Evaluating spillover effect of non-grain production on land rent: Empirical insights from Jiangsu, China

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Abstract

Affected by low profitability of food crops, non-grain production has put a threat on Chinese food security. Though widely discussed, its impact on land rent has not been fully studied. This study explores the spillover effect of non-grain production from the perspective of factor opportunity cost. Data are extracted from 273 plots in Jiangsu province, China. Outcomes show that non-grain production significantly increases the land rent of surrounding plots by 222.02yuan/mu. This spillover effect exhibits a stronger trend as contracted land scale expands. However, the kin relationship among contract parties can weaken this effect, which points out that social ties can work as a mediator in resisting the external shock of non-grain production. Similarly, guided price set by governments is an indicator when land rent reaches an unreasonable level and hinders grain production. Far from being a spontaneous process of pure market forces, rural land use is actively harnessed by government at all levels. Hence, the study recommends a comprehensive land use plan and regional regulated land transfer market in order to achieve a balance between food security and diversified agricultural structure. Restrictions should not be imposed on the informal land transfer among acquaintances.

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Keywords: food security, non-grain production, land rent, opportunity cost, spillover effect

Introduction

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The farmland use transition to non-grain production has become a widespread phenomenon in China, especially in coastal and central granary areas where arable land with high quality (Tang et al., 2021). Grain acreage has witnessed a consecutive decline since 2016. In 2019, it dropped to 116063.6 thousand hectares, only accounting for 69.95% of total cultivated areas for all kinds of crops. This fact indicates that grain production and food security may be faced with new risks despite of a series of supportive policies aiming at improving farmers' willingness to plant grain crops. Non-grain production is defined as the conversion of large quantities of farmland to other crops, such as nursery plantation, cash crops, and poultry farming. Intuitively, farmer's crop selection is heavily driven by comparative profit of different crops. Rapid urbanization and economic progress dramatically changes consumers' daily eating pattern from a carbohydrate-oriented style to a more diversified habitat, leading to more consumption on vegetables, fruits and protein. This demand side switch transmits from the price mechanism and causes a lower profit from grain production (Yu, 2018). Data in the National Compilation of Cost-Benefit of Agricultural Products adds evidence to this conclusion. In 2018, the average production cost of rice, wheat and soybeans in China was $526.49 \, yuan /mu$ 111 $yuan = 0.1571$ USD, 1 $mu = 0.0667$ Hectare. while the average profit from these three crops was only 481.69 $yuan/mu$, altogether resulting in the cost-benefit rate of -7.83%. This figure declined by 14.94% compared with that five years ago. At the same time, the average cost-benefit rate of vegetable was 39.14% and the value for apple was 53.29%. The noteworthy profit disparity between cereal crops and cash crops attracts farmers in non-grain production in spite of higher production risk and investment.

Although non-grain production brings wealth for farmers and prevents further rural-urban income gap, it can not be ignored that the major aim of farmland use is to provide sufficient food and ensure food security in the political means (Leonhardt et al., 2019; Tongwei et al., 2020). To achieve this goal, food security has been put on the top agenda by the Chinese government. The principal of agricultural and farmland policy is to 'ensure the basic supply of cereal and the absolute self-sufficiency of grain ration'. In 2022, the Central First File stressed again that non-grain production should be alerted and food security should be achieved through 0.65 trillion kilograms grain production.

Several studies investigated the effects of non-grain production. Environmentally, the conversion to non-grain production can lead to sever pressure to local environment by accelerating soil erosion, threatening local biodiversity and aggravating non-point source pollution (Ziegler et al., 2009; Chatvijitkul et al., 2017; Bussi et al., 2018). In terms of socio-economic impacts, this change may pose a threat to food security by altering agricultural structure. For instance, Ge et al. (2018) constructed a per capita farmland area (PCEA) metric and found that farmland transition was driven by changes in agricultural labor, which lead to grain production to spatial difference, i.e., South China experienced a decline trend in grain production. Another line of research investigated this effect from the perspective of time and space. Yue et al. (2019) used multi-temporal high-resolution aerial photographs from 2005 to 2015 in China to investigate the trends of four categories of non-grain production (pond farming, duck rearing, nursery plantation and vegetable production). Their results revealed that non-grain production exhibited strong spatial auto-correlation and conspicuous regional disparities due to local traditions and the clustering effect.

