Will farmland transfer reduce grain acreage? Evidence from Gansu province, China

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Abstract

Purpose – The purpose of this paper is to examine the impacts of farmland renting-in on planted grain acreage.
Design/methodology/approach – A survey data of five counties were analyzed with the two-stage ordinary least squares model.
Findings – Households renting-in land trended to plant more maize, and the more land was rented by a household the more maize was planted, while wheat acreage showed non-response to farmland renting-in.
Practical implications – Overall, the analysis suggests that policy makers should be prepared for different changing trends of grain crop acreage across the nation as farmland transfer continues. Future research should pay attention to the effect of farmland transfer on agricultural productivity and rural household income growth.
Originality/value – As the Chinese Government is promoting larger-scale and more mechanized farms as a way of protecting grain security, it is important to understand whether farmland renting-in will reduce planted grain acreage. This study provides empirical evidence showing the answer to that question may differ across different regions and depend on the particular grain crop in question.

Keywords Food security, Crop choice, Farmland rental market, Farmland transfer, Grain security, Instrumental variable

Paper type Research paper

1. Introduction

With the largest population and grain consumption in the world, China has made great strides in improving agricultural productivity, allowing the country to feed 22 percent of the world's population with less than 9 percent of the world's arable land (Hubacek *et al.*, 2007; Zhang, Cui and Zhang, 2014; Jiao *et al.*, 2016). However, population growth and declining arable land continue challenging food security (Anderson and Strutt, 2014; Unnevehr and Hoffmann, 2015;

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Zhang *et al.*, 2016; Li *et al.*, 2017). To ensure grain security, the Chinese Government has been pursuing a self-sufficiency policy aimed at domestic production of 95 percent of the wheat, rice, and maize demand (Rada *et al.*, 2015; Zhuo *et al.*, 2016). Besides, the Chinese Central Government's "First Document" in 2016 and 2017 placed grain security as one of the government's top priorities, and put forward farmland consolidation as one of the key strategies to achieve food security targets. Although small family-operated farms have been driving productivity growth for several decades, new growth models are needed to match the food demand of an increasingly urbanized population (Tan *et al.*, 2008; Feng, 2008; Chen *et al.*, 2011). Deepening rural farmland market reforms is considered as a promising approach to address the food security challenges facing China (Zuo *et al.*, 2015; Rada *et al.*, 2015; Wang *et al.*, 2017).

For this purpose, the government has openly encouraged farmland transfer, resulting in significantly growing of farmland rental market in rural China. The release of surplus labor from rural areas to urban industrial sectors also contributed to this growth (Kung, 2002; Zhang, 2008; Feng *et al.*, 2010; Gao *et al.*, 2012; Ito *et al.*, 2016). Only 5.2 percent of contracted farmland in China was transferred in 2007, but this ratio rose to 33.3 percent by the end of 2015 (Cheng, 2009; Ministry of Agriculture of the People's Republic of China, 2016).

The acceleration of farmland rental markets has important implications for China's food security by improving agricultural productivity (Deininger, 2003; Feng *et al.*, 2010). Lots of studies from China found that households renting land achieved higher allocative efficiency and technical efficiency than those without (Lohmar *et al.*, 2001; Carter and Yao, 2002; Feng, 2008). Tan *et al.* (2006) showed that the development of land rental markets may reduce fragmentation, consequently improve China's agricultural productivity. Further farmland transfer can also release more surplus farm labor into off-farm labor markets, and the resulting occupational diversification can boost income and reduce inequality in rural areas (Masterson, 2007; Jin and Jayne, 2013). In an empirical analysis based on 8,000 households in China's nine leading agricultural provinces, Jin and Deininger (2009) found that the development of land rental markets greatly improved rural households' income from non-agricultural sectors. The positive impacts of farmland rental markets and farmland consolidation on agricultural productivity were also proved by studies in Northern Ethiopia, Kenya, and Europe (Crecente *et al.*, 2002; Benin *et al.*, 2005; Pašakarnis and Maliene, 2010; Jin and Jayne, 2013; Lisec *et al.*, 2014; Hartvigsen, 2014).

On the other hand, farmland rental markets may have some negative impacts on agricultural production and food security. Conversion of farmland to non-farm uses can reduce land resources for food production (Chen *et al.*, 2014; Liu *et al.*, 2014). Besides, there is a large body of empirical evidence that yields decline as farm size grows, and an increasing evidence of an inverse U-shaped relationship between farm size and yields caused by rising wage rates in China and other Asian countries, so farmland transfer does not necessarily bolster food security (Rada *et al.*, 2015; Wang, Chen, Gupta and Huang, 2015; Otsuka *et al.*, 2016).

