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Land Rental Markets, Specialization, and Rural Household Income: Evidence from the North China Plain

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Using panel data for the years 2013, 2015, and 2017 collected through field surveys in eight counties in the North China Plain, we examine the relationship between smallholders' land rental behavior and their (agricultural) incomes, with a particular focus on heterogeneous specialization among smallholders. We find that farming-specialized households experience a significant higher increase in agricultural income and a larger decrease in poverty incidence by renting in land than nonspecialized households. Off-farm specialized households had a decreased likelihood of being poor by renting out land, whereas nonspecialized households experienced no decrease in poverty incidence after renting out land.

Key words: heterogeneous effects, livelihood strategy, smallholders

Introduction

Despite tremendous progress alleviating extreme poverty around the world, poverty rates remain stubbornly high in low-income countries (World Bank, 2018). Farmland is a vital productive asset of rural communities in developing countries, which has made redistributive land policies a priority in reducing poverty and raising economic equality (de Janvry and Sadoulet, 2001). Among existing reforms, the land rental market enables households to access more land with a relatively low financial burden (Holden and Otsuka, 2014), while also contributing to income enhancement and poverty reduction (Mendola and Simtowe, 2015).

Studies in sub-Saharan African and Southeast Asian countries have shown that land rental markets serve as a mechanism by which farmland can be transferred from land-rich to land-poor households.[1] In countries where agricultural production is the main source of rural income, land accessibility is recognized as a necessary condition for income growth and poverty alleviation

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[1] See Muraoka, Jin, and Jayne (2018) for Kenya, Ainembabazi and Angelsen (2016) for Uganda, Wineman and Liverpool-Tasie (2017) for Tanzania, Deininger and Jin (2008) for Vietnam, Deininger, Jin, and Nagarajan (2008) for India.

(Wineman and Liverpool-Tasie, 2017). However, as wage rates increase, the agricultural sector inevitably faces a declining comparative advantage in many developing countries (Takahashi, Chang, and Shobayashi, 2018). Additionally, an increasing share of rural household income is generated from off-farm activities (Davis et al., 2010). As a result, income disparity becomes disconnected from land disparity (Huang et al., 2019). However, under these new economic circumstances, the effects of land rental markets on rural households' income and poverty may change, and the results might become heterogeneous.

This paper takes the North China Plain as a particular case for examining the effects of land rental markets on rural household income. With rising wages and declining agricultural comparative advantage in China (Wang et al., 2016; Huang et al., 2019), off-farm activities are sought by the rural poor (Wang, Huang, and Rozelle, 2017). The agricultural sector's contribution to the economy, in terms of gross domestic product (GDP), declined from 40% in 1970 to less than 10% in 2013 (Deininger et al., 2014). Correspondingly, rural poverty and income disparity are becoming new challenges, attracting a great deal of attention from policy makers. For instance, in 2014, 70.17 million people in China lived below the national poverty line (2,300 RMB per capita; Liu, Liu, and Zhou, 2017). The land rental market is treated as the primary solution for rural poverty (Yuan et al., 2018).[2] Calls for policy changes promoting large-scale agricultural production through land rental markets have become more demanding (Li et al., 2013).

There are extensive studies examining the effects of land rental markets on rural household incomes in China; however, the conclusions are rather inconsistent. For instance, Hou, Huo, and Yin (2017) found that renting in land increases household agricultural and total income. While Zhang et al. (2018) found that renting-out households had lower total income compared to nonrenting households, renting-in households on average obtained the largest benefits in total income. There are several potential reasons for such inconsistent findings. First, most existing studies focused on specific regions within China, and the effect of land rental markets on household income is context-dependent. Second, most early studies were based on cross-sectional data (Hou, Huo, and Yin, 2017; Zhang et al., 2018; Zhang, 2008), and panel data were rarely used. Practically, if unobserved covariates affected both land-renting behavior and household income, the cross-sectional data might have a serious endogeneity problem (Zhang et al., 2018), which could yield contradictory findings. Third, households with different resources are increasingly becoming specialized in certain sectors, and households with different livelihood strategies may exhibit different objectives, resource utilizations, and income outcomes. However, existing studies seldom take such heterogeneity into account when exploring the effects of land-renting behavior on household income.

This paper aims to explore the effects of land-renting behavior on household income, with an explicit focus on the diverse specialization of household livelihood strategy. To address the potential endogeneity issue, an instrumental variable approach will be applied, in combination with a fixed effect panel data model. The fixed effect model can be an effective estimator to control potential endogeneity due to time-invariant omitted variables (e.g., household asset levels, market accessibility), which affect household incomes. A number of income equations were estimated based on panel data collected in the provinces of Henan and Shandong for the years 2013, 2015, and 2017. Variables indicating land-renting behavior and household specialization status are included in the model as the main explanatory variables.

The results show that land renting in played an important role in increasing household total (agricultural) income and reducing rural poverty. However, there was significant heterogeneity with farming-specialized households experiencing a significant progressive increase in household income from land renting in. Meanwhile, land renting out by off-farm specialized households significantly increases total income and reduces the likelihood of being poor (using the international high poverty line), whereas land renting out does not affect the household total income and poverty status among nonspecialized households.

[2] In China, the Rural Land Contracting Law states that the ownership of farmland can never be changed; only the management rights can be transferred, with contractual rights retained by the lessor (Lyu, Chen, and Zhang, 2019).

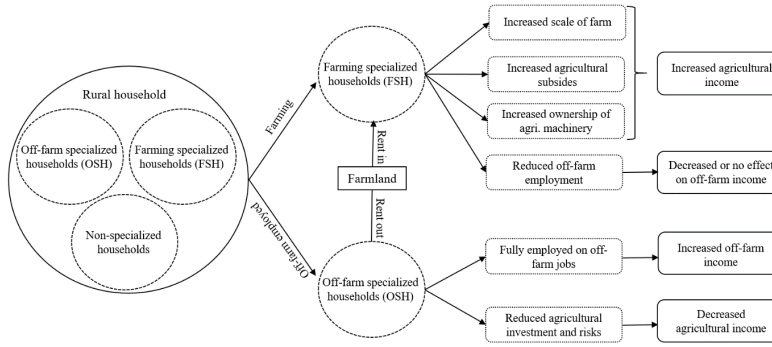

Figure 1. Conceptual Framework of Households' Specialization and Income Change

An Analytical Framework

The Chinese government has issued various policies promoting the development of land rental markets (Liu et al., 2017). Since 2012, the government has been piloting a land titling program with the expectation to enhance the development of land rental markets by securing land tenure rights. Then, a further separation of land use rights into contract rights and tradable management rights was implemented in 2016 (e.g., Wang et al., 2018; Lyu, Chen, and Zhang, 2019). These programs have led to the rapid development of land rental markets. The transfer rate of arable land soared to 35% by the end of 2016, with more than 70 million households participating in rural land rental markets (Wei and Yan, 2017). To analyze the heterogeneous effects of land renting on household income, a simple analytical framework was established.

