical model.

Table 1. The definition and data description of the variables in the model.

Variables	Definition	Mean	Standard Deviation
	Dependent variable		
Adoption	1 if farm household adopts agricultural machinery in any planting grain processes; 0 otherwise	0.59	0.49
	Predicator variables		
Registration	1 if land right of farm household has been officially registered; 0 otherwise	0.50	0.50
Adjustment	1 if farm household has experienced land adjustment before the land right officially registered; 0 otherwise	0.95	0.21
Registration × Adjustment	The interaction item of Registration and Adjustment. 1 if both Registration and Adjustment are equal to 1; 0 otherwise	0.48	0.50
	Householder-level variables		
Gender	1 if householder is male; 0 female	0.88	0.32
Age	Age of householder in years (year)	52.39	10.96
Education	1 if householder has received a high school diploma or above; 0 otherwise	0.11	0.32
Health	1 if householder has a healthy status; 0 otherwise	0.84	0.36
Job	1 if householder engages in agriculture; 0 otherwise	0.56	0.50
	Household-level variables		
Farm employment	The ratio of members engaging in agriculture to total members (%)	31.46	27.51
Off-farm employment	The ratio of off-farm members to total members (%)	27.46	26.29
Farm income	The ratio of farm income to total income (%)	50.72	39.70
Land size	The area that farm household is managing land (mu [a])	9.92	28.65
Loan	1 if farm household has borrowed the production fund; 0 otherwise	0.06	0.25
Specialty	1 if farm household is good at planting grain; 0 otherwise	0.05	0.23
Cooperation	1 if farm household belongs to cooperative organization; 0 otherwise	0.02	0.13
Subsidy	The amount of agricultural subsidy from government (RMB [b])	0.70	0.46
Internet	1 if farm household can use the Internet; 0 otherwise	0.27	0.45
	Location-level variables		
Distance	Distance between household and the nearest business center (Km)	7.25	9.22
Plain	1 if farm household belongs to plain village; 0 otherwise	0.32	0.47
Road	The share of concrete road in total road (%)	59.88	29.71

Note: [a] 1 mu is approximately equal to 667 m^2 or 0.067 ha; during the survey period, [b] 1 US dollar was approximately equal to 6.12 RMB (Chinese Yuan).

3.3. Method

This study focuses on exploring the quantitative impacts of land registration and adjustment experience on the adoption of agricultural machinery. The dependent variable for Adoption is the binary variable. Therefore, this study employs the binary Probit model for econometric regression. The basic model is set as follows Equation (1):

$$\begin{aligned} Adoption_{pci} = \; & \beta_0 + \beta_1 Registration_{pci} + \beta_2 Adjustment_{pci} + \\ & \beta_3 Registration_{pci} \times Adjustment_{pci} + \gamma X + \delta_c + \tau_p + \varepsilon_{pci} \end{aligned} \quad (1)$$

where the subscripts of p, c, and i represent province, county, and household, respectively; Adoption is the binary variable, which value 1 means that farm household adopts agricultural machinery in planting grain and 0 means otherwise; Registration is a dummy variable, which value 1 represents that

land right of farm household has been officially registered and 0 represents otherwise; Adjustment is the binary variable, which value 1 means that farm household has experienced land adjustment before the land right officially registered and 0 means otherwise; Registration × Adjustment represents the interaction item of Registration and Adjustment; X is the vector of other control variables; β_0 is the constant; β_1, β_2, and β_3 are estimated parameters; γ is the vector of estimated parameters for control variables; δ values are the county dummies; τ values are the province dummies; ε is the random error term.

4. Results

4.1. Descriptive Results

Figure 2 shows a heatmap of Pearson's correlation coefficients for the dependent and focal variables of the model. The results show that: (i) there is a positive correlation between *land registration* and the *agricultural machinery adoption*; (ii) there is a positive correlation between *adjustment experience* and the *agricultural machinery adoption*; (iii) there is a positive correlation between the interaction of *land registration*, *adjustment experience*, and *agricultural machinery adoption*.

