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Land Rental Market Participation and Its Impact on Fixed Investment and Household Welfare: Evidence from Chinese Apple Production Sites

Jianyun Hou [1,2], Xuexi Huo [1,*] and Runsheng Yin [2]

[1] College of Economics and Management, Northwest Agricultural &Forestry University, Yangling 712100, Shaanxi, China; houjianyun2008@126.com
[2] Department of Forestry, Michigan State University, East Lansing, MI 48823, USA; yinr@anr.msu.edu
* Correspondence: xuexihuo@nwsuaf.edu.cn

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Abstract: Using a large dataset from the specialized apple production sites of China and multiple econometric methods, we identify the main determinants of farmers' land rental decisions and the effects from renting land in on their investment and economic welfare. It is found that having more effective cultivated land before renting in has a significantly negative effect on the land rented in, that households with rich land endowments or large areas of land rented in usually invest more in fixed assets, and that efficient provisions of credit and insurance are helpful to encourage investments in fixed assets. As a result, renting in land generates gains in terms of agricultural income, total income, and productive expenditure.

Keywords: land rental; investment; welfare; apple production sites; China

1. Introduction

It is widely believed among policymakers and economists that markets in developing countries for the exchange of rights to cropland are capable of temporarily or permanently facilitating low-cost but efficient transactions, which allow land to realize its most productive use [1]. In order to promote efficiencies of scale in agricultural production, and to secure land usage rights and raise farmland rental intensity in Asia, especially in Vietnam and China, land registration and certification has been carried out. Previous ideas have, however, also met challenges from the empirical findings that neither the land sales market nor tenancy markets are efficient in the use and allocation of land, and they are not conducive to social equity [2]. The effects of land rental market participation on smallholders' equity, efficiency and welfare are therefore ambiguous, and new empirical evidence is required [3].

Against this backdrop, our article intends to make two contributions to the literature regarding the performance of land rental markets in Asian countries. Firstly, with imperfect factor markets in mind, we will analyze the impact of labor, credit and insurance market access together on land market participation. The non-land production factor markets are imperfect due to high transaction costs. How these imperfect factor markets have affected land market participation is inconclusive from previous studies [4]. We will add to these studies by assessing the role of factor market access in determining the likelihood and intensity of participation on demand. Secondly, by considering household expenditures, total household income, off-farm income, and agricultural income, we measure the welfare gains from land rental activities on a broader range of indicators than previous studies. The evidence will be helpful for understanding how land rental may benefit the welfare of smallholders.

In order to address these questions, we choose apple farms as a typical case, and build nationally representative household-level cross-sectional data from Eastern, Central and Western China. Given the

fact that specialization and economies of scale are prioritized in China's agricultural and rural land policy, high-value agricultural crops like fruits and vegetables—some of the few outputs with comparative advantages in domestic and international markets—represent one important potential direction of agricultural transformation. Specifically, as the biggest apple producer and trader in the world, China has millions of farmers engaged in apple production. On the micro level, apple production usually entails more land-related investment, implying that tenure arrangements and duration might be more complex and active. Clarifying the perennial role of land rental activities in apple production will therefore be quite helpful towards understanding the mechanisms, functions and efficiency of general land markets in China.

This paper is structured as follows. In Section 2, we will review how insecure property rights, imperfect labor and credit markets, and a lack of social security limit the redistribution function of land rental market as well as their economic effects. Section 3 presents data sources and provides descriptive statistical evidence on land rental market development within specialized apple production sites. Section 4 illustrates a conceptual framework and corresponding empirical strategy. Section 5 discusses empirical results by estimating the determinants of land rental market participation, quantifying the factors affecting households fixed investments and assessing the economic effects of land tenure behavior on households' welfare. Section 6 concludes with policy implications.

2. Chinese Land Rental Markets

Previous theory suggests at least three approaches to explain why China's land rental markets function poorly: insecure property rights, imperfect labor and credit markets, and a lack of social security. A growing number of studies stresses how insecure property rights reduce farmers' willingness to participate in land rental markets, discourage land-related investment, and prevent migration. The overall results imply that well-defined and well-protected land property rights have stimulated an active land rental market, which may have profound long-term implications for the development of private land rights and fertility behavior [5]. Moreover, tenure insecurity also reduces migration in forested areas, which has implications for the conservation of recently replanted regions [6]. Against this background, institutions that either lower transaction costs or secure property rights have been found to be crucial in explaining cross-regional variations in the development of rental market [7]. The Chinese central government has also instituted a policy to strengthen farmers' usage and leasing rights. Thus, the nature of China's cultivated land rental contracts has become more formalized, and the length of time in which tenants are able to cultivate the rented plots has increased [8].

Previous literature has examined the effects of non-market land allocation, combined with uneven labor market development, on the efficiency of the agricultural sector [9]. It is found that the emergence of off-farm employment has significantly stimulated households to rent out cultivated land [10]. At the same time, a number of factors, including credit rationing and scope to use land as collateral to overcome information imperfections inherent to credit markets, may increase land purchase prices over and above the present values of agricultural profits [11]. However, some works have shown that controlling for levels of other fixed resources and households' access to credit does not affect either the amount of land leased or its tenure status [12]. Unfortunately, pervasive rationing in the highly regulated rural credit markets in China has led to poor credit access and ineffectiveness in activating land rental markets and promoting agricultural investments [13].