Specialization and Household Land-Renting Behavior

In an open rural economy, households are not constrained exclusively to farming but can also be employed in off-farm sectors. This is especially the case in China, where the number of migrant workers has risen over the last 3 decades. During this time, a household's comparative advantage, in either agricultural production or off-farm employment, evolved and became stronger given its heterogeneous resources. Such resources include a household's natural, human, physical, financial, and social capital, access to markets for agricultural production, and the agro-ecological conditions, policies, and institutions it faces. In other words, farming and off-farm specialization strategies depend to a large extent on relatively long-term factors, and household specialization is quite stable over the long run. Once there is a comparative advantage, households will further reinforce their position, specializing in farming or off-farm employment. Land is one essential resource for which households with different specializations must make adjustments through market channels, given that total available land is constrained within a certain space and time (Yao, 2000). A well-functioning land rental market enables rural households to transfer land to maximize total income (Zhang et al., 2018). Land renting decisions by economically rational farmers are, therefore, determined by their comparative advantages (Zhang et al., 2020).

As shown in Figure 1, it is assumed that there are three types of rural households, including farming-specialized households (FSH), off-farm specialized households (OSH), and nonspecialized households. To FSH, specializing in farming indicates that they earn more agricultural income with more advantage in farming. In this case, they are often motivated to rent in more land to increase total income. For OSH, the opportunity costs of farming (instead of off-farm employment) might be significantly higher than their actual earnings from farming. In this situation, holding farmland might, in fact, decrease household income. When taking these heterogeneities in livelihood strategies into account, the effects of land rentals on household income might be significantly different.

FSH, Land Renting In, and Household Income

Renting in land is expected to be more profitable for FSH than for other households. First, compared to OSH and nonspecialized households, FSH often spend more time on farming-related activities and their income is primarily from farming. Nonspecialized households may rent in land that would otherwise be left idle by relatives or friends from extended family to secure the land tenure rights (Tang et al., 2019),[3] and they have low agricultural productivity in general. In contrast, FSH that rent in land tend to focus on realizing economies of scale as a way to increase agricultural productivity (Ji et al., 2018). FSH with more arable land are more willing to adopt new technologies, acquire advanced farming knowledge, and pay more attention to productive technology improvements (Hu et al., 2022).

Second, FSH tend to invest more in advanced farming machinery after land renting in, such as tractors and combine harvesters, while nonspecialized households are often reluctant to invest (Wang et al., 2016). The use of large machinery not only reduces production costs but also allows the service provision to nonspecialized households on a fee-for-service basis. In fact, many service providers make this bulk capital good accessible to Chinese rural households on a rental basis (Zhang, Yang, and Thomas, 2017).

Third, FSH often receive more agricultural subsidies with expansion of farm size. According to the guidelines set by China's Ministry of Finance, grain subsidies are given to the tenants farming the land rather than the contractors of the farmland (Zhang et al., 2020). A study conducted in nine Chinese provinces showed that more than one-third of direct grain subsidies were paid to actual operators (Zou, Mishra, and Luo, 2020). To promote agricultural modernization, some subsidies are available only to large-scale FSH (Yi, Sun, and Zhou, 2015). Taking the above observations into account, the following hypothesis was formulated:

Hypothesis 1. *Farming-specialized households (FSH) experience a higher increase in household income than nonspecialized households from land renting in.*

OSH, Land Renting Out, and Household Income

For OSH, holding land is becoming an irrational option because OSH are equipped with more advantages in earning income from off-farm jobs. Recent studies showed that increasing off-farm wages contributed to a significant reduction in poverty, particularly in China (Mat, Jalil, and Harun, 2012; Liu, Liu, and Zhou, 2017). Farming is becoming a secondary source of income, and wages are far exceeding profits from farming. Especially when employment in the off-farm sector increases, more rural households are expected to rent out part or all of their land in order to be fully employed in the off-farm sector.

OSH are motivated to rent out their land when there is a proper market price, and their operational size will decrease, even to 0. When land rental income is large enough to compensate for the loss of crop production profits and agricultural subsidies, OSH might actually increase their agricultural income. The comparative advantage of OSH in off-farm activities makes the gain from renting out land—and from shifting more labor time to off-farm employment—far larger than that for nonspecialized households. In contrast, nonspecialized households might rent out part of land due to old age or other uncontrollable reasons, and there is almost no significant income increase without labor migration to off-farm sectors. Thus, this leads to the second hypothesis:

Hypothesis 2. *Off-farm specialized households (OSH) obtain higher income growth than nonspecialized households through land renting out.*

[3] Since most migrated smallholders still wish to return to hometowns in the future, it is rational for them to rent out land to relatives or friends for little or no compensation to secure a claim on the land (Wang et al., 2021).

Data Collection

Sampling and Data Collection

The dataset was collected from 621 households during three rounds of field surveys in 2013, 2015, and 2017. The Henan and Shandong provinces were specifically selected for three reasons. First, the farming areas of these two provinces are typical of the North China Plain, with smallholders the dominant farming group. Second, the land rental market in these two provinces has been developing rapidly. By 2017, the rate of contracted land transferred equaled 32%–35% (Tuliu, 2016). Third, there is an obvious gap between agricultural revenue and off-farm wages in these two provinces. Off-farm employment is a primary livelihood strategy for many rural households to cope with scarce land resources (Deng, Li, and Zhang, 2020). The probability proportional to size was adopted to sample the households in four steps. More detail about the field survey can be found in Wang et al. (2021).

The field survey was conducted thr"ugh 'ace-to-face interviews. From June to August in 2013, 621 households were interviewed. In 2015 and 2017, two rounds of follow-up surveys were conducted. Finally, 559 households were tracked in 2015, and 550 households in 2017, representing 90.0% and 88.6% of the baseline sample size, respectively. Four observations were dropped from the analysis due to either negative agricultural income (in one case) or extremely large farms (84.3 hectares), with an agricultural income over 2.3 million RMB. In sum, the sample used for analysis consists of 1,726 observations, 618 from 2013, 558 from 2015, and 550 from 2017. Table S1 in the online supplement (see www.jareonline.org) presents detailed definition and measurement of the variables.

A regression analysis was performed to examine potential attrition bias. The dependent variable was a dummy variable, indicating whether a baseline household was reinterviewed in the second and third round of the survey, with the explanatory variables comprising those used in the empirical analysis. Table S2 reports regression results. The results show that, none of the explanatory variables are statistically significant with respect to the reinterviewed dummy variable. This finding suggests that the attritions of two rounds follow-up surveys are unlikely to have had much impact on the empirical analysis of this study, although efficiency might be affected due to reduced sample size.

Measuring Household Income and Poverty Status

It is assumed that a rural household's total income comes from two main sources: (i) agricultural income, which includes income from crop production and other sources (e.g., raising livestock, forestry, fishery, agricultural machinery services, net land rentals, and agricultural subsidies) and (ii) off-farm income, which includes nonfarm employment wages, retirement pensions, business income, transfer income, and nonagricultural subsidies (e.g., rural senior living allowance, low income subsidy).

To calculate agricultural income, the revenue of each crop was calculated by multiplying the output and its market price. For households that harvested crops for self-consumption, revenue was calculated using the average village price. Subtracting the corresponding costs gives the income of each crop; then, all crop income was added together to get total crop income. Adding in other types of agricultural income, resulted in total agricultural income. Off-farm income was calculated for each household member with off-farm employment. Additionally, if the household had a retirement pension, business income, or other related transfer income, it was included as off-farm income. Adding together household agricultural income and off-farm income results in total income.