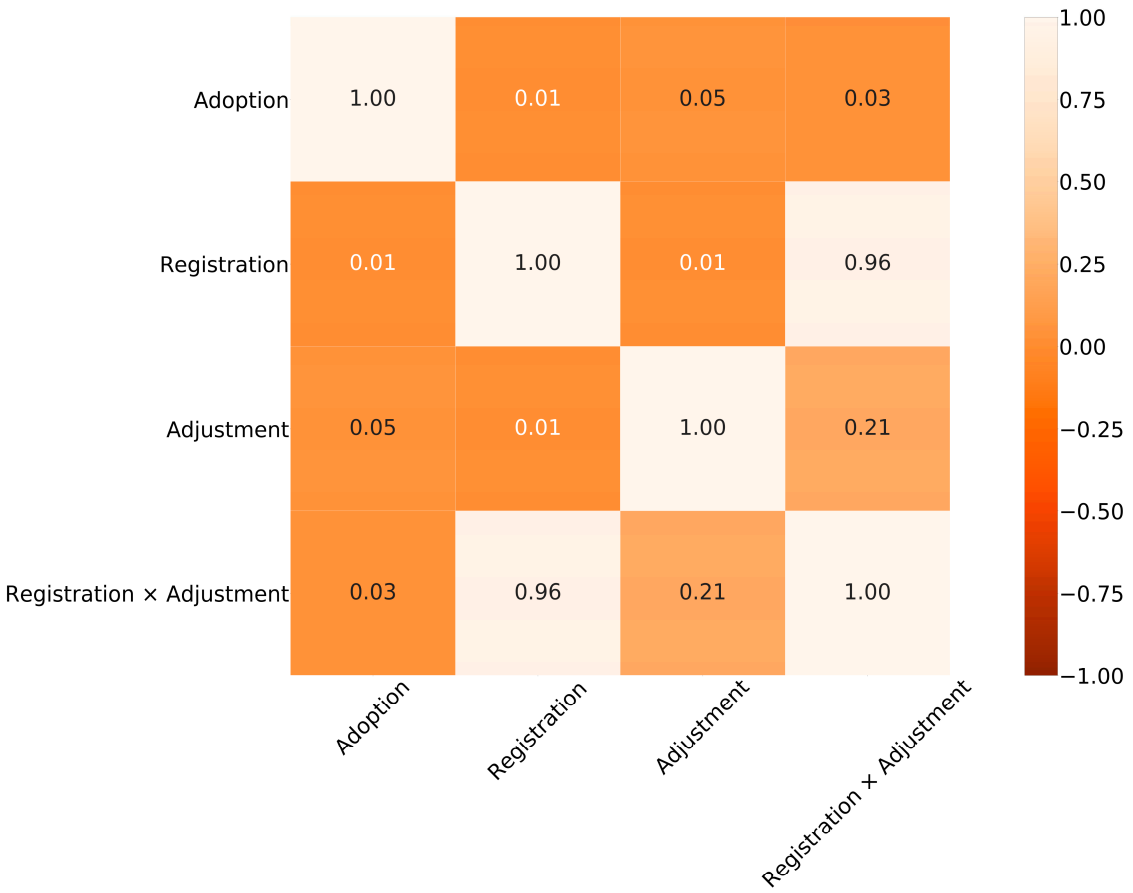

Figure 2. The heatmap of Pearson's correlation coefficients.

In addition, the mean difference can help us understand the sample structure and provide a basis for the choice of an econometric model. Figure 3 shows the mean differences in the adoption of agricultural machinery by land registration, adjustment experience, and their interaction. The results show that the groups that registered land or experienced adjustment, or both, are more inclined to adopt agricultural machinery. However, only the mean difference between groups with and groups without adjustment experience is significant ($p < 0.05$).