Farmland transfer may also lead to changes in crop mix – for example, it may result in a substitution of cash crops for grains – which bears important implications for China's grain food security policy. Grain crops are generally considered to be relatively land-intensive crops (Huang and Chen, 1999). Farmers that specialize more in grain crops are therefore more likely to rent additional land than farmers specializing in less land-intensive crops. On the other hand, well-functioning land rental markets transfer land from low-productive to relatively high-productive farmers (Otsuka, 2007; Ma *et al.*, 2017). With the development of farmland rental markets, more and more farmland in China is now used for non-grain production since planting grain crops has relatively low earnings (Zhao *et al.*, 2017). Moreover, farmland renting-in often comes with enlarging of farm size and reducing of farmland fragmentation, which favors the mechanized farming, and these changes may play significant roles in agricultural production, including agricultural productivity and grain acreage, and then make effects on food security. In addition, households show different behaviors on agricultural investments between contracted land and rented-in land (Gao *et al.*, 2012; Muraoka *et al.*, 2015),

which may also make effects on determining households' crop choice. In fact, some surveys indeed showed that farms renting-in land preferred to plant high profitable cash crops (Li and Gao, 2013; Huang, 2014; Zhang, Qu and Wei, 2014; Zhang, 2016). Besides, Yi and Cheng (2010) found that in Zhejiang and Hebei provinces, farms with leased land planted a larger portion of their farmland to non-grain crops than those without leased land. However, Zhang and Du (2015) found a negative relation between the percentage of non-grain crop area and farm size – the percentage of non-grain areas was relatively high before reaching the 50-mu threshold, and starts dramatically declining afterwards. This dispute indicates that the effects of farmland renting-in are different across regions. The Central Government of China is promoting farmland transfer and increasing farming scale as a way of protecting grain food security (Rada *et al.*, 2015), while few studies have examined the impacts of farmland renting-in on grain acreage, and these scanty studies on this issue mainly focused on eastern coastal areas and central plain areas of China, with little attention on backward areas in Western China. Therefore, it is important to understand how farmland renting-in affects grain crop acreage.

The purpose of this paper is to examine: how farmland renting-in affects crop choice and grain acreage; and whether farmland renting-in affects the acreage of different grains differently. Our econometric analysis is based on a survey conducted in 2015 covering 705 households in 25 villages of Gansu province. We find that farmland renting-in has significantly boosted planted grain crop area. But individual grain acreage responds differently to land transfers. While wheat acreage is little affected by land renting-in, maize acreage responds to land renting-in quite significantly. We rationalize these differences in the context of farm household decisions and policy incentives.

The rest of paper is organized as follows. The next section describes the study area and survey methods. Section 3 presents the variables and two-stage ordinary least squares (2SLS) model employed. In Section 4, the results are reported. Discussion and conclusion are offered in the final section.

2. Study area and data

This study selected five counties in Gansu province, China (Figure 1). Gansu province is located in the upstream of Yellow River basin, where the Loess Plateau, Qinghai-Tibet Plateau, and Inner Mongolian Plateau join one another. The land area of Gansu province is 42.58×10^4 square kilometers, about 4.7 percent total area of China. It is one of the major grain producing provinces in Northwestern China. In 2015, the planted grain crops area is 2,850 hectares, accounting for 2.5 percent of national level (National Bureau of Statistics of the People's Republic of China, 2015). In addition, Gansu province is one of the less developed region of China with relative poor agricultural production conditions and a low level of urbanization. With the implementation of the "land conversion from farmland to forest or grassland" policy, Gansu's farmland has shrunk significantly. In particular, grain acreage has experienced a sharp decline from 70.07 percent in 2010 to 67.72 percent in 2014 (Editorial Board of Gansu Development Yearbook, 2012, 2014 and 2016).

Gansu province has also made great progresses in farmland transfer. About 16.1 percent of contracted farmland in Gansu province was transferred by the end of March 2014 (Liang and Ma, 2014), and 18.87 percent (measured by rented-in land area) of contracted farmland in studied areas was transferred, and 34.18 percent of households involved in farmland transfer by the end of 2013, according to our survey.