Another group of outcomes that we are interested was household poverty status. In 2015, the World Bank updated the international poverty line, establishing three poverty lines: US$1.9/day (extreme poverty line), US$3.2/day, and US$5.5/day (World Bank, 2015). Given that the extreme poverty rate in China was only 0.7% in 2015 (World Bank, 2018), the upper two lines were used to define poverty in this study. To be specific, household poverty status was measured with two binary

outcomes. First, if a household's total income per capita per day was below US$5.5 (21 RMB), it was defined as rural poor (with an upper bound).[4] Second, if a household's total income per capita per day was lower than US$3.2 (12.2 RMB), it was defined as rural poor (with a middle bound). Two thresholds were used as a double-check on robustness. If there was a significant correlation between land-renting behavior and household income, adopting two thresholds can further show which group of rural households benefit the most from land transfer.

Defining Household Specialization

Previous studies often define household specialization according to income source (Zhang, Peng, and Kong, 2019), but simply categorizing rural households in this way may be misleading (Liu et al., 2020). On one hand, household incomes are the dependent variables of interest, hence it would cause endogeneity problem if income resources were used to define FSH and OSH. On the other hand, the income source has low connection with specialization because of the generational differences within the family. Specifically, younger, unmarried family members are more likely to be employed in the off-farm sector in rural China. However, younger generations tend to have fewer responsibilities within the family; compared to household heads, their occupations have limited influence on a household's livelihood strategy (Wang, Qiu, and Yu, 2019). To serve as a better proxy of household livelihood strategy, this study focuses on the head of household's main occupation.

Considering the significant differences between agricultural revenue and off-farm wages, specialization is defined according to the household head's time allocation during the year. First, if the household head spent at least 185 days (more than half a year) on farming or off-farm employment,[5] then the household is likely to have adopted a specialized livelihood strategy. Second, with the household livelihood strategy remaining stable, the three-period panel of data was leveraged instead of using a 1-year time allocation, two periods were used as the minimum requirement. Specifically, if a household head spent more than 185 days working on-farm for at least two periods, the household was categorized as an FSH. The same strategy was applied to OSH; if a household head spent more than 185 days doing off-farm work for at least two periods, the household was categorized as an OSH. Households that were neither FSH nor OSH were defined as nonspecialized households. Overall, the survey found that the majority of rural households are nonspecialized households (about 70%), with a slightly higher number of FSH (17%) than OSH (about 13%).

Estimation Strategy

To examine the relationship between land-renting behavior and household income by taking into account the heterogeneity of household specialization, the following two groups of analysis were performed. First, the relationships between land-renting behavior and (i) household income and (ii) poverty status were examined. Second, the analysis went deeper to examine the heterogeneous relationships between land-renting behavior and (i) rural household income and (ii) poverty status, considering the distinctions among FSH, OSH, and nonspecialized households. These two groups of analyses help identify how heterogeneity in household specialization influences the observed effects of land rental markets on rural household income and poverty status.

[4] The poverty line is calculated using the converted value of US dollars into Chinese yuan (RMB) according to purchasing power, instead of exchange rate.

[5] The threshold of 185 days was set mainly for identification. Typically, farmers in the North China Plain plant wheat (winter) and maize (summer) in rotation, and there is almost no farmland idle all year round. If a household farms as the main livelihood strategy, irrigation, fertilization, pest control, and daily management are all essential to get expected yields. In practice, the farm's work, especially for daily management, is spread throughout the year. Therefore, a minimum of 6 months is needed for attentive farming, and it would be difficult for households to concurrently maintain stable off-farm employment. We have also tested other cut-off points and found consistent conclusions.

Land-Renting Behavior, Household Income, and Poverty Status

The following equation estimates the relationship between land-renting behavior (including both renting in and renting out) and (i) household income and (ii) poverty status:

$$Y_{it} = \alpha_i + \alpha_1 R_{it}^{in} + \alpha_2 R_{it}^{out} + \alpha_3 X_{it}' + \delta_t + \left(\vartheta_j \times \delta_t\right) + \varepsilon_{it}, \tag{1}$$

where Y_{it} is the dependent variable. Equation (1) includes (i) the natural logarithm of household agricultural income, (ii) the natural logarithm of household total income, and (iii) the poverty status of household i at time t. By taking the natural logarithm, it is assumed that the explanatory variables have linear effects on the growth rates of household income. R_{it}^{in} and R_{it}^{out} are binary variables that indicate whether household i had rented in and rented out farmland at time t, respectively. The estimated parameters α_1 and α_2 are of most interest. $\boldsymbol{X}_{it}$ is a vector of household-specific control variables that are expected to affect household incomes; α_i is a household fixed effect that captures a farmer's unobserved time-invariant household characteristics like management ability and risk preference; $\boldsymbol{\delta}_t$ is a vector of year dummy intended to capture the time-related effect; and $\boldsymbol{\varphi}_j \times \boldsymbol{\delta}_t$ is the interaction term of time and village dummies, intended to control for time-varying unobservables at the village level.

Specialization, Land Renting, and Household Income

To test hypotheses I and II, the heterogeneous relationship of land-renting behavior, and household income, poverty status between specialized and nonspecialized households, we developed equation (2):

$$\begin{aligned} Y_{it} = {} & \beta_i + \beta_1 R_{it}^{in} + \beta_2 R_{it}^{out} + \beta_3 \left(R_{it}^{in} \times H_{it}^{FSH}\right) + \beta_4 \left(R_{it}^{out} \times H_{it}^{OSH}\right) \\ & + \beta_5 X_{it}' + \delta_t + \left(\vartheta_j \times \delta_t\right) + \varepsilon_{it}, \end{aligned} \tag{2}$$

where H_{it}^{FSH} is a dummy variable indicating whether household i is an FSH, and H_{it}^{OSH} indicates whether household i is an OSH. As with equation (1), we controlled for household fixed effects as well as time-varying unobservables at the village level. If the coefficient β_3 was positive and statistically significant, it indicated that renting in land had significantly increased income for FSH (hypothesis I was tested); if β_4 was positive and statistically significant, it indicated that renting out land had significantly increased income for OSH (hypothesis II was tested).

Endogeneity Check and Solution Methods

Although the fixed effect (FE) model could eliminate potential endogeneity bias due to time-invariant household characteristics and other unobserved covariates, it provides no guarantee that the estimations are free from endogeneity bias due to time-variant unobserved covariates. To address this problem, two additional groups of analysis were conducted.

First, the analysis was performed with the instrumental variable (IV) approach. If the FE model and the IV approaches yield consistent estimations, the results would be more confident. To find two potentially valid IVs, a widely used approach was applied (Feng and Heerink, 2008; Zhang et al., 2018), which is to use the share of interviewed households that rented in land ($R_{it}^{v\_in}$) and rented out land ($R_{it}^{v\_out}$) living in the same village except for the sampled household. First, land renting by other households living in the same village can serve as a good proxy for the local land rental market (Qiu et al., 2020), which could significantly affect a household's land renting behavior. For instance, a village with a high percentage of renting-in households could indicate fierce competition for land supply, and the land rental market would become a lessor's market. Vice versa, a village with a high percentage of renting-out households might indicate that the local land rental market is a lessee's

market. Considering that the interaction terms of $R^{in} \times H^{FSH}$ and $R^{out} \times H^{OSH}$ are also endogenous, we adopted the commonly used method by adding the interaction terms of the original IVs (share of households in the same village renting in/out) and H^{FSH} or H^{OSH} as instrumental variables. Table S3 (columns 1 and 2) shows the first-stage relationship between the instrumental variables and the endogenous variables; the estimated coefficients between the share of village renting-in and renting-out households are strongly correlated with household renting-in and renting-out behavior. On the other hand, the share of other interviewed households that rented in or rented out land cannot directly affect household income. The Cragg–Donald Wald F-statistic is as high as 1,332 (Tables 2 and 3); thus, the weak identification is not of concern. When distance from homestead to the county, a totally exogenous variable, is added to the IV list, the overidentification test shows that the p-value of the Sargan statistic is 0.14, hence the null hypothesis that all IVs are exogenous could not be rejected.[6] To examine whether the exclusion restriction assumption is satisfied with IVs, regression of the error term from the equation (1) and IVs was re-run. If the coefficients are different from 0 and statistically significant, then IVs might be correlated with potential unobservables. Results in Table S3 (columns 3–6) show that all coefficients are equal to 0, and none of them are statistically significant.