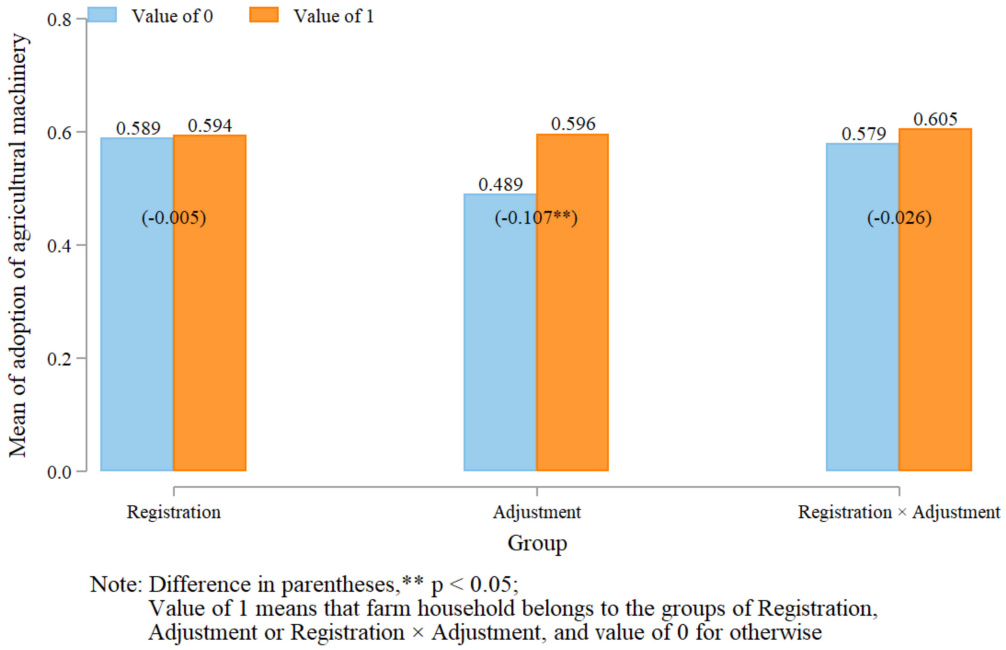

Figure 3. Mean difference of adoption of agricultural machinery by groups.

In summary, both the Pearson's correlations and mean differences help us understand data structure. Although the statistical results show that land adjustment experience may play an important role in the adoption of agricultural machinery, it is still necessary to discuss the relationship by econometric models. However, previous studies have paid little attention to this relationship. Thus, this study uses an econometric model to discuss the quantitative impacts of land registration, adjustment experience, and their interactions on the adoption of agricultural machinery.

4.2. Empirical Results

4.2.1. Impacts of Registration and Adjustment on Agricultural Machinery Adoption

Table 2 presents the empirical estimates. In Table 2, the dependent variables for all models are binary discrete variables (whether or not farmers adopt agricultural machinery). Meanwhile, this study used a causal identification strategy that gradually adds explanatory variables. More specifically, in Models (1) to (5), a stepwise process was used to add the focal variables, county and province dummy variables, householder variables, household variables, and location variables. For all models, the value of Wald χ^2 was significant at a level of 1%, and the R^2 values gradually increase, indicating that the identification strategy was suitable. Additionally, since the Probit model was non-linear, a marginal effect (i.e., Model (6)) was calculated on the basis of Model (5) to quantify the relationship.

As shown in Models (1) to (5) in Table 2, the coefficient of Registration was not significant except in Model (1), which indicates that the impact of land registration on the adoption of agricultural machinery may be uncertain. The coefficient of Adjustment was significantly negative ($p < 0.01$) except in Model (1), which indicates that the impact of adjustment experience on the adoption of agricultural machinery may be negative. The coefficient of Registration × Adjustment was significantly positive ($p < 0.10$), which indicates that the combined impact of land registration and adjustment experience on the adoption of agricultural machinery was positive. As shown in the marginal effects estimates (Model (6) of Table 2), compared with other farmers, those who have experienced land adjustment before land registration are 14.2% more likely to adopt agricultural machinery. In addition, in Model (5) of Table 2, the variables Off-farm employment, Subsidy, and Internet can also increase farmers' enthusiasm for adopting agricultural machinery.

Table 2. The impact of registration and adjustment on the adoption of agricultural machinery.