The survey was conducted from April to September, 2015. Five counties were selected using the sampling methods of Huang *et al.* (2012). Specifically, all 86 counties or districts in Gansu province were sorted from high to low by the average total industry output value per capita in 2012, an indicator of the economic development level. The counties were then divided into five groups, and a county was randomly chosen from each group to represent that group. Within each county, five townships were randomly chosen, generating totally 25 townships in

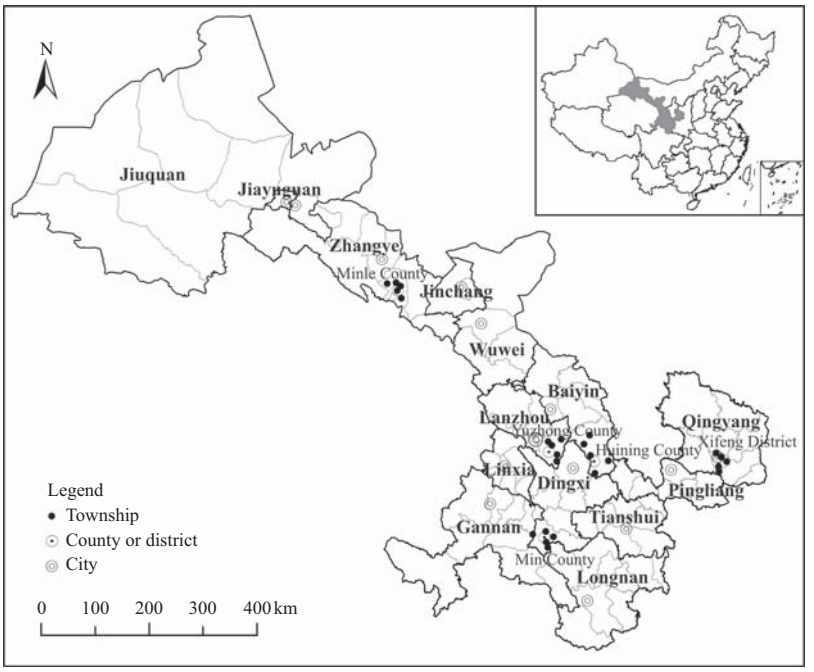

Figure 1.
Location of 25 sample townships

the sample. The five selected counties are Xifeng District, Yuzhong County, Minle County, Huining County, and Min County. Their average total industry output value per capita in 2012 was 23,691 yuan, 8,656 yuan, 4,453 yuan, 1,447 yuan, and 778 yuan, respectively (Table I). Furthermore, one village was randomly selected from each township, yielding 25 villages in the sample. Finally, we interviewed 20-30 rural households from each village, and the survey was conducted with the household head. Totally 705 households were surveyed. The interview was conducted by students of Lanzhou University with proper training. They were randomly dropped off in the front door of a household to conduct the interview. The questionnaire contains demographic information, planting and breeding situation, inputs and outputs of crops, farmland types and area, farmland lease situations, and willingness to transfer farmland. After excluding from the sample the households that rented out all land and did not grow any crops, we are left with a sample of 603 households for the ensuing analysis.

3. Variables and estimation model

3.1 Variables

The two main grain crops in rural areas of Western China are wheat and maize, which take up 39.83 percent of the total planted area in our study. Three dependent variables are defined as

Sample counties	City	Average industrial output value per capita (yuan)	Group	Number of households	Number of households included in analysis
Xifeng District	Qingyang	23,691	1	144	141
Yuzhong County	Lanzhou	8,656	2	157	115
Minle County	Zhangye	4,453	3	123	78
Huining County	Baiyin	1,447	4	132	128
Min County	Dingxi	778	5	149	141

Table I.
Sample structure

representative of grain acreage shares: wheat acreage share (the percentage of planted wheat area to total planted area on a farm), maize acreage share (the percentage of planted maize area to total planted area on a farm), and the sum of the two (grain acreage share).