Second, the stability of the estimates to the selection on unobserved covariates was examined with the method developed by Oster (2019). If the relationship between the core independent variables (R_{it}^{in} and R_{it}^{out}) and unobservables in a linear model can be recovered by the relationship between core independent variables and observables, then a ratio of selection on unobservables to observables ($\tilde{\delta}$) can be calculated using the following equation:

$$\tilde{\delta} = \frac{\left(\widetilde{\beta} - \beta^{*}\right)\left(\tilde{R} - R^{0}\right)}{\left(\beta^{0} - \widetilde{\beta}\right)\left(R_{\max} - \tilde{R}\right)}, \tag{3}$$

where R_{max} is a hypothetical R^2 from a regression of the outcome on treatment and both observed and unobserved controls;[7] $\tilde{\beta}$ is the coefficient estimated from equation (1) when all controls (observed) are included, and $\tilde{R}$ is the corresponded R^2, β^0 is the estimated coefficient with no controls; and β^* is the true consistent estimator. Assuming that the true coefficients equal 0 ($\beta^* = 0$) and given the R_{max}, $\tilde{\delta}$ is interpreted as the extent of selection on unobservables relative to the observables that would be needed to drive the estimated coefficient to 0. If $\tilde{\delta} = 1$, then the selections on unobservables are as important as the selections on observables. A negative $\tilde{\delta}$ indicates that controlling for observables moves the estimated coefficient away from 0, and the unobservables would be negatively correlated with the controls to drive the estimator to 0. In addition, a set of bounds for the treatment effects was developed with the given bounds on δ and R_{max}. If 0 is excluded from the identified set of treatment effects, the existence of a treatment effect could not be rejected. In calculating the bounds for the treatment effects, we used the bound $\tilde{\beta}$, which is the coefficient of the treatment variable estimated from fixed-effect regressions. The other bound was $\tilde{\beta}^*$, which is the value of the treatment effects when both δ and R_{max} are equal to their respective upper bounds. Two values were set to conduct the test (i.e., $R_{max} = 1.3\tilde{R}$, which was proposed by Oster, 2019, and $R_{max} = 1$, which is the maximum value of R^2), indicating that the estimation with both observables and unobservables fully controlled.

[6] We have re-run equations (1) and (2) with distance from the homestead to the county as an additional instrumental variable, and the results are robust. The results can be obtained upon request from the first author.

[7] Oster (2019) developed a STATA command, *psacalc*, to perform two related procedures for evaluating the robustness of the estimation results to omitted variable bias. This command was applied to test for the robustness by estimating the following treatment effects using equation (1).

Table 1. Descriptive Statistics of the Survey Households

Variable	2013 (*N* = 618)	2015 (*N* = 558)	2017 (*N* = 550)
Households' land renting-in behavior			
Percentage of households that rented in land (%)	33.66	22.22	18.00
Area of rented-in land (ha)	1.12	1.25	1.27
Area of rented-in land among FSH	1.24	1.47	1.52
Area of rented-in land among non-FSH	0.54	0.70	0.76
Households' land renting-out behavior			
Percentage of households that rented out land (%)	12.62	28.85	35.45
Area of rented-out land (ha)	0.32	0.27	0.29
Area of rented-out land among OSH	0.34	0.26	0.31
Area of rented-out land among non-OSH	0.31	0.27	0.28
Households' income and poverty status			
Agricultural income (RMB)	28,130	41,659	37,273
Off-farm income (RMB)	38,916	44,098	57,383
Total income (RMB)	67,046	86,758	94,656
Under the poverty status (high line = 5.5 USD/day), 1 = yes, 0 otherwise	0.23	0.23	0.19
Under the poverty status (middle line = 3.2 USD/day), 1 = yes, 0 otherwise	0.10	0.09	0.08

Source: Calculated from authors' survey.

Results and Discussions

Description of the Land Rental Market and Household Income Distribution

For the land rental status change in 2013–2015, it is found that 134 (21.7%) households changed their land renting-in status; among these, the 32 FSH households account for 30.5% of FSH. Meanwhile, 151 (24.4%) households changed their land renting-out status; among these, the 48 OSH households account for 55.8% of OSH. In 2015–2017, 68 households (13.1%), 8 FSH (9.1% of FSH) included, changed land renting-in status; at the same time, 74 households (14.3%), 9 OSH (12.3% of OSH) included, changed land renting-out status. These changes provide us with sufficient variation to examine the relationship between land renting decisions and household income.

The land rental market in the North China Plain showed an increasing trend toward consolidation. The share of households with rented-in land slowly decreased from 34% to 18%; however, the average size of rented-in land increased from 1.12 hectares to 1.27 hectares, an increase of about 0.15 hectares (Table 1). On the other hand, renting out has become prevalent among smallholders. In 2013, 12.6% of households rented out land; by 2017, this had increased to 35.5%. The average size of rented-out land was much smaller and remained stable during the study period (from 0.33 hectares to 0.31 hectares).[8]

During the study period, off-farm income increased from 39,000 to 57,000 RMB (Table 1); agricultural income increased from 2013 to 2015 but declined from 2015 to 2017. As a result, the share of off-farm income within total household income increased, and the share of agricultural income experienced a relative decline. Figure 2 further compares the distribution of differences

[8] The total rented-in and rented-out land areas for all households in the sample do not balance, even though most land rentals in rural China take place within the same village. This discrepancy can be explained by two main factors. First, households that rented out land completely and migrated out of the village could not be interviewed. This is a well-known problem that scholars studying rural land rental markets in China face (Zhang et al., 2018). Second, an increasing share of rural land is rented in by co-operatives, agribusinesses, or entities other than households living within the same village. The percentage of land rented in by co-operatives and agribusinesses reached 20.4% and 9.4%, respectively, in 2013, and 22.7% and 9.8%, respectively, in 2017 (Ministry of Agriculture of the People's Republic of China, 2017).