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Registration	−0.645 ***	−0.227	−0.213	−0.354	−0.357	−0.080
	(0.217)	(0.268)	(0.268)	(0.279)	(0.279)	(0.063)
Adjustment	−0.061	−0.724 ***	−0.729 ***	−0.885 ***	−0.905 ***	−0.203 ***
	(0.154)	(0.232)	(0.231)	(0.236)	(0.237)	(0.053)
Registration × Adjustment	0.691 ***	0.502 *	0.489 *	0.623 **	0.635 **	0.142 **
	(0.222)	(0.278)	(0.278)	(0.290)	(0.290)	(0.065)
Gender			0.149	0.144	0.141	0.032
			(0.094)	(0.096)	(0.096)	(0.022)
Age			−0.004	−0.003	−0.003	−0.001
			(0.003)	(0.003)	(0.003)	(0.001)
Education			0.193 *	0.134	0.136	0.030
			(0.103)	(0.104)	(0.103)	(0.023)
Health			0.121	0.072	0.081	0.018
			(0.087)	(0.089)	(0.089)	(0.020)
Job			0.035	0.149 *	0.138	0.031
			(0.066)	(0.085)	(0.086)	(0.019)
Farm employment				−0.001	−0.001	−0.000
				(0.002)	(0.002)	(0.000)
Off-farm employment				0.005 ***	0.005 ***	0.001 ***
				(0.002)	(0.002)	(0.000)
Farm income				−0.001	−0.001	−0.000
				(0.001)	(0.001)	(0.000)
Land size				0.003	0.003	0.001
				(0.003)	(0.003)	(0.001)
Loan				−0.010	−0.012	−0.003
				(0.134)	(0.135)	(0.030)
Specialty				0.236	0.158	0.035
				(0.185)	(0.185)	(0.041)
Cooperation				0.007	0.006	0.001
				(0.259)	(0.260)	(0.058)
Subsidy				0.420 ***	0.424 ***	0.095 ***
				(0.077)	(0.077)	(0.017)
Internet				0.243 ***	0.222 ***	0.050 ***
				(0.074)	(0.075)	(0.017)
Distance					−0.025 ***	−0.006 ***
					(0.006)	(0.001)
Plain					0.488 ***	0.109 ***
					(0.156)	(0.035)
Rode					−0.002	−0.001
					(0.003)	(0.001)
Constant	0.282 *	0.935 **	0.845 *	0.674	1.036 **	
	(0.150)	(0.384)	(0.438)	(0.455)	(0.471)	
County dummies	No	Yes	Yes	Yes	Yes	Yes
Province dummies	No	Yes	Yes	Yes	Yes	Yes
Wald χ^2	15.651 ***	825.349 ***	833.258 ***	875.000 ***	882.002 ***	882.002 ***
R^2	0.004	0.366	0.369	0.386	0.396	0.396
Obs.	2934	2934	2934	2934	2934	2934

Note: Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.2.2. Estimated Results of Robustness Tests

To ensure that the estimates in Table 2 are reliable, robustness tests were used, with the results shown in Table 3. In Table 3, Model (1) represents the sub-sample regression (farmers without land transfer), while Model (2) changes the regression method to a logit model.

As shown in Table 3, we also controlled for householder-level variables, household-level variables, location-level variables, and county and province dummy variables. The estimates in Table 3 are similar to those in Table 2. More specifically, the coefficient of Registration was not significant, the coefficient of Adjustment was negative ($p < 0.01$), and the coefficient of Registration × Adjustment was positive ($p < 0.10$). Thus, the results of Table 3 indicate that the results of Table 2 are robust.

Table 3. The estimated results of robustness tests.

	Model (1)	**Model (2)**
Registration	−0.223	−0.570
	(0.290)	(0.460)
Adjustment	−0.737 ***	−1.608 ***
	(0.261)	(0.401)
Registration × Adjustment	0.512 *	1.080 **
	(0.301)	(0.483)
Gender	0.199 **	0.250
	(0.101)	(0.173)
Age	−0.003	−0.006
	(0.003)	(0.006)
Education	0.197 *	0.211
	(0.116)	(0.187)
Health	0.068	0.118
	(0.098)	(0.159)
Job	0.070	0.223
	(0.093)	(0.152)
Farm employment	−0.000	−0.001
	(0.002)	(0.003)
Off-farm employment	0.004 **	0.008 ***
	(0.002)	(0.003)
Farm income	−0.001	−0.001
	(0.001)	(0.002)
Land size	−0.001	0.006
	(0.003)	(0.006)
Loan	0.033	−0.037
	(0.156)	(0.244)
Specialty	−0.050	0.255
	(0.192)	(0.351)
Cooperation	−0.151	−0.109
	(0.295)	(0.488)
Subsidy	0.417 ***	0.748 ***
	(0.084)	(0.136)
Internet	0.203 **	0.376 ***
	(0.083)	(0.134)
Distance	−0.026 ***	−0.044 ***
	(0.006)	(0.010)
Plain	0.453 ***	0.928 ***
	(0.169)	(0.297)
Rode	−0.003	−0.006
	(0.003)	(0.005)
Constant	1.004 **	1.860 **
	(0.496)	(0.804)
County dummies	Yes	Yes
Province dummies	Yes	Yes
Wald χ^2	753.363 ***	656.835 ***
R^2	0.380	0.398
Obs.	2215	2934

Note: Robust standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; Model (1)–(3) means the models of sub-sample data, the Logit model, and the instrumental regression, respectively.