The key explanatory variable is rented-in land share, defined as the percentage of rented-in farmland on a farm, where the total land area is equal to a households' contracted farmland area plus rent-in and minus rent-out. Previous studies mainly examined whether households plant non-grain crops on rented-in farmland or not, and how planted non-grain crops area on rented-in farmland changes with the increasing of rented-in farmland (Yi and Cheng, 2010; Zhang and Du, 2015; Zhang and Jiang, 2016). This study assumes that given the same farm size and plot size, not only the fact that whether a household rent-in land or not will affect crop choice, the relative size of rented-in farmland area to contracted land area and the component of operating farmland may also play roles in determining crop choice of a household. Thus, rented-in land share is employed as the key explanatory variable for it not only measures whether household rented-in land or not, but also contains information on the relative size of rented-in area land to contracted land area, and the component of operating land of a farm. We expect this variable to be negatively correlated with our dependent variables, based on conclusions of previous studies (Yi and Cheng, 2010; Zhang and Jiang, 2016).

According to previous studies, control variables in our model include farmer characteristics, household characteristics, crop profitability, agricultural policy, and county dummies (Feng and Heerink, 2008; Feng *et al.*, 2010; Yi and Cheng, 2010; Huang *et al.*, 2012; Che, 2016). Farmer characteristics include household head age, age square, education, and health condition. Household characteristics include family labor ratio, off-farm income ratio, and per capita land area. Crop profitability includes wheat profit per mu and maize profit per mu. These are factors directly related to agricultural production. Policy variables include grain subsidies received, land reallocation, and land transfer policy, which exhibit sizable variation across our sample. County dummies were included to control for cross-county differences in climate, soil, and economic conditions. Land reallocation and land transfer policy were employed as instrumental variables (IVs), given that they affect land renting-in but not crop choice.

Table II reports the descriptive statistic of dependent variables and explanatory variables. The average wheat, maize, and grain acreage shares are 19.65, 22.18, and 41.83 percent, respectively. The average rented-in land share is 4.80 percent in the study area, indicating a primary stage of farmland transfer in Gansu province. Household heads have an average age of 51.03 years old, which is a little higher than that of national level (46.75 years old) in a survey conducted in 2003 (Che, 2016) and close to that of in North Henan province (50.21) in 2009 (Yan and Huo, 2016). The average educational year of household head is 6.04 years which is lower than that of North Henan province (7.50 years) in the survey of Yan and Huo (2016) in 2009, indicating a poor education condition in Northwestern China. More than 90 percent of household heads are in general or good health condition. Households have an average family labor ratio of 66.24 percent and average off-farm income ratio of 68.00 percent which is very close to the data (65.68 percent) in Wang *et al.*'s (2017) study on Chongqing in 2012 and 2014, suggesting that off-farm income has become a critical income source to households in the study area. The average per capita land area is 2.51 mu which is a little higher than that of whole country (1.77 mu) in 2003 (Che, 2016). This variable has a very small minimum value of 0.06 mu per capita due to severe mismatch between contracted farmland area and family size to some households. Some villages have not reallocated their farmland since the starts of Household Contracted Responsibility System, while family size of some households in these villages has enlarged by a few times. This finally resulted in the severe mismatch between contracted farmland area and family size. The average profit per mu of wheat and maize are -0.49×10^3 yuan and -0.24×10^3 yuan, respectively. The negative values and large

Variable	Mean	SD	Min.	Max.
Dependent variables				
Wheat acreage share (%)	19.65	24.66	0	100
Maize acreage share (%)	22.18	28.07	0	100
Grain acreage share (%)	41.83	35.94	0	100
Explanatory variables				
Rented-in land share (%)	4.80	14.88	0	98.60
Farmer characteristics				
Household head age	51.03	11.08	22	81
Age^2	2,726.53	1,146.78	484	6,561
Education (years)	6.04	3.91	0	16
General health condition, general = 1; others = 0	0.18	0.39	0	1
Good health condition, good = 1; others = 0	0.73	0.44	0	1
Household characteristics				
Family labor ratio (%)	66.24	22.95	0	100
Off-farm income ratio (%)	68.00	32.48	0	100
Per capita land area (mu)	2.51	2.20	0.06	16.50
Agricultural production characteristics				
Wheat profit per mu ($\times 10^3$ yuan)	−0.49	0.45	−1.17	1.18
Maize profit per mu ($\times 10^3$ yuan)	−0.24	0.77	−1.65	2.45
Political characteristics				
Grain subsidies, yes = 1; others = 0	0.80	0.40	0	1
Land reallocation	1.14	0.70	0	3
Land transfer policy, yes = 1; no = 0	0.58	0.49	0	1
County dummies				
Xifeng, household in Xifeng District = 1; others = 0	0.23	0.42	0	1
Yuzhong, household in Yuzhong County = 1; others = 0	0.19	0.39	0	1
Minle, household in Minle County = 1; others = 0	0.13	0.34	0	1
Huining, household in Huining County = 1; others = 0	0.21	0.41	0	1