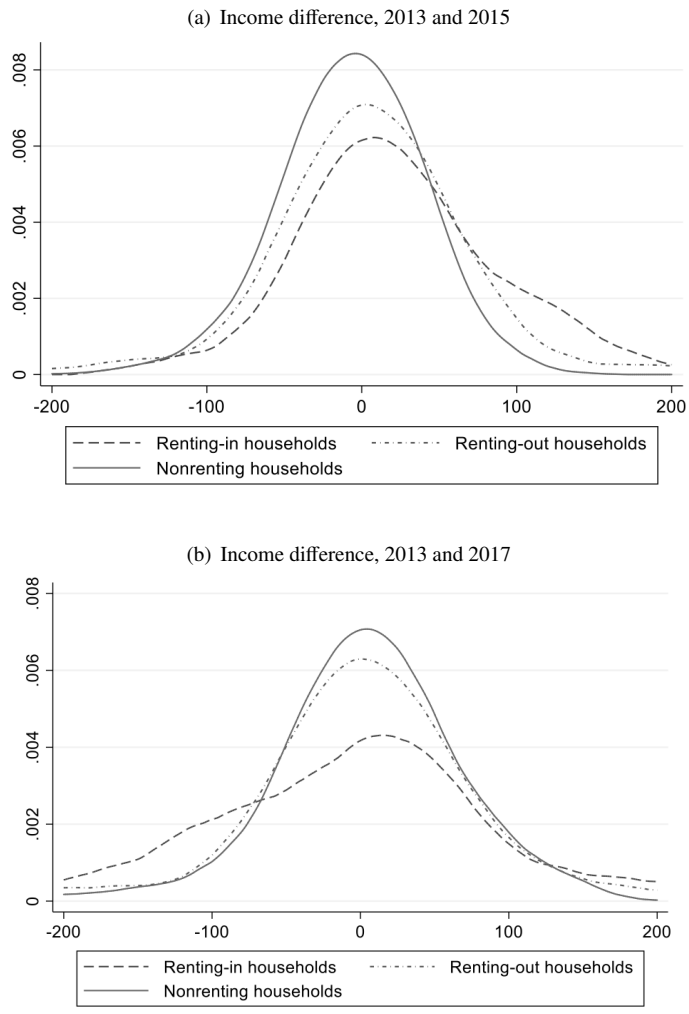

Figure 2. Total Income Difference among Households with Different Land-Renting Behavior

in households with different land-renting behavior from 2013 to 2015 and from 2013 to 2017. Compared to autarkic households, the distribution of income difference for the renting-in and renting-out households is right-skewed from 2013 to 2015. This suggests that households with rented-in (rented-out) land had higher income growth compared to autarkic households. However, when extending the comparison from 2013 to 2017, the income differences became insignificant.

From the perspective of household specialization, the distribution of income difference among FSH and OSH is rather right-skewed during 2013 to 2015 compared to nonspecialized households (Figure 3), indicating overall higher income growth among FSH and OSH. However, if the longer period of 2013–2017 is examined, only the distribution of income difference from OSH is right-skewed, while FSH and nonspecialized households showed no difference. Considering both descriptive comparisons from household land-renting behavior and their specialization perspectives, it was expected that household agricultural income might experience some decline from 2015 to 2017, while off-farm income and total income showed an overall increasing trend.

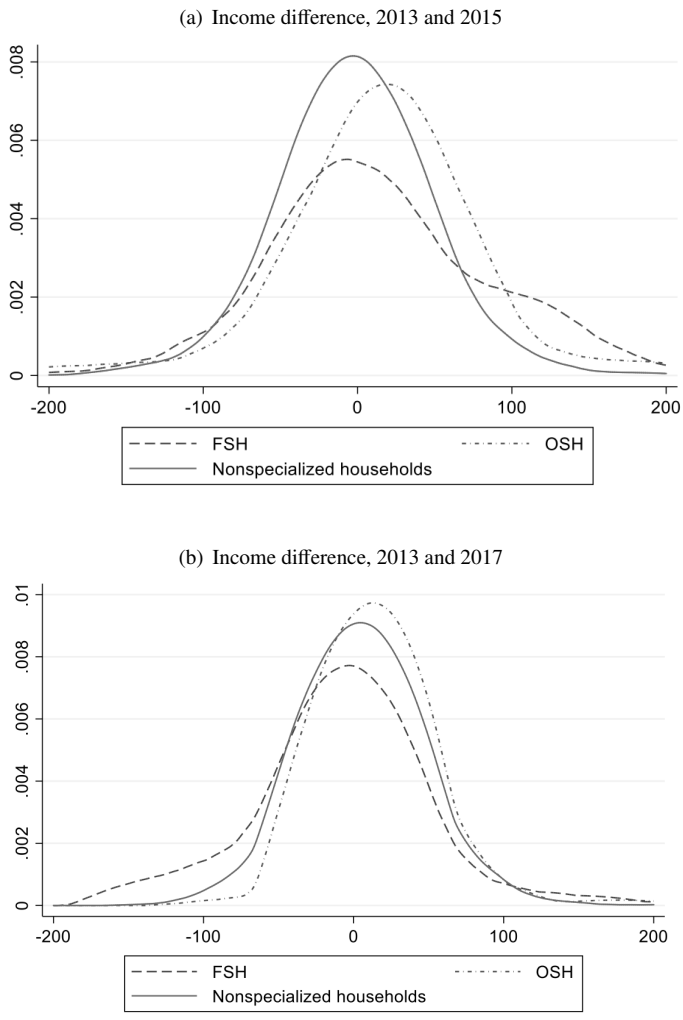

Figure 3. Total Income Difference among Households with Different Specializations

Land Renting, Specialization, and Household Income

Table 2 reports both the estimated relationship of land-renting behavior and their incomes.[9] First, without considering household specialization, the FE estimation (equation 1) and the IV estimation show that households with rented-in land were significant and positively associated with agricultural income and total income (a 1.28% increase in agricultural income and a 0.68% increase in total income); households with rented-out land were negatively associated with agricultural income (a 1.15% decrease) but had a slight increase (0.13%) in total income. This result matches the expectation that renting in land shows a positive relationship with agricultural income and renting out land has a downward effect on agricultural income but could be a positive effect on total income, since off-farm income increment might compensate for the loss of agricultural income.

[9] The results with off-farm income were not presented because many households do not have off-farm income, which was numerically coded as 0. To avoid repetitive results, only agricultural income and total income were reported with the same specifical model.

Table 2. Regression Results (fixed effects) for Household Income (N = 1,726)