Non-grain production increases cost of grain production by improving opportunity cost of land (Haile et al., 2014; Su et al., 2019). It is widely believed that comparative low benefit leads to non-grain production and grain acreage will increase following the rise of grain price (Su et al., 2019). However, there is also contradictory evidence. Tang et al. (2021) found that potential value of farmland may be changed with its use transition, and it can also lead to a spatial spillover effect on the adjacent plots. Benefit from cash crops are generally higher than that from cereal crops. Thus, non-grain production is an activity with high input and high return. This will further increase opportunity cost of grain production and lower its benefit. Grain production cost are dominated by labor cost, land rent and material fees. Considering the expansion of chemical industry and the development of social services, adverse effects brought by non-grain production on labor cost and material fees will be tampered. The other important cost, land rent, however, will rise due to the inelastic supply of farmland.

In light of these considerations, it is of interest to investigate the exact effect of non-grain production on

farmland rent. The aims of this study are (1) to test the hypothesis that farmland use transition to non-grain production has a positive spillover effect on the land rent of grain production; (2) to investigate the circumstance of farmers' characteristics and governmental intervention that may cause or counteract this purposed relationship. To address both aims, we first use basic regression analysis of a first-hand survey data both at the farmer and plot level. To obtain a deeper insight into the heterogeneity between this relationship, we then employ Quantile regression and divide the full sample into subgroups. The present study is an attempt to enrich the body of literature by expanding its study perspective from production cost, and by providing well-founded evidence due to the detailed data set we use in the empirical part.

The remainder of the paper is organized as follows, Section 2 provides background information and theoretical framework. Section 3 portrays data sources and empirical strategy applied in this study. Section 4 presents the main results of the empirical analysis. The last part draws conclusions and proposes some policy implications based on previous analysis.

Background and theoretical framework

2.1 Farmland rental market in rural China

As land is an important input for all industries and the provision of it is constraint by natural resources, land transfer in rural areas is far from active before 2000 (Benjamin and Brandt, 2002; Zhang et al., 2002). With the economic prosperity initiating from the 21th century and a large amount of labor force releasing from the agricultural sector, farmland transfer became more popular across the nationwide, especially in the Yangtze River Delta regions. At the very beginning, land transfer usually happened in an informal way. Farmers who turned to off-farm employment were inclined to leave their land to friends or relatives. Oral agreement instead of a formal written contract was used. Under this circumstance, crop rent other than cash rent was more preferred by land lessors, and rental duration was not fixed. This means the transaction continue from year to year until one of the parties decides to end it. These characteristics together indicate that trust and social network play a prominent role in rural farmland market. Constraint by the deficiency of land market in rural areas, land lessors prefer to select kinship-related tenants to increase tenure security and avoid potential risk during the transaction (Stein and Mesfin, 2021).

'Rural Land Contract Law' came into effect in 2003, marking the permission of land transfer from the national perspective. It is believed that farm size could be improved through land transfer, and along with the development of agricultural outsourcing, agricultural productivity and efficiency can also rise to a higher level (Heltberg, 1998; Helfand and Levine, 2004). In 2008 and 2009, promotion of farmland transfer was proposed formally in the 'Central No.1 Document'. Responding to the call of central government, government at local levels promulgate a number of polices and regulations. Jiangsu province, as an example, introduced both direct and indirect subsidies to promote land transfer. At the same time, more guidance on land transfer implementation has been proposed in order to make the land rental market a standardized one.

2.2 Theoretical support

Exploring the determinants of land rent has always been a hot spot in agricultural economics. According to Koemle et al. (2019), farmers individual characteristics, farmland characteristics, and agricultural policy were the most crucial factors influencing land rent for grain production. Demographics of farmer household are captured by farmer's gender, age, educational background, family labors, and off-farm employment (Lanjouw, 1999; Tratnik et al., 2009; Holden and Tilahun, 2021). In addition, land rental contract characteristics, such as land leasing (Vejchodská et al., 2022), lease term of land (Deng et al., 2019), and village traits are expected to have an impact on the land rent as well (Feng and Heerink, 2008; Barton, 2011; Appiah et al., 2020). Different from the basic production factor, land rent is not only determined by market equilibrium, but also partially controlled by the state. Thus, agricultural policy and subsidy policy for farmland lease (Lackman, 1977; Koguashvili and