Notes: 1 mu is 1/15 hectares; age^2 is the square of household head age; education is education condition of household head; health condition is the health condition of household head; family labor ratio is equal to number of labors over family size, and family labors including all family members who ware able-bodied, not in school and between 16 and 65 years old (Huang *et al.*, 2012); off-farm income ratio is equal to off-farm income over total income; per capita land area is equal to contracted farmland over family size; wheat profit per mu and maize profit per mu are average values of households for each village; profit = price × yield-production cost (including labor cost, machine cost, seed cost, water cost, fertilizer cost, chemical cost and all other fees for material and service purchased for wheat or maize production), without including subsidies, and labor cost includes the cost of hired labor and family labor, machine cost includes the cost of rented machines and machines owned by households; grain subsidies is the answer of household to the question that "Have your family received grain subsidies last year?"; land reallocation is the frequency of farmland that has been reallocated by any kind of reallocation, since the start of Household Contracted Responsibility System; land transfer policy is the answer of household to the question that "Do you know that the Chinese Central Government are encouraging farmland transfer?"

Table II.
Descriptive statistics of variables used in analysis

variation of these two variables are mainly due to the high labor cost (cost 7.41 days per mu in wheat production, 10.54 days per mu in maize production, and 88.79 yuan per day in average of our survey) and large variation on labor demand to grow these two crops between households using machine and those without using machine, respectively. At the policy level, 80 percent of household think that they received the grain subsidies, and 58 percent of households know that government is promoting farmland transfer. Frequency of farmland reallocation has an average value of 1.14 times and 20 percent of villages did not experience any land reallocation, while Henan province has an average farmland reallocation frequency of 2.69 times in a survey conducted in 2009 (Yan *et al.*, 2014), suggesting a relative stable land tenure in the study area.

3.2 Econometric model and identification strategy

Our econometric model examines the impacts of land renting-in on planted grain acreage. The key econometric issue is the potential simultaneity bias arising from omitted variables that simultaneously affect farmland transfers and crop choice.

The IV estimation technique is a commonly adopted solution to the endogeneity problem, and many previous studies used IVs to overcome the endogeneity bias (Levitt, 1997; Hoxby, 2000; Acemoglu *et al.*, 2001; Satyanath and Sergenti, 2004; Ruseski *et al.*, 2014). It transfers correlational relationships among dependent variables and independent variables into causal relationships (Heckman, 2000; Burgess *et al.*, 2017). Thus, a 2SLS model with IVs was selected in this study.

To yield valid results, instruments must predict the exposure, must affect the outcome only through the exposure, and must not share unmeasured common causes with the outcome (Nguyen *et al.*, 2016). Lots of studies found that land tenure security has great impacts on farmland transfer (Li *et al.*, 2009; Yi and Cheng, 2010), and land reallocation reflects the security of land tenure. Land reallocations have served, and at some places still serve, as a substitute for land rental markets (Deininger and Jin, 2005). The more land reallocations have taken place, the lower likelihood of households to transfer their land. Hence, land reallocations have a direct impact on land transfer. Besides, government's encouragement policies on farmland transfer may also promote farmland transfer behaviors of rural households. Variables on land reallocation and land transfer policy determine the demand and supply of farmland rental market in an area. In addition, a rural household's crop choice and land portfolio decisions should not be directly affected by such transaction costs. Thus, land reallocation and land transfer policy satisfy the condition of instruments, and were employed as IVs for a household's farmland lease decision in our model.

Our basic econometric model is written as follows:

$$y_{ic} = \alpha_0 + \alpha_1 R_{ic} + X'\mu + D'\varphi + u_{ic} \tag{1}$$

where y_{ic} is wheat, maize, or grain acreage shares for a household i in county c; R_{ic} is rented-in land share for a household i in county c; X' is a vector of exogenous variables including farmer characteristics, household characteristics, crop profitability, and grain subsidies; D' is a vector of county dummies; and u_{ic} is the random disturbance term which is assumed to be independently and identically distributed; α_0, α_1, μ, and φ are parameters to be estimated.