	Agricultural Income				Total Income			
	FE	IV	FE	IV	FE	IV	FE	IV
Variable	1	2	3	4	5	6	7	8
R^{in}, 1 = household rents in land, 0 otherwise	1.28*** (0.09)	1.48*** (0.14)	1.11*** (0.10)	1.31*** (0.14)	0.68*** (0.07)	0.75*** (0.11)	0.55*** (0.07)	0.61*** (0.10)
$R^{in} \times H^{FSH}$			0.72*** (0.22)	0.71*** (0.21)			0.61*** (0.18)	0.64*** (0.20)
R^{out}, 1 = household rents out land, 0 otherwise	−1.15*** (0.11)	−1.18*** (0.12)	−1.06*** (0.11)	−1.11*** (0.12)	0.13* (0.08)	0.17* (0.09)	0.03 (0.08)	0.05 (0.10)
$R^{out} \times H^{OSH}$			−0.47** (0.19)	−0.35* (0.20)			0.45*** (0.13)	0.51*** (0.15)
Plots	0.09*** (0.02)	0.09*** (0.02)	0.08*** (0.02)	0.09*** (0.02)	−0.00 (0.02)	−0.00 (0.02)	−0.01 (0.02)	−0.01 (0.02)
Contracted land	0.64*** (0.11)	0.64*** (0.11)	0.60*** (0.11)	0.61*** (0.11)	0.32*** (0.07)	0.32*** (0.07)	0.32*** (0.07)	0.322*** (0.07)
Age	0.01** (0.00)	0.01** (0.00)	0.01** (0.00)	0.01** (0.00)	−0.00 (0.00)	−0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Education	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.03*** (0.01)	0.02*** (0.01)	0.02** (0.01)	0.02** (0.01)
Household size	−0.01 (0.03)	−0.02 (0.03)	−0.02 (0.03)	−0.02 (0.03)	0.09*** (0.02)	0.09*** (0.02)	0.09*** (0.02)	0.09*** (0.02)
Laborers	0.06* (0.03)	0.06* (0.03)	0.07** (0.03)	0.06* (0.03)	0.15*** (0.03)	0.15*** (0.03)	0.14*** (0.03)	0.14*** (0.03)
Village leader	0.37*** (0.13)	0.38*** (0.13)	0.32*** (0.12)	0.34*** (0.12)	0.22* (0.12)	0.23* (0.12)	0.20* (0.12)	0.21* (0.12)
Co-operative membership	0.16 (0.11)	0.14 (0.12)	0.17 (0.11)	0.15 (0.11)	0.16 (0.11)	0.15 (0.11)	0.15 (0.10)	0.15 (0.11)
School children	0.02 (0.07)	0.02 (0.07)	0.01 (0.07)	0.01 (0.07)	0.08 (0.06)	0.08 (0.06)	0.09 (0.06)	0.09 (0.06)
Elderly	−0.00 (0.09)	−0.00 (0.09)	0.01 (0.09)	0.01 (0.09)	−0.10 (0.07)	−0.10 (0.07)	−0.08 (0.07)	−0.08 (0.07)
Titling	0.20 (0.41)	0.08 (0.42)			0.36 (0.23)	0.34 (0.23)		
Town distance	−0.00 (0.02)	0.00 (0.02)	−0.00 (0.02)	0.00 (0.02)	−0.02** (0.01)	−0.02* (0.01)	−0.03** (0.01)	−0.02** (0.01)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies × Village dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.80*** (0.29)	0.70** (0.29)	0.84*** (0.28)	0.73** (0.28)	2.58*** (0.24)	2.55*** (0.24)	2.52*** (0.23)	2.49*** (0.24)
R^2	0.58		0.59		0.29		0.31	
Weak identification test (Cragg–Donald Wald F-statistic)		1,332[0.00]				1,332[0.00]		
Overidentification test of instruments (Sargan statistic)		0.00				0.00		
Overidentification test of instruments (Sargan statistic, adding distance from homestead to the county to the IV list)		0.14				0.14		

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5% and 1% levels, respectively.

Second, further considering the heterogeneity in household specialization, the results of columns 3, 4, 7, and 8 in Table 2 revealed significant heterogeneous relationships between land renting in or renting out and incomes among FSH and OSH. For instance, an increase in agricultural income was observed among FSH when renting in land; however, the coefficient of R^{in} was still statistically significant (Table 2, columns 3 and 4), indicating that renting in land had also increased non-FSH agricultural income. These positive correlations are also consistent with observed increase of household total income (Table 2, columns 7 and 8).

On the other hand, OSH relationships when renting out land ere quite different. Renting out land among OSH significantly decreased agricultural income (a 1.18% decrease) but significantly increased OSH total income; and no significant coefficient of R^{out} was observed. This indicates that the increase in households' total income can mainly be attributed to the increase among OSH when renting out land, while the nonspecialized households renting out land showed no significant increase in total income but a significant decline in agricultural income instead. Households that rented out land would allocate more time to off-farm employment. The comparative advantage of off-farm employment allows renting-out households to obtain higher household income. From another perspective, the surveyed data show an increasing trend for off-farm monthly wage, from 3, 095 RMB per month in 2013 to 4, 891 RMB per month in 2017, these changes helped renting-out households maintain stable higher incomes. OSH especially could gain more benefit from off-farm employment when they rented out the contracted land. These results also verify the hypotheses that land renting in could significantly increase household income and agricultural income while land renting out significantly increases total OSH income by increasing off-farm income. The comparative advantages in human capital and other resources among OSH make the gains from renting out land much larger than for nonspecialized households.

Land Renting, Specialization, and Household Poverty Status

Despite the significant correlations observed from the above analysis, all are based on the mean changes, which provide no interpretation of the distributional effect. In this subsection, the focus shifted to the lowest quantile of the rural households (i.e., households below the poverty lines). In Table 3, the estimated relationship between land-renting behavior and household poverty status was presented by different cutting-lines. Same as above, the estimated results were first shown without concern for the heterogeneity of household specialization. Both the FE and the IV estimation showed that renting in and renting out land were negatively associated with household poverty status by any definition of poverty (Table 3, rows 1 and 3). For instance, with the higher (or upper) poverty line, renting in land decreased a household's probability of being poor by about 0.22%; however, renting out land showed minimum correlation with household poverty status. Only when the middle boundary was applied as the poverty cutoff were the coefficients estimated as weakly statistically significant. This result indicates that the development of the land rental market can play a significant role in reducing rural poverty through land renting in by rural households, while renting out land has minimal effect on decreasing rural poverty.

Second, when considering the heterogeneity of rural household specialization, the estimated coefficients for the interaction term ($R^{in} \times H^{FSH}$) were not significant by any poverty line cutoff in either the FE or the IV estimations. A rather small coefficient was identified (between −0.01 and −0.16, Table 3), while the coefficients of R^{in} were statistically significant, indicating no difference in the reduction of poverty among FSH and nonspecialized households when renting in additional land. This result is intuitively reasonable since the incidence of poverty among FSH might be significantly lower. Regarding the land renting out, it was found that the estimated coefficients of the interaction term ($R^{out} \times H^{OSH}$) were only significant at the higher (upper) poverty line, indicating that land renting out is only effective in reducing poverty among the OSH, with poverty defined by the upper boundary cutoff.

Table 3. Regression Results (fixed effects) for Poverty Status (N = 1,726)