Researchers also ascribe the temporary rural labor migration to migrants' lack of social security. They argue that rural land tenure insecurity due to frequent reallocation and abusive requisition—has resulted in the lack of functional land markets, which are major policy challenges China faces in its still-unfinished economic transition [14]. In the process, specific institutional frameworks need to be put in place to avoid potentially excessive dependence on the provision of welfare and inequity in allocating released land in villages. Specifically, as village land ownership remains collective and as land use rights can be periodically reallocated, out-migrating individuals can be deprived of those rights once they give up farming. Moreover, the intensity of this insecurity varies according to the

village-level management of land use and the contractual status of land plots [15]. It has thus been claimed that the dilemma of whether or not to redistribute cannot be resolved effectively without coordinated reforms in household registration, which could help hundreds of millions of Chinese rural migrant workers permanently settle in cities and release their farmland to those who stay in the countryside [16]. A widespread literature has analyzed the effects on property investments generated by planning decisions that determine land use changes, emphasizing in particular the significant impact resulting from the designation for transportation purpose [17]. Meanwhile, analyses of functional correlations of property prices with the main locational and socioeconomic variables, which generally contribute to define the market value of properties, has been also performed [18].

Having clarified the functional limitations of land markets, we now turn to the economic effects of land rental market development. A growing body of empirical literature focuses on the equity and efficiency impacts of Chinese land market. There is a consensus among economists that production efficiency increases from rental market participation. In particular, the empirical case from rice farmers suggests that households who rent land achieve higher technical efficiency than those that do not. Meanwhile, rice production on rented plots was technically as efficient as on contracted plots [19]. The logic behind this finding is that by transferring land from less able and more affluent households who join the non-farm sector to poorer ones with ample household labor, thus allowing more effective use of potentially idle land—rental markets are not only critical for non-agricultural growth, but can also contribute to significant productivity gains [20]. Although the emergence of land markets has been fairly recent, they have been developing fairly quickly over the past decade, with beneficial effects in terms of allocative efficiency and equity [21].

Finally, researchers have found inconsistent effects of land markets on equity or disparity. Empirical evidence suggests that rural households who acquire land through markets significantly increase their farm income, so rental markets gave rise to a new source of income and increased inequality in farm income. Widening disparities in land rights and farm income, however, did not constitute a further retreat from equality, but instead had compensatory effects on overall inequality, as the markets helped out families who would have otherwise fallen to the lower end of income distribution [22]. Deininger and Jin [23], and others, have argued otherwise.

In summary, the transfer of land rights from those who move to nonfarm sectors, or migrating households, to those who continue farming, or remaining farm households, is critically important for the successful industrialization, specialization and structural transformation of the Chinese agriculture sector [24]. The effects of land rental markets are, however, not well quantified within areas of highly specialized cash crop production.

3. Land Tenure in Apple Production Sites

This section describes the sampling methodology used to obtain reasonably representative information on the development and economic effects of land rental markets within specialized apple-producing regions. We also report complementary information on general economic indicators from household surveys. Descriptive statistics indicate that rented-in land increases households' per capita total income.

3.1. Sampling Methods and Basic Characterization

This study is based on a field survey conducted by the China Agriculture Research System (CARS) during 2013/14 in Coastal (Shandong Province), Central (Henan Province), and Western (Shaanxi and Gansu Province) Chinese apple production sites. A supplemental questionnaire was administrated to specialized households with over half of their total income coming from agriculture. In particular, apple production in the sample areas remains the most important overall source of income. The field survey involving land transactions elicits information on respondents' contractual details, current occupation, and income levels.

A multi-stage sampling procedure was used to select counties and their sub-divisions and farm households. In the first stage, 122 counties in four northern provinces—namely, Shandong, Henan, Shaanxi, and Gansu—were randomly selected (see Figure 1). To ensure that all apple producers had the same probability of appearing in the sample, the probability proportional to size sampling method was used. Overall, 12 counties were randomly selected in the seven provinces and 1079 sample households were selected for interview. Detailed information on land transactions and production was collected via face-to-face questionnaire interview in 2014.

Characteristics of the sample households are described in Table 1. Sample farm households still rely heavily on apple production as their main source of income, at 81 percent. Compared with autarkic farmers, the sample households who rented land in obtained higher per capita total income and agricultural income, which implies that land rental market development could play a role in reducing poverty and equilibrating income. Little difference was observed between the autarkic and land-rental groups on most land-related investment, except for hired labor input. On the other hand, the average cost of hired labor input per unit area of renting-in farmers is about twice that of autarkic growers. It has been suggested that in order to operate labor-intensive farms well, hired labor must be employed during the farming season, but the high monitoring cost of hired labor may offset the increase in efficiency from land expansion. However, such judgment does not immediately appear in sample sites because most farms are far from reaching the optimal scales and if factor markets functioned effectively, they would reallocate land, labor and machinery so as to wipe out the inefficiency associated with labor allocation.