The first stage can be expressed by the following equation:

$$R_{ic} = \beta_0 + Z'\gamma + X'\theta + D'\omega + \varepsilon_{ic} \tag{2}$$

where Z' is the vector of IVs including land reallocation and land transfer policy; X' is the vector of exogenous variables; D' is a vector of county dummies; and ε_{ic} is the random disturbance term; β_0, γ, θ, and ω are parameters to be estimated.

4. Results

4.1 First-stage regression

Estimation results of Equation (2) are presented in Table III. Overall the two IVs are each correlated with the key endogenous variable, rented-in land share, at 1 percent level. Land reallocation is negatively correlated with rented-in land share of households, and its coefficient is −6.398. This result is consistent with the study of Li *et al.* (2009) and the study of Yi and Cheng (2010), suggesting that unstable land tenure will prevent farmland transfer. Land transfer policy is positively correlated with rented-in land share of households, and its coefficient is 6.994. The active effects of government policy are reflected by these results.

Variable	Coef.		SE
Constant	−11.866		10.832
Exogenous variables			
Household head age	0.819*		0.445
Age^2	−0.008*		0.004
Education	−0.176		0.162
General health condition	1.183		0.997
Good health condition	4.026***		1.029
Family labor ratio	0.023		0.020
Off-farm income ratio	−0.049***		0.018
Per capita land area	−0.827***		0.318
Wheat profit per mu	0.784		1.190
Maize profit per mu	−0.075		0.736
Grain subsidies	−0.813		1.083
Xifeng	0.211		1.621
Yuzhong	3.239*		1.951
Minle	7.944***		1.747
Huining	0.986		1.556
Instrumental variables			
Land reallocation	−6.398***		0.960
Land transfer policy	6.994***		1.390
Number of observations		603	
F (17, 585)		14.63	
Prob. > F		0.000	
R^2		0.223	
Adjusted R^2		0.201	
Root MSE		13.3051	
Testing of the first stage			
Partial R^2		0.141	
Robust F (2, 24)		47.977	
Prob. > F		0.000	

Table III.
First-stage regression results

Notes: The standard errors are robust standard errors clustered at village level. *,**,***Statistically significant at 10, 5 and 1 percent levels, respectively

A number of tests were run to formally test the power of the instruments. The partial R^2 statistic measures the correlation between our endogenous variable and instruments after partialling out the impact of independent variables (Bound *et al.*, 1995). The partial R^2 in our model is 0.141, indicating a medium level of explanatory power of the instruments. The F-statistic (47.977) exceeds the empirical value of 10, suggesting that reliable inference can be drawn from 2SLS estimators (Stock *et al.*, 2002). Overall the set of instruments in our regression is fairly reliable and strong.

A few coefficients in the first-stage regression can help understand a farm household's decision of renting farmland. Rented-in farmland share seems to depend on the household head's characteristics. The coefficients on household head age and age square, respectively, are 0.819 and −0.008, and both of them are significant at 10 percent level. This indicates an inverted U-shaped relation between household head age and households' rented-in land share – the rented-in land share increases with age up to a peak point of 53.21 years old, after which it starts declining. The coefficient of the household head's health condition (good health condition) is 4.03 and significant at 1 percent level. Farming is labor intensive, and the household head frequently is the main labor supplier in rural China. Good health seems to boost the household head's ambition to expand the farm.

Among household characteristics, the ratio of off-farm earnings to the household's total income is negatively correlated with the rented-in land share at 1 percent level, with a coefficient of −0.049 and standard error of 0.018. This suggests that 1 percentage point increase in off-farm income ratio may result in a 0.049 percentage point decrease in rented-in land share. This is likely because off-farm employment tends to have a higher return to labor than farm work.

4.2 Second-stage regression

Table IV reports the 2SLS estimation results of Equation (1). Overall rented-in land share has no significant impact on wheat acreage share ($p > 0.1$), but boosts planted maize acreage ($p < 0.01$). The total grain acreage also increases with rented-in land share ($p < 0.05$), which is likely to reflect the positive response of maize acreage share to farmland renting-in. The irresponsiveness of wheat acreage to farmland renting-in is likely due to the low profitability of growing wheat in China – the average profit per mu of wheat is −489 yuan, and the average profit per mu of maize is −237 yuan without subsidy (Table I). In the regions we surveyed, wheat is mostly grown as a subsistence crop in small patches of land (Yuan *et al.*, 2010), and only has 0.55 mu per capita of land planted to wheat in average of our sample. The significant coefficient of 0.774 in the maize and 1.063 in all grain regression indicates that 1 percentage point increase in rented-in land share leads to 0.774 percentage point increase in maize acreage share, and 1.063 percentage point increase in grain acreage share. In addition to its relative profitability, maize is widely used as fodder,