	Poverty Status (high line)				Poverty Status (middle line)			
	FE	IV	FE	IV	FE	IV	FE	IV
Variable	1	2	3	4	5	6	7	8
R^{in}, 1 = household that rented in land	−0.22***	−0.25***	−0.19***	−0.24***	−0.12***	−0.15***	−0.12***	−0.16***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.03)	(0.04)	(0.03)	(0.04)
$R^{in} \times H^{FSH}$			−0.16*	−0.10			−0.01	0.01
			(0.09)	(0.09)			(0.06)	(0.06)
R^{out}, 1 = household that rented out land	−0.04	−0.07	0.03	−0.00	−0.05*	−0.07**	−0.04	−0.05
	(0.04)	(0.05)	(0.05)	(0.052)	(0.03)	(0.03)	(0.04)	(0.04)
$R^{out} \times H^{OSH}$			−0.30***	−0.32***			−0.07	−0.08
			(0.08)	(0.09)			(0.06)	(0.06)
Plots	0.01	0.01	0.01	0.01	−0.00	−0.00	−0.00	−0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Contracted land	−0.09**	−0.10**	−0.10**	−0.10**	−0.06*	−0.06*	−0.06*	−0.06*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)	(0.04)	(0.04)
Age	0.00	0.00	0.00	0.00	−0.00	−0.00	−0.00	−0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education	−0.01	−0.01	−0.01	−0.01	−0.00	−0.00	−0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Household size	0.05***	0.05***	0.05***	0.05***	0.00	0.00	0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Laborers	−0.05***	−0.05***	−0.05**	−0.05***	−0.02**	−0.03**	−0.02**	−0.02**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Village leader	−0.03	−0.04	−0.03	−0.03	−0.04	−0.04	−0.04	−0.04
	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)	(0.03)	(0.03)
Co-operative membership	−0.09	−0.09	−0.09	−0.08	−0.04	−0.04	−0.04	−0.03
	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)	(0.03)	(0.03)
School children	−0.03	−0.03	−0.04	−0.04	−0.01	−0.01	−0.01	−0.01
	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)	(0.03)	(0.03)
Elderly	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04
	(0.05)	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)	(0.04)	(0.04)
Titling	0.04	0.05			0.05	0.06		
	(0.09)	(0.09)			(0.05)	(0.05)		
Town distance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies × Village dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.31**	0.32**	0.34**	0.36**	0.28**	0.30***	0.29**	0.30***
	(0.15)	(0.15)	(0.15)	(0.15)	(0.11)	(0.11)	(0.11)	(0.11)
R^2	0.10		0.12		0.07		0.07	
Weak identification test (Cragg–Donald Wald F-statistic)		1,332[0.00]				1,332[0.00]		
Overidentification test of instruments (Sargan statistic)		0				0		
Overidentification test of instruments (Sargan statistic, adding distance from homestead to the county to the IV list)		0.14				0.14		

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5% and 1% levels, respectively.

These results support the premise that FSH rent in more land with the purpose of building large-scale farms, thereby earning higher income, primarily through an increase in agricultural income, while nonspecialized households could, to a lesser extent, also significantly increase their agricultural income through land renting. Renting in land could, therefore, significantly reduce rural poverty. OSH benefit significantly when renting out land, despite the fact that they might lose a substantial part of agricultural income. Renting out land might help the relatively poor get out of poverty, but the effect is rather limited at the upper bound. At the lower bound, renting out land among OSH played no role in reducing rural poverty. Hence, when considering the relationship between the land rental market and rural poverty reduction, caution should be taken for nonspecialized households.

Robustness Check: Testing the Stability of the Estimated Coefficients

We examined the stability of the estimated coefficients from the FE estimations; Table 4 presents the results from the two procedures. Columns 1 and 2 show two sets of the treatment effect estimates, their standard errors, and the corresponding R^2. Specifically, column 1 presents the estimates derived from the baseline estimation without any controls; column 2 shows the estimates using equation (1) with the FE estimation and the full set of controls. Column 3 reports the identified sets for the treatment effects, given the values for $R_{max} = 1.3\tilde{R}$ and the corresponding value of δ (the ratio of selection on unobservables to observables). Columns 4 reports the identified sets for the treatment effects, given the values for $R_{max} = 1$ and the corresponding value of δ. For the treatments with significant values in the fixed-effect model for land-renting behavior, the bounding sets do not include 0. This suggests stability of the estimated coefficients. Columns 4 and 6 present $\tilde{\delta}$, the relative degree of selection on observed and unobserved controls for a zero-treatment effect. For treatment variables, the selection on unobservables has to be greater than the selection on observables to explain away the effects ($\tilde{\delta} > 1$). Except for the $\tilde{\delta}$ for treatment effects of renting out land in agricultural income, other $\tilde{\delta}$ for treatment effects with significant values are larger than 1. It can therefore be concluded that the estimates of the treatment effects of land renting on household income and poverty status are robust to selection on unobservables.

Conclusions and Policy Implications

This study examines the effects of land-renting behavior on household income and poverty using panel data collected through field surveys in eight counties in two provinces of the North China Plain for the years in 2013, 2015, and 2017. A major difference compared to previous studies is the consideration of households' livelihood specialization by defining farming-specialized households (FSH), off-farm specialized households (OSH), and nonspecialized households. An FE model and an IV approach were used to correct for potential endogeneity, and the stability of estimates to selection on unobservables was further examined to serve as a robustness check. Two conclusions emerged from the analyses.

First, consistent with the previous findings, we confirm that land renting in plays an important role in increasing household total income, particularly among FSH, who experience a higher increase in household income from land renting in than nonspecialized households. The regression analyses result further suggest a positive relationship between land renting in and poverty reduction. Our second main finding is that land renting out by OSH can significantly increase household total income and reduce the likelihood of living below the international high poverty line; land renting out might not be strongly associated the household total income and poverty reduction among nonspecialized households. The regression analyses result further suggest a negative relationship between land renting out and OSH agricultural incomes, compared with nonspecialized households.

Table 4. Robustness Check for the Stability of the Estimated Coefficients with Fixed Effect Models

	Baseline Effect			Effect with Full Controls			$R_{max} = 1.3\tilde{R}$		$R_{max} = 1$	
	$\tilde{\beta}$	St. Err.	R^2	$\tilde{\beta}$	St. Err.	R^2	Identified Set	δ	Identified Set	δ
Treatment Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Outcome 1: Agricultural income										
RI	1.58***	0.11	0.24	1.28***	0.09	0.58	[1.02, 1.28]	2.7	[0.39, 1.28]	1.2
RO	−1.67***	0.10	0.33	−1.15***	0.11	0.58	[-1.15, -0.14]	1.07	[-1.15, 5.39]	0.47
Outcome 2: Total income										
RI	0.51***	0.07	0.06	0.68***	0.07	0.29	[0.68, 0.78]	1, 106.16	[0.68, 5.28]	165.87
RO	0.07	0.10	0.00	0.13*	0.08	0.29	[0.13, 0.18]	−20.66	[0.13, 37.72]	−2.59

Notes: The control variables include household head's age and education, village cadre, and whether household is a co-operative member, household size, number of laborers, school children, elderly, and distance to the township. R is the regression R^2 of the model with full controls. Single, double, and triple asterisks (*, **, and ***) indicate significance at the for 10%, 5% and 1% significance levels, respectively. Control variables include age and education of household head, village leader, co-operative membership, household size, number of laborers, school children, elderly, and distance to the township.

Thus, land transfer is a suitable strategy to improve rural smallholders' economic wellbeing. To promote land transfer, the Chinese government has been implementing land titling programs, which have a promotion effect on the land rental market by changing perceptions about tenure security. However, small-scale, nonspecialized agricultural production is still common in China because of certain institutional factors (Yang and Liu, 2012). The Chinese government should take more measures to promote land rental markets except for the land titling program. The imperfect credit market still poses a strong barrier to households' financing abilities, and many households are unable to access enough capital to change to specializing in farming with a large-scale operation. Rural-to-urban migrants are also still experiencing various forms of acculturative stress from both urban work and rural family, and migrated farmers tend to lack a sense of belonging in urban areas (Zhong et al., 2016). This impedes households from renting out all of their farmland and adopting an off-farm specialized strategy. Land rental transactions are restricted to a close circle of relatives, outnumbering formal transactions (Ma et al., 2020; Tang et al., 2019), and specialized strategies are often delayed or prohibited among rural poor.