5. Discussion

Based on data from 2934 farming households in rural China, this study focuses on the quantitative impacts of land registration, adjustment experience, and their interactions on the adoption of agricultural machinery. The contributions of this study are as follows: (i) under the guidance of property rights theory and endowment effects, this study focuses on the quantitative impact of heterogeneous land

registration on agricultural inputs; (ii) it further enriches the understanding of property rights theory and endowment effects. China is the world's largest developing country and empirical evidence from there may provide a reference for land property reform in other developing countries. This study may also provide some policy references for developing countries to realize agricultural modernization and revitalize the countryside.

The results of this study have some similarities and differences from previous studies. First, we found no significant impact of land registration on the adoption of agricultural machinery. This is consistent with Brasselle et al. [40], Beekman and Bulte [37], Domeher and Abdulai [38], Lovo [36], and Goldstein et al. [39], who report that property rights security may not obviously affect agricultural input. Second, there was a negative impact of adjustment experience on the adoption of agricultural machinery. Finally, there was a positive impact of the interaction of land registration and adjustment experience on the adoption of agricultural machinery. These findings differ from those of Hong et al. [41], who reported that land registration positively affects the investment incentive of farmers without land adjustment experience.

The findings of this study are interesting because property rights are important [60]. However, due to the endowment effect [42], the registration process of property rights is also very important [57]. The endowment effect does not change individuals' preferences, but strengthens their motivation to maintain the status quo [61,62]. Thus, when the land rights of a farming household have been officially registered without land adjustment, famers may be less willing to transfer land due to the endowment effect. This may be a barrier to solving the problem of land fragmentation. In return, there was no impact of land registration without adjustment experience on the adoption of agricultural machinery. Therefore, when land has been adjusted without land registration, farmers' property rights may be insecure, which may decrease their willingness to invest in agriculture [26,31–35]. Additionally, there was a negative impact of adjustment experience without land registration on the adoption of agricultural machinery. When the land rights of a farming household have been officially registered after land adjustment, the adjustment helps optimize land resource allocation [9], while registration helps improve property security [68]; in return, there is a positive impact of the interaction of land registration and adjustment experience on the adoption of agricultural machinery. In summary, to explore the relationship between the security of property rights and agricultural inputs, we should not only pay attention to the results of property rights registration, but also to the process of property rights registration.

In addition, this study has several deficiencies, which can be addressed in future studies. Specific among them are as follows: (i) This study focused on the quantitative impacts of land registration, adjustment experience, and their interactions on the adoption of agricultural machinery. Future studies could further explore the driving mechanisms behind these quantitative relationships. (ii) Agricultural machinery is only one important agricultural input. Future studies could further discuss whether the findings of this study are applicable to other important agricultural inputs (e.g., soil improvement, irrigation facilities, etc.). (iii) The data of this study is set such that land registration and land adjustment were prior to agricultural machinery adoption, which may partly solve the problem of mutual causality. Future studies could further test the findings of this study by instrumental variable method. (iv) China has a special land ownership institution; namely, ownership belongs to the village collective, while contract and management rights belong to individual farmers. Future studies could further explore whether the findings of this study are applicable to developing countries where rural land ownership is private.

6. Conclusions and Implications

From the perspective of property rights theory and endowment effects, data from 2934 farming households in rural China are used to determine the quantitative impacts of land registration and adjustment experience on the adoption of agricultural machinery. The results are as follows:

1. Land registration does not affect the adoption of agricultural machinery.

2. Adjustment experience has a negative impact on the adoption of agricultural machinery.
3. The interaction of land registration and adjustment experience has a positive impact on the adoption of agricultural machinery.

Based on the above findings, we can also derive some policy implications. Although the security of land property rights is important for agricultural investment, we should also pay attention to the process of making land property rights secure. That is, when the government promotes land registration to ensure the security of land property rights, the first thing that the government should do is respect farmers' willingness to optimize the allocation of land resources via land adjustment. In addition, this study finds that using the Internet can improve the adoption of agricultural machinery. The internet can help farmers obtain information on agricultural technology, which may increase their likelihood of adopting agricultural technology. This suggests that the government increase internet access in rural areas.

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