	Wheat		Maize		Grain crops	
Independent variables	Coef.	SE	Coef.	SE	Coef.	SE
Constant	−23.494	18.278	13.503	8.549	−9.992	16.881
Key variable of interest						
Rented-in land share	0.289	0.271	0.774***	0.299	1.063**	0.496
Exogenous variables						
Household head age	0.771	0.708	−0.616	0.513	0.155	0.759
Age^2	−0.006	0.007	0.006	0.005	−0.001	0.008
Education	−0.054	0.264	0.229	0.254	0.175	0.266
General health condition	−1.906	4.409	−1.894	2.911	−0.012	5.606
Good health condition	−0.683	3.391	−2.941	3.446	−3.624	5.139
Family labor ratio	−0.027	0.032	−0.009	0.029	−0.036	0.047
Off-farm income ratio	0.104***	0.041	0.047	0.038	0.151**	0.070
Per capita land area	0.026	0.846	0.679	0.687	0.653	1.367
Wheat profit per mu	7.843*	4.578	−9.123***	2.243	−1.280	4.107
Maize profit per mu	−6.814***	1.546	22.208***	3.040	15.394***	3.459
Grain subsidies	4.374*	2.248	2.525	3.716	6.898*	3.966
Xifeng	32.998***	6.958	14.188	4.636	47.185***	5.796
Yuzong	9.945*	5.855	38.642***	4.596	48.587***	9.844
Minle	12.457**	5.270	−11.637*	6.458	0.820	9.920
Huining	8.329*	18.278	36.108***	4.394	44.437***	6.226
Number of observations	603		603		603	
Wald χ^2 value	1,020.71		1,295.63		2,289.48	
Prob. > χ^2	0.000		0.000		0.000	
R^2	0.311		0.449		0.379	
Root MSE	20.447		20.824		28.303	

Notes: The standard errors are robust standard errors clustered at village level. *,**,***Statistically significant at 10, 5 and 1 percent levels, respectively

Table IV. Regression results of second stage

a commodity rather than a subsistence crop. Although wheat and maize are both row crops suitable for mechanized farming, maize seems to be a better choice for rented-in farmland.

Farmer characteristics, including the age, education, and health condition of household head, have no significant effect on crop choice and grain acreage. These results indicate that the crop and acreage choice for rural households mainly depends on the convenience of production, and the profit of a special crop, but not the household head's personal characteristics. Note that, the convenience of production means suitable for relative large-scale and mechanized farming among rural households. For example, a farm can grow 50 mu grain crops without hiring labors, but impossible to grow 50 vegetables or flowers hiring labors.

Among variables of household characteristics, off-farm income ratio significantly increases the wheat acreage share (0.104) and total grain acreage share (0.151), but does not seem to affect maize acreage share. A 1 percentage point increase in off-farm income ratio leads to a 0.104 percentage point increase in planted wheat share, and 0.151 percentage point increase in planted grain crops share. Households with high off-farm income ratio tend to have less labor available for farming. Wheat as a less labor-demanding crop is certainly a popular choice for households with scarce family agricultural labor. In contrast, maize, as a commodity crop, demands a higher level of commitment from the household's laborers than wheat.

Wheat profit per mu has a positive correlation with wheat acreage share, and a negative correlation with maize acreage. The estimated coefficients (7.843 in wheat regression and −9.123 in maize regression) suggest that a 1,000 yuan increase in wheat profit per mu will lead to 7.843 percentage point increase in wheat acreage share, and 9.123 percentage point decrease in maize acreage share. Maize profit per mu has a negative effect on wheat acreage share, and a positive effect on maize acreage share. The significant positive response of total grain acreage to maize profit per mu is likely a result of mechanization, and large-scale planting of maize. The estimated coefficients (−6.814 in wheat regression, 22.208 in maize regression, and 15.394 in grain regression) suggest that a 1,000 yuan increase in maize profit per mu will reduce wheat acreage share by 6.814 percentage point, and boost maize acreage share by 22.208 percentage point and total grain acreage share by 15.394 percentage point.