To facilitate land rental markets in rural China, two specific recommendations can be generated. First, from the demand side, it is suggested that government provide more financial supports to rural households who have strong comparative advantages in agricultural production to engage in farming work. For large-scale producers, policies that promote land transfer may be upscaled. Second, from the supply side, government could engage more effort in creating off-farm employment opportunities in rural areas for households who have a comparative advantage in off-farm jobs. The establishment of rural enterprises like agricultural product processing enterprises may be one strategy for achieving this (Steiner and Atterton, 2015). Working in local areas not only gives employee a sense of belonging but also helps them save on commuting or migration costs.

Although this study is limited to two provinces in China, the main insights may prove useful for other parts of rural China and other developing countries with similar rural land tenure systems and underdeveloped labor markets as well. It is reiterated, however, there are still a number of unsolved issues. First, it is rather difficult to define FSH and OSH in the field. We used household head's working day as a proxy, but these indicators might not be accurate, which could lead us to under- or overestimate the true heterogeneous relationship between land-renting behavior and household income. A more accurate indicator should be designed to capture such underlying differences. Second, although we used both FE and IV approaches to address the potential endogeneity, other methods with better identification should be employed to further examine the robustness of our findings, and a larger sample should be designed to ensure a high level of external validity. These limitations should be taken into account when interpreting the results and be avoided in the future research.

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Online Supplement: Land Rental Markets, Specialization, and Rural Household Income: Evidence from the North China Plain

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Table A1. Definitions and Descriptive Statistics of Independent Variables and Control Covariates

Variable	Definitions	2013 (*N* = 618)	2015 (*N* = 558)	2017 (*N* = 550)
Household type				
R^{in}	Households with land renting-in behavior, 1 = yes, 0 otherwise	0.34	0.22	0.18
R^{out}	Households with land renting-out behavior, 1 = yes, 0 otherwise	0.13	0.29	0.35
H^{FSH}	Households with farming-specialized livelihood strategy, 1 = yes, 0 otherwise	0.17	0.17	0.17
H^{OSH}	Households with off-farm specialized livelihood strategy, 1 = yes, 0 otherwise	0.14	0.14	0.14
Household characteristics				
Age	Age of the household head (years)	51.80	53.83	55.42
Education	Education years of the household head (years)	8.10	7.01	7.11
Village leader	If household member was a village leader, 1 = yes, 0 otherwise	0.05	0.06	0.08
Cooperative membership	Whether the household joined a co-operative, 1 = yes, 0 otherwise	0.11	0.14	0.11
Family size	Number of household members	4.05	4.12	4.08
Laborers	Number of laborers	2.87	2.66	2.59

Continued on next page…

The material contained herein is supplementary to the article named in the title and published in the *Journal of Agricultural and Resource Economics* (*JARE*).

Table S1. – continued from previous page

Variable	Definitions	2013 (*N* = 618)	2015 (*N* = 558)	2017 (*N* = 550)
Household characteristics				
School children	Whether there was at least one school going child in the household, 1 = yes, 0 otherwise	0.45	0.54	0.53
Elderly	Whether there was at least one person aged above 65 in the household, 1 = yes, 0 otherwise	0.24	0.30	0.30
Plots	Number of contracted land plots	2.76	2.58	2.51
Contracted land	Area of the contracted land (ha)	0.56	0.56	0.55
Titling	Whether the land titling program was implemented, 1 = yes, 0 otherwise	0.00	0.16	0.72
Town distance	Distance from the homestead to the township (km)	6.46	6.64	5.81

Data source: Calculated from authors' survey.

Table S2. Results of the Attrition Analysis for Both 2015 and 2017 Follow-Up Surveys (*N* = 618)

Variable	Households Had Tracked in 2015 Survey (1 = track surveyed) 1	Households Had Tracked in 2017 Survey (1 = track surveyed) 2
Treatment variables		
R^{in}, 1=household rented-in land	0.19 (0.32)	0.22 (0.30)
R^{out}, 1=household rented-out land	-0.09 (0.41)	0.26 (0.42)
Household characteristics		
Plots	-0.05 (0.09)	0.01 (0.09)
Contracted land	0.32 (0.45)	0.46 (0.46)
Age	0.01 (0.02)	0.02 (0.01)
Education	0.05 (0.04)	-0.01 (0.04)
Household size	0.09 (0.16)	0.08 (0.15)
Laborers	-0.10 (0.18)	-0.08 (0.17)
Village leader	-0.33 (0.57)	-0.59 (0.49)
Cooperative membership	0.04 (0.54)	-0.04 (0.48)
School children	0.14 (0.33)	0.38 (0.32)
Elderly	-0.03 (0.37)	-0.10 (0.35)
Titling[a]	Omitted	Omitted
Town distance	0.05 (0.03)	0.05 (0.03)
Constant	0.95 (1.05)	0.38 (0.99)
R^2	0.95	0.38

Notes: [a]Land titling program has not been implemented in 2013, the variable is omitted from the regression.
Source: Authors' survey.

Table S3. Regression of the Potential Endogenous Variable and Errors Terms of the Dependent Variables (*N* = 1,726)

					Poverty Status	
	R^{in}	R^{out}	Agricultural Income	Total Income	High Line	Middle Line
Outcome Variables	**1**	**2**	**3**	**4**	**5**	**6**
Percentage of renting-in households except for the sampled one	-19.59***	0.14	0.00	-0.00	-0.00	0.00
	(0.35)	(0.37)	(0.27)	(0.21)	(0.12)	(0.08)
Percentage of renting-out households except for the sampled one	-0.26	-18.21***	-0.00	-0.00	0.00	0.00
	(0.34)	(0.36)	(0.20)	(0.13)	(0.08)	(0.06)
Plots	0.00	0.01	0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.27)	(0.21)	(0.12)	(0.08)
Contracted land	-0.02	-0.05**	-0.00	-0.00	0.00	0.00
	(0.02)	(0.02)	(0.20)	(0.13)	(0.08)	(0.06)
Age	-0.00	0.00	-0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.03)	(0.02)	(0.01)	(0.01)
Education	0.001	-0.00	0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.16)	(0.08)	(0.05)	(0.04)
Household size	0.00	0.00	0.00	0.00	-0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Laborers	-0.01	-0.01	-0.00	0.00	-0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Village leader	-0.06**	-0.03	-0.00	0.00	0.00	-0.00
	(0.02)	(0.03)	(0.05)	(0.03)	(0.02)	(0.01)
Co-operative membership	0.04	0.04	-0.00	-0.00	-0.00	0.00
	(0.02)	(0.02)	(0.05)	(0.03)	(0.02)	(0.01)
School children	0.01	0.01	-0.00	0.00	-0.00	0.00
	(0.01)	(0.01)	(0.15)	(0.12)	(0.06)	(0.03)
Elderly	0.01	-0.02	0.00	-0.00	-0.00	0.00
	(0.02)	(0.02)	(0.17)	(0.10)	(0.05)	(0.03)
Titling	16.97***	-11.34	0.00	-0.00	0.00	0.00
	(0.32)	(0.33)	(0.10)	(0.06)	(0.03)	(0.02)
Town distance	0.00	0.01	-0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies * Village dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	7.10	2.37***	0.00	-0.00	0.00	-0.00
	(0.15)	(0.16)	(0.44)	(0.26)	(0.15)	(0.11)

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5% and 1% levels, respectively.
Source: Author's survey.