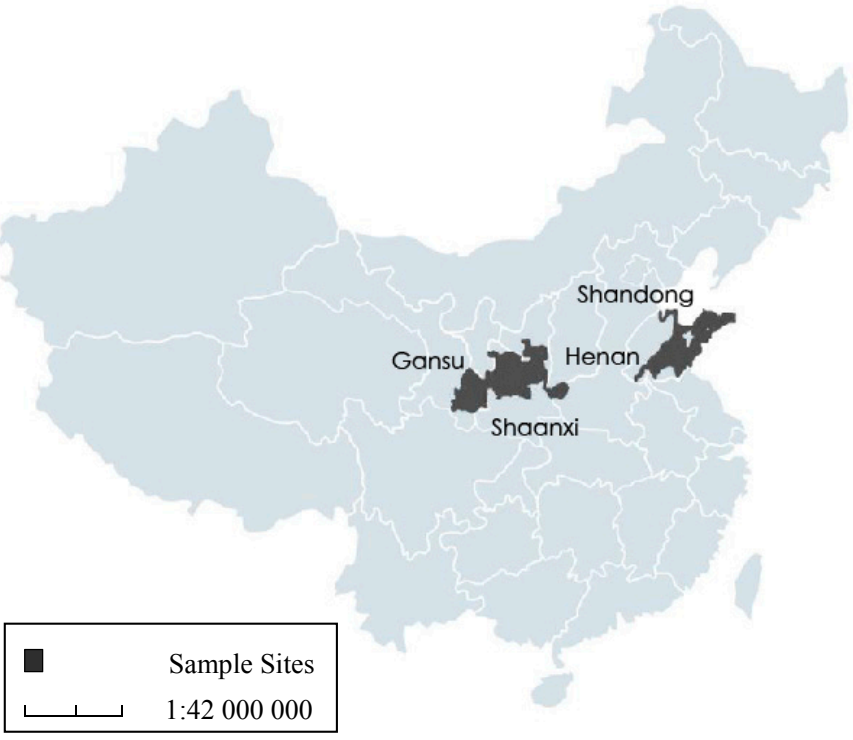

Figure 1. Geographic locations of sample sites.

Table 1 also demonstrates that small-scale farms make up a major part of production, even though renting land in slightly increases the size of land holding per capita. Furthermore, the average farm size of most apple farmers is less than one hectare. According to Hayami's research [25], commercial crops like sugarcane and pineapple have grown faster in Asia under the peasant mode of production than in the plantation system. Such observations point to higher production efficiency in small farms than large ones, even in the production of commercial crops. In the sites specialized in apple production,

high comparative profits stimulate farmers with tiny and fragmented farmland to optimize their operational scales through land markets. The average size of each plot was significantly larger for rented-in farmers than autarkic ones, which also shows that conglomeration is another force driving rent-in arrangements.

Table 1. Basic characteristics of the sample.

	Autarky (N = 851)		Rented-in (N = 190)		Total (N = 1041)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Inputs						
New equipment investment per mu (Y 1000)	1.94	1.81	1.85	1.90	1.88	1.98
Fertilizer per mu (Y 1000)	1.59	1.59	1.53	1.36	1.59	1.59
Manure per mu (Y 1000)	0.54	0.48	0.55	0.54	0.47	0.58
Other variable capital input per mu (Y 1000)	0.90	0.76	1.00	1.40	0.98	1.31
Cost of hired labor per mu (Y 1000)	0.79	0.98	2.41	20.75	1.08	8.88
Income makeup						
Per capita total income (Y 1000)	16.81	14.63	20.72	17.96	17.48	15.34
of which from apple production (percent)	80.44	27.73	83.73	25.75	81.06	27.39
of which from non-farm employment(percent)	15.28	26.22	11.87	23.52	14.64	25.77
of which from other(percent)	4.83	14.02	4.36	13.04	4.73	13.83
General characteristics						
Whether family members participate non-farm work (percent)	34.04	-	30.72	-	33.36	-
Output value per unit area (Y 1000)	10.05	7.69		9.95	6.94	7.69
Scale of finance via credit activity (Y 1000)	22.87	106.04	35.38	124.07	25.10	109.42
Farmland size per capita (mu)	2.44	2.15	3.29	3.28	2.59	2.44
Irrigable (percent)	62.14	-	65.10	-	63.13	-
Average size per plot (mu)	3.95	4.75	5.04	8.38	4.14	5.61
Household population size	4.34	1.57	4.46	1.64	4.37	1.59
Agricultural laborers	2.12	0.95	2.14	0.76	2.13	0.92
Apple sale price (Y/kg)	4.62	2.08	5.46	5.16	4.76	2.96
Household head age	50.48	9.55	48.47	7.88	50.43	9.31
Household head education level(1 = literacy; 2 = primary; 3 = junior middle; 4 = senior middle; 5 = bachelor)	2.89	0.88	2.85	0.75	2.89	0.85

Note: 1 mu = 0.06667 hectare; 1 Yuan = 0.1499 US dollar; There are 13 observations that rent land in and out at the same time, and 25 observations that rent land out which are excluded in Table 1.

3.2. General Characteristics of Land Rental Markets in Apple Production Sites

Table 2 illustrates that there is a gap between the incidence of land rented in and rented out, which means that, attracted by high comparative gains, apple producers have strong desire to rent land in for apple production, rather than the later. Land transactions in apple production sites are characterized by close geographical relationships; most transactions happen within the community, among relatives, friends or neighbors, mainly because information asymmetry drives high land market transaction costs. A rational way for farmers to overcome those costs is through their social networks.

Apples are a long-term perennial cash crop, which bears returns 3–5 years after planting, and can be harvested for 5–20 consecutive years, and most land lease lengths are consistent with this life cycle. It is also widely accepted that longer lease terms are associated with higher tenure security, encouraging long-term land-related investment and high productivity because their longer contract length assures tenants of the security of their tenure. Land tenure contracts within sample mainly included gift and fixed rents, and share-based contracts were not observed. Land transfers as gifts mostly happened among relatives and within other close social networks. Share-cropping contracts are rarely found in modern economies because they often trigger high monitoring and enforcement costs. At 84 percent, land contracts in written form took the majority, which may also imply that rental contracts are becoming increasingly formal. In addition, apple growers are more disposed to rent land in than subsistence farmers or grain producers because of the higher profits.

Table 2. Characteristics of apple growers' land rental market participation.

	Total (N = 1079)		Shandong (N = 359)		Gansu (N = 271)		Shaanxi (N = 358)		Henan (N = 91)	
	Freq	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**
Autarky	851	78.87	299	83.29	189	69.74	299	83.52	64	71.11
Land market participants	228	21.13	60	16.71	82	30.26	59	16.48	27	30.00
of which rented in	190	17.61	52	14.48	58	21.50	56	15.64	24	26.67
of which rented out	25	2.32	6	1.67	13	4.80	3	0.84	3	3.33
of which rented in and out	13	1.20	2	0.56	11	4.06	0	0.00	0	0.00
Scope of land rented										
Within villagers' group	148	64.91	38	63.33	53	64.63	32	54.24	25	92.59
Within village	43	18.86	16	26.67	5	6.10	20	33.90	2	7.41
Within town	26	11.40	6	10.00	15	18.29	5	8.47	0	0.00
Outside town	8	3.51	0	0.00	6	7.32	2	3.39	0	0.00
Others	3	1.32	0	0.00	3	3.66	0	0.00	0	0.00
Land rental partners										
Relatives	47	20.61	17	28.33	9	10.98	12	20.34	9	33.33
Acquaintance	33	14.47	8	13.33	18	21.95	5	8.47	2	7.41
General farmers	85	37.28	13	21.67	40	48.78	22	37.29	10	37.04
Enterprises	6	2.63	1	1.67	5	6.10	0	0.00	0	0.00
Village collectives	57	25.00	21	35.00	10	12.20	20	33.90	6	22.22
Land rental behavior organized by										
Farmers themselves	189	82.89	50	83.33	65	79.27	50	84.75	24	88.89
Local government	38	16.67	9	15.00	17	20.73	9	15.25	3	11.11
Rural organizations	1	0.44	1	1.67	0	0.00	0	0.00	0	0.00
Land contract form										
Oral	73	32.02	20	33.33	28	34.15	9	15.25	16	59.26
Written	154	67.54	40	66.67	53	64.63	50	84.75	11	40.74
Other	1	0.44	0	0.00	1	1.22	0	0.00	0	0.00
Land contract type										
Gift	17	7.46	4	6.67	7	8.54	5	8.47	1	3.70
Fixed rent	211	92.56	56	93.33	75	91.46	54	91.53	26	96.30
Land contract duration										
<5 years	28	12.28	7	11.67	5	6.10	14	23.73	2	7.41
5–20 years	129	56.58	25	41.67	60	73.17	29	49.15	15	55.56
>20 years	71	31.14	28	46.67	17	20.73	16	27.12	10	37.04
Crops planted before renting in										
Grain	74	38.95	19	36.54	19	32.76	21	35.59	4	16.67
Apple	122	44.21	31	59.62	39	67.24	33	55.93	19	79.17
Greenhouse	3	1.58	2	3.85	0	0.00	1	1.69	0	0.00
Other	29	15.26	8	15.38	0	0.00	4	6.78	4	16.67
Crops planted after renting in										
Grain	13	6.84	1	1.92	8	13.79	4	6.78	0	0.00
Apple	177	93.16	51	98.08	50	86.21	52	88.14	24	100.00

4. Conceptual Framework and Empirical Strategy

Based on the approach of Chamberlin and Ricker-Hilbert, we assume that a household maximizes utility by redistributing land in order to reduce the gap between its effective and expected land sizes [3]. Specifically, famers' desired land size is usually determined by productive assets, access to credit and insurance markets [1], labor endowment [26], and other heterogeneous characteristics. Land rental market participation decisions can thus be written as:

$$R_i = L^*(\mathbf{X}) + \lambda L + \mu \quad (1)$$

where $i = 1, 2$. R_1 and R_2, respectively, represent the discrete decision of whether or not to participate in the land market, and the amount of land rented in. When $R_1 = 1$, the household rents in land, and R_2 can be observed as well. Effective land endowment before renting in is indicated by L, and L^* represents the expected optimal land scale. $\mathbf{X}$ is the vector of variables that affect farmers' land market participation. We define pre-rental farm size as the amount of land for which a household has use and leasing rights. Generally, rich land endowments mean land scarcity does not constrain agricultural

production. In such circumstances, households have less motivation to participate in land rental markets. Therefore, we may predict that the coefficient on λ will be negative.

Other variables in **X** are defined as follow. Economies of scale are important driver of farmers' land market participation, because their presence (or absence) would systematically affect the shadow price of land for different farm size classes. Possible economies of scale could arise from the presence of indivisible factors of production or cost elements, leading to an initial range of farm size where the average cost of production declines with growth. Specifically, optimal farm sizes tend not to exceed the scale at which family labor is fully occupied and the costs of inseparable fixed productive assets are well shared. To achieve the economies of scale associated with land-related factors, crop production is generally organized on a scale corresponding to the optimum scale of farmers' productive assets and labor endowments, indicated, respectively, by K and H.

Households' access to credit and insurance are denoted by C and I. For small and fragmented landholders in a land-scarce economy, accesses to credit and insurance have two implications: loans from any source are helpful to alleviate low levels of fixed capital and improve on poor infrastructural development. On the one hand, credit market imperfections that increase the shadow price of credit for small producers would reduce their competitiveness in the land market, possibly outweighing the supervision cost advantage they enjoy. Households should thus be expected to use the rental markets to equilibrate the per-unit costs of land [27]. Access to agricultural insurance could reduce agricultural production risk to provide stable expectation and stimulate farmers' investment motivation. Therefore, one might predict that access to credit and access to insurance could have a positive effect on farmers' land rental market participation, particular to the area of land rented in.

Production environment variables are other determinants of farmer's land market participation [23]. Access to agricultural irrigation is denoted by W and labor saving technology adoption by T; apple sales price before renting land in is P and household members who participate in non-farm employment are denoted by O; the number of cultivate land plots is denoted by N; age of household head and education and geographic location are denoted by A, E, and G; and μ is the error term. G_1, G_2 and G_3 are the dummy variables of sample household location.

The linear expression of Equation (1) might be written as:

$$\begin{aligned} R_i \quad &= z_0 + z_1 L + z_2 K + z_3 C + z_4 H + z_5 W + z_6 I + z_7 T + z_8 N + z_9 P \\ &\quad + z_{10} O + z_{11} A + z_{12} E + z_{13} G_1 + z_{14} G_2 + z_{15} G_3 + v \end{aligned} \tag{2}$$

where R_1 and R_2 represent, respectively, the discrete decision of whether or not to participate in the land market, and the amount of land rented in, and v is the error term. Both Probit and Tobit models will be used to estimate the determinants of farmers' land market participation. It should be noted here that the significance of $\hat{z}_3$ and $\hat{z}_1$ have important policy implications for equity and efficiency. A positive and significant $\hat{z}_3$ implies that credit access plays an important role in explaining the low concentration of land rent in specialized agricultural production areas, so rural credit reform would help activate land rental markets. The significance and magnitude of z_1 are used to test the hypothesis that rental markets redistribute land from households with rich labor endowment to those with labor scarcity.

Our final step is to illustrate how land market participation affects households' land-related investments and farm productivity. Investment indicators are measured by the machinery investment (e.g., investment on tractor, trench digger, under-tree tiller, pesticide sprayer, and field mower) after renting land in. The resulting empirical model is expressed as:

$$Y = \delta_0 + \delta_1 K + \delta_2 R + \delta_3 L + \delta_4 H + \delta_5 I + \delta_6 W + \delta_7 G_1 + \delta_8 G_2 + \delta_9 G_3 + \zeta \tag{3}$$

where δ is the vector of coefficients to be estimated and ζ is the error term. Considering that households' land transfer decisions are endogenous to some specific characteristics like capability and fixed assets, we must properly address the potential bias. Based on the approach of Wooldridge, the Instrumental

Variable (IV) method is used to overcome this concern [28]. The IV model of Equation (3) can be written as:

$$Y = \beta_0 + \beta_1 K + \beta_2 R_{IV} + \beta_3 L + \beta_4 H + \beta_5 I + \beta_6 W + \beta_7 G_1 + \beta_8 G_2 + \beta_9 G_3 + \zeta \quad (4)$$

where R_{IV} is the instrumental variable of R; β includes the relevant coefficients to be estimated with β_0 being the intercept; and τ is the error term.

Using aggregated community- or regional-level information to lessen endogeneity of micro survey data is common in microeconometrics [29], given the fact that households' decisions are usually affected by the surrounding environment but not vice versa. Following Li and Song (2016), thus, we choose "the occurrence rate of the households renting land in or out at the community level" as an instrumental variable of R [30]. Our empirical analysis indicates that renting land in or out decisions are indeed embedded in the community social network in rural China [31]. This suggests that R_{IV} and R are associated, while the former is independent of the latter [30].

Meanwhile, we will also estimate the effect from renting land in on farmer households' welfare. The economic welfare is indicated by average apple income per mu (1 mu = 0.06667 hectare), total household off farm income, total household income, and total household expenditure. A reduced-form function is applied to quantify the causal relationship. The empirical model is:

$$Y = \lambda_0 + \lambda_1 K + \lambda_2 R + \lambda_3 L + \lambda_4 H + \lambda_5 I + \lambda_6 W + \lambda_7 G_1 + \lambda_8 G_2 + \lambda_9 G_3 + \rho \quad (5)$$

where λ are the relevant coefficients to be estimated and ρ is the error term.

The IV model of Equation (5) could thus be:

$$Y = \kappa_0 + \kappa_1 K + \kappa_2 R_{IV} + \kappa_3 L + \kappa_4 H + \kappa_5 I + \kappa_6 W + \kappa_7 G_1 + \kappa_8 G_2 + \kappa_9 G_3 + \varsigma \quad (6)$$

where κ represent the coefficients to be estimated and ς is the error term.

5. Empirical Results

5.1. Determinants of Renting in

We first tested the collinearity of independence variables. The correlation matrix indicates that the variance inflation factor is less than 5, which suggests that collinearity problem is not severe and further empirical analysis can be carried out. Table 3 presents the results of evaluating the determinants of renting-in decision using the Probit model, and the area rented in using the Tobit Model. We find that having more cultivated land before renting in has a negative effect on the area of rented-in at the significance level of 1%, indicating that land rental markets in specialized apple production sites increase the amount of land available to the land-scarce growers. It should be noted that in the presence of scale economies, liberalization of land rental markets might lead to large-scale land concentration, thereby depriving poor households' access to land. Our finding is consistent with Jin and Deininger [20], and Deininger and Jin [23], in which the authors define the effect of resources transfers from relatively land-rich to land-poor households as an equity effect of land rental markets.

We also find that the value of inseparable productive assets plays a positive role in land rental decisions, as households with higher value of machinery are significantly more likely to rent land in. This finding implies that better utilizing the fixed costs of machinery investment motivates households to expand their scale by renting land in. Meanwhile, an expanded scale also requires further investments in machinery to substitute for scarce labor. In most countries, a staircase effect has occurred between land scale and fixed investments, driving expansion in farm scale.

Table 3. Determinants of renting land in.

	Probit Model	Tobit Model
Effective cultivated land before renting in (mu)	−0.0266 ***	−0.8577 ***
	(−3.04)	(−5.54)
Value of productive assets (Y 1000)	0.0130 ***	0.4553 ***
	(2.92)	(6.6)
Number of household agricultural laborers	0.0200	0.1684
	(0.38)	(0.18)
Financing scale via credit (Y 1000)	0.0003	0.0259 ***
	(0.81)	(4.91)
Access to agricultural insurance(=1)	−0.0028	4.1181 **
	(−0.02)	(2.19)
Access to agricultural irrigation (=1)	0.0720	−0.7208
	(0.58)	(−0.36)
Number of cultivated land plots	0.0357 ***	0.3811 ***
	(3.07)	(2.81)
Adoption of labor saving technology (=1)	1.5224 **	18.8721 **
	(2.14)	(2.14)
Apple sale price before renting land in	0.0945 ***	0.9886 **
	(2.77)	(2.41)
Household members participate in nonfarm employment (=1)	−0.0667	−1.3569
	(−0.63)	(−0.79)
Age of household head	−0.0134 **	−0.2412 ***
	(−2.49)	(−2.69)
Education level of household head	−0.0880	−0.7479
	(−1.49)	(−0.78)
Located in Shaanxi Province (=1)	−0.5031 ***	−4.1335
	(−2.75)	(−1.38)
Located in Gansu Province (=1)	−0.5222	−7.3486 **
	(−2.66	(−2.24)
Located in Shandong Province (=1)	−0.8752 ***	−11.9563 ***
	(−4.8)	(−3.98)
Constant	0.1679	1.0606
	(0.39)	(0.15)
Number of observation	1040	1040
Log likelihood	−423.3955	−874.2939
LR	152.98	120.85
Prob > Chi2	0.0000	0.0000
Pseudo R^2	0.1249	0.0804

Note: Likelihood Ration is a statistic that can be used to test relevant hypotheses when the constrained and unconstrained models have been estimated through a maximum likelihood method. The statistic is twice the difference between the unconstrained and constrained log-likelihoods. Prob > Chi2 gives the probability of accepting a null hypothesis. Pseudo R^2 is a goodness-of-fit measure for limited dependent variable models. Numbers in parentheses are z values. *** $p < 0.01$; ** $p < 0.05$.

Another finding of interest is that neither agricultural labor endowment nor nonfarm employment affects the amount of land rented in or the discrete decision. This result differs from most research results on Africa, such as Lunduka et al. for Malawi [32], Chamberlin and Jacob for Malawi [3] and Zambia, and Jin and Jayne for Kenya [33]. Contrary to this study, they show that labor endowment is another factor pivotal for households to be able to access the land markets. That is, households with richer labor endowments are more likely to rent land in. The reason for this difference might be that family laborers within sample sites are easily substituted by labor-saving equipment, dwarfing adoption of cultivation technology and the hiring of labor from rural markets. In other words, having less household labor does not constrain production substantially because labor markets outside the household and fixed investments can be used to equilibrate labor inputs. This substitution effect suggests a relatively low valuation of household labor and that household labor endowments do not create absolute competitive advantages in perennial cash crop production.

The positive and significant coefficients for access to credit and insurance respectively indicate that households with more capital, who may be able to rent more land in, intensify land usage by utilizing higher levels of purchased inputs such as machinery and fertilizer. This result indicates that land, credit and insurance have to be analyzed together. Improvements in rural credit will simultaneously stimulate land rental development.

We also find that land consolidation is another driving force for household land decisions. The long-observed positive relationship between plot size and output for major crops in China suggests that fragmentation has imposed a significant cost [34]. Land transfer via the rental market is an effective choice to overcome the inefficiency it causes. Therefore, households with small plots are more likely to rent land in.

5.2. Impacts of Land Tenure on Agricultural Investment

Fixed investment is measured by the aggregate value of all types of a household's productive investments within the two years prior to study. This aggregation allows fixed investment to be treated as a continuous variable, with consequently richer options for empirical analysis. To check the robustness of the endogeneity correction, we applied the Durbin-Wu-Hausman test with one potentially endogenous regressor, "the size of land rented in", instrumented by "the occurrence rate of the households renting land in or out at the community level" [30]. The test statistic F(1, 1079) = 26.344 (p = 0.0000) led to a rejection of the null hypothesis that land transaction is exogenous.

Table 4 shows the Least Square and IV regressions for the factors affecting fixed investments. The results indicate that greater land endowment and more land rented in have significant effects on households' fixed investments. The significance of farm size may be due to supply or demand effects. On the supply side, greater farm size leads to higher income or capital flows; on the demand side, larger farm size necessitates or perhaps affords the opportunity for greater investments. Expanding farm size by renting land in requires more investment to substitute for relatively scare labor and other factors.

Another interesting result is the significant and positive effect of credit access on fixed investment. This implies that access to credit has a statistically significant role in determining the investment behavior of farmers, thus showing that credit requirements in the farming sector have increased rapidly over the past few decades resulting from the increase in mechanization and rise in equipment prices. More access to credit will be beneficial for households to avoid the development trap and smooth intertemporal investment and consumption.

The significance of crop insurance is mainly due to it reducing expected income shocks from various natural risks. In particular, crop insurance schemes may be launched to cover farmers against losses from drought, pest attacks, hailstorms, thunderstorms, heavy rains, and other natural hazards, with the payment of small premiums in addition to credit markup [35]. Based on the abovementioned empirical evidence, we have reason to believe that differential access to credit plays an important role in explaining observed differences in fixed input use in developing countries. An important policy implication of this result is that rural development and increases in investment must originate from agricultural credit and insurance reform.

Table 4. Determinants of fixed investment.

	OLS	IV
Scale of land rented in (mu)	0.3753 ***	
	(8.92)	
Happening rate of renting land in the community level		4.9119 ***
		(8.85)
Scale of land before renting in (mu)	0.1570 ***	0.6817 ***
	(3.74)	(4.28)
Number of household agricultural laborers	0.4974 *	0.3737
	(1.67)	(0.36)
Financing scale via credit (Y 1000)	0.0013	0.0900 ***
	(0.50)	(6.45)
Access to agricultural insurance (=1)	0.7582	4.9637 **
	(1.09)	(1.97)
Access to agricultural irrigation (=1)	−1.1216	−0.1817
	(−1.55)	(−0.07)
Number of cultivated land plots	0.0914	0.0409
	(1.53)	(0.2)
Apple sale price before renting land in	−0.0003	−1.0262
	(0.00)	(−1.52)
Household members participate in nonfarm employment (=1)	−0.6131	1.7501
	(−1.01)	(0.82)
Age of household head	−0.1195 ***	0.0559
	(−3.89)	(0.51)
Education level of household head	0.2391	0.2202
	(0.72)	(0.19)
Located in Shaanxi Province (=1)	0.1550	−1.1597
	(0.13)	(−0.29)
Located in Gansu Province (=1)	2.8881 **	4.7879
	(2.40)	(1.14)
Located in Shandong Province (=1)	0.2183	7.4623 *
	(0.19)	(1.86)
Constant	12.3879 ***	−4.6674
	(4.90)	(−0.52)
Number of observation	1040	1040
R^2	0.1770	0.0829
Adjusted R^2	0.1640	0.0631

Note: R^2 means the fraction of the variation in the dependent variable that is explained by the explanatory variables. Adjusted R^2 means a goodness-of-fit measure in multiple regression analysis that penalizes additional explanatory variables by using a degrees of freedom adjustment in estimating the error variance. Numbers shown in parenthesis are *t* and *z* values. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

5.3. Impacts of Land Tenure on Farm Productivity and Income

The previous statistical evidence suggests a positive correlation between renting land in and household welfare, but identifying whether or not that correlation is causal requires further analysis quantifying the directions and magnitudes of these effects using micro survey data. Table 5 presents the empirical results of model (5) and (6) and demonstrates the effects of renting land in on households' apple production income, off-farm employment income, total income and expenditure, respectively. Comparing OLS and IV estimates suggests that endogeneity in land decisions might have caused the welfare gains from rental market participation to be underestimated. Unconstrained access to land rental markets would significantly improve household agricultural income on the tenant side. Each additional mu rented in creates an extra 2440 yuan RMB in income on average, indicating that land rental is closely linked to agricultural revenue.

Table 5. Regression estimates of factors affecting the value of apple production.

	Apple Production		**Off-Farm Income**		**Total Household Income**		**Total Household Expenditure**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Value of productive assets (Y 1000)	0.5945 ***	0.2339	−0.0327	0.1323	0.5812 ***	0.1323	0.0921	−0.6565 ***
	(3.80)	(1.14)	(−0.43)	(1.33)	(2.78)	(1.33)	(0.63)	(−3.09)
Scale of land rented in	0.7392 ***		−0.1629		2.8089 ***		0.6300 ***	
	(3.43)		(−1.57)		(9.72)		(3.16)	
Happening rate of renting land in the community level		2.4407 ***		−0.9947 ***		−0.9947 ***		4.2194 ***
		(3.51)		(−2.96)		(−2.96)		(5.90)
Scale of land before renting in	−0.1195	0.2076	0.3921 ***	0.2653 **	0.8435 ***	0.2653 **	0.3060	0.9030 ***
	(−0.54)	(0.82)	(3.67)	(2.17)	(2.84)	(2.17)	(1.48)	(3.45)
Number of household agricultural laborers	4.4941 ***	4.5350 ***	−2.0771 ***	−2.0439 ***	1.7521	−2.0439 ***	1.7481	1.8737
	(2.86)	(2.79)	(−2.74)	(−2.60)	(0.83)	(−2.60)	(1.20)	(1.12)
Access to agricultural insurance (=1)	3.6389	1.8705	0.6477	1.6752	4.4594	1.6752	6.8174 **	1.3582
	(1.00)	(0.48)	(0.37)	(0.88)	(0.91)	(0.88)	(2.00)	(0.33)
Access to agricultural irrigation (=1)	10.5063 ***	10.5306 ***	−0.5929	−0.8135	14.9023 ***	−0.8135	−1.7947	−2.2361
	(2.75)	(2.68)	(−0.32)	(−0.43)	(2.92)	(−0.43)	(−0.51)	(−0.55)
Located in Shaanxi Province (=1)	1.7260	−1.3751	3.4909	3.9798	9.6018	3.9798	7.7095	4.6405
	(0.30)	(−0.23)	(1.24)	(1.35)	(1.23)	(1.35)	(1.41)	(0.73)
Located in Gansu Province (=1)	14.6794 **	13.7299 **	−5.4036 *	−5.9040 *	13.1751	−5.9040 *	20.4048 ***	22.4347 ***
	(2.36)	(2.11)	(−1.80)	(−1.88)	(1.58)	(−1.88)	(3.50)	(3.33)
Locates in Shandong Province (=1)	16.7883 ***	16.8599 ***	−8.2286 ***	−9.5611 ***	16.0709 **	−9.5611 ***	1.3426	5.9159
	(3.00)	(2.85)	(−3.05)	(−3.35)	(2.14)	(−3.35)	(0.26)	(0.97)
Constant	16.8580 **	17.9667 **	16.5556 ***	17.2109 ***	31.2474 ***	17.2109 ***	28.8685 ***	27.3485 ***
	(2.37)	(2.44)	(4.84)	(4.85)	(3.28)	(4.85)	(4.37)	(3.60)
Number of observation	1040	1040	1040	1040	1040	1040	1040	1040
R^2	0.0584	0.1133	0.5391	0.5086	0.1471	0.2970	0.1154	0.0352
Adjusted R^2	0.0446	0.1005	0.5324	0.5058	0.1347	0.2978	0.1027	0.0213

Note: Numbers shown in parenthesis are *t* values and z values. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

Table 5 also reports the relationship between land rented in and off-farm employment income. Given the relatively high profit margins of apple production, devoting more land to apple growth will increase the shadow price of off-farm work. Thus, the intensity of land renting-in has significantly negative effects on households' off-farm income. Renting land in has a strong positive association with total family income and expenditure, indicating that greater land size might lead to more cash flows, relieving farmers' cash constraints and activating their willingness to consume. Taken together, Table 5 provide strong evidence that renting land in from market produces large welfare gains on average. Furthermore, land rented substitutes, rather than compensates, for off-farm employment.

6. Conclusions and Policy Implications

Compared with other crop production, apple production usually entails more land-related investment, implying that tenure arrangements and duration might be more active and complex. Clarifying the role of land rental activities in apple production will therefore be quite helpful towards understanding the mechanisms, functions and efficiency of general land markets in China. Therefore, the research purposes of this paper are to identify the determinants affecting apple growers' decisions to rent land in and how much to rent in, and to quantify the effects of renting in on households' welfare. The relevant data are collected within specialized apple production sites in Northern China, not only because the apple industry is important to Northern China's rural economy, contributing to income increases and supplying four-tenths of the world's total production, but also because little attention has been paid to the function and role of land rental markets in high value-added crop sectors, where such markets tend to be more competitive. Our empirical analysis enables us to draw the following main conclusions.

First, we find that land area owned by households, inseparable productive assets, access to credit and insurance, and land fragmentation, have significant effects on households' participation in the land market. Interestingly, in contrast to the results from Africa, our findings imply that neither agricultural labor endowment nor nonfarm employment affect the amount of land rented in, or the discrete decision to rent in. The reason for these differences might be that household laborers within our sample sites are easily substituted by investment in labor-saving equipment, dwarfing the impact of adoption of cultivation technology and labor hired from rural markets. From the policy perspective, we see that the direction of land redistribution is from households with higher land endowments to those with less; on the other hand, land, credit and insurance have to be examined together.

Our second finding is that farm households with rich land endowments or large scale of land rented in usually invest more in fixed inputs. Efficient supply of both credit and insurance helps to make larger investments. Thus, access to various forms of credit and agricultural insurance contributes to explaining the observed differences in fixed input use in developing countries. An important policy implication of this result is that rural development and investment increases may have to originate from agricultural credit and insurance reform.

Finally, renting land in from markets will result in significant welfare gains, including household agricultural income, total income, and expenditures. In other words, land rental markets have high potential to improve agricultural productivity and augment the welfare of smallholders.

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