Grain subsidies have a positive effect on wheat acreage share and on total grain acreage share. The estimated coefficients (4.374 in wheat regression and 6.898 in grain regression) suggest that a household receiving subsidies has 4.374 percentage point more farmland devoted to wheat than a household without, and 6.989 percentage point more to grain acreage share. All county dummies are statistically significant except Xifeng in the wheat analysis and Minle in the grain crops analysis, indicating noticeable differences in grain acreage shares across the counties likely due to climate, soil, and economic factors.

5. Discussion

Grain security is one of the top policy priority of Chinese Government (Wang, Wu and Sun, 2015; Jiang *et al.*, 2017). As China continues deepening its reforms of the rural land rental markets, it is important to understand the implications of farmland transfer and consolidation for the nation's grain food security. Such implications need to be understood at the farm level by examining the farmer's crop choice and the incentives of growing grain crops. Unfortunately, few studies have examined these issues. This paper fills the gap by studying the impacts of a farmer's rented-in land share on grain acreage share. Our econometric model is identified with a set of instruments, which finally depends on the demand and supply of farmland transfer in the area.

The main finding of our analysis is that households renting-in land trended to plant more maize, and the more land was rented by a household the more maize was planted,

while wheat acreage showed non-response to farmland renting-in. Our results are in stark contrast to a previous study conducted in Eastern China, which showed that farmland consolidation tends to encourage planting of non-grain crops and discourage planting of grain crops (Yi and Cheng, 2010). A possible explanation is that households in the eastern and central developed areas have higher opportunity costs to grow grain crops than those of in western economic backward areas. It resulted in that households in developed areas have stronger urge to grow cash crops with highly profitable than those of in backward areas. Moreover, poorer information flow and transportation (Wu, 2015a; Zhang and Lu, 2016) in backward areas of Western China greatly reduced the anti-risk capability of households, compared with those in eastern and central developed areas. This leads to the fact that rural households in Western China bear higher risk to plant high profitable cash crops. Therefore, maize, as a crop with relative high profit (Wu, 2015b), low risk on yield and price (Dercon, 1996; Gale, 2013) and suitable for relative large-scale and mechanized farming among rural household (Perelman, 1972), becomes a popular crop among households renting-in land.

However, our findings are consistent with those from a national study conducted by Zhang and Du (2015), showing that farmland renting-in boosts planted grain acreage. Taken together, these findings suggest that the effects of farmland renting-in on grain crop acreage are likely to vary across regions. Policy makers should expect that the changing trends of grain crop acreage differ in different parts of the nation.

Our analysis also suggests that within the bundle of grain crops defined by the government, there could be differential acreage responses to farmland transfer. In our sample, wheat as a subsistence crop (Yuan *et al.*, 2010) does not seem to be considered in a household's farmland renting-in, while the increasing commodification of maize makes it a strong crop choice for farmers with ambition to expand farm.

While these results may depict an optimistic picture as it relates to grain food security, they also suggest that productivity and profitability is at the heart of a farmer's cropping decision, as can be seen from the sharp contrast responses between wheat and maize acreage decisions to farmland renting-in. From a policy perspective, food security should seek to find the most effective way of improving profitability of grain crops. While the government has been granting large amount of subsidies to encourage farmers to grow grain crops, these programs are highly costly to the society and may not be the most effective way of promoting grain production.

Results of this study could provide some hints for understanding the role of farmland transfer in crop choice, and help policy maker to adapt some strategies to ensure food security. On the other hand, it is also worth noting that our results are based on a single-year data in one province, and some variation may exist among years and regions. Applying panel data methods to such data sets would reduce the impact of unobserved household and village heterogeneity that plagues simple cross-section analyses. Thus, a more robust research involving multiple years and regions is needed in further studies.

6. Conclusion

This study sheds light on the impacts of farmland renting-in on grain acreage. The 2SLS model with IVs was employed to solve the endogeneity problem of this study. The results indicate that households renting-in land trended to plant more maize, while wheat acreage showed non-response to farmland renting-in. Regarding to these results are contrast with the results of some other studies and two grain crops showed different responses to farmland renting-in in our study, the responses of grain crops to farmland transfer may differ across different regions and different grain crops. It is suggested that farmland transfer may be beneficial to China's grain self-sufficiency policy in some areas similar with Gansu province, but policy makers should be prepared for different changing trends of

grain crop acreage across the nation as farmland transfer continues. Besides, productivity and profitability is at the heart of a farmer's cropping decision. Thus, more research is needed to examine whether farmland transfer improves the productivity of grain crops and rural household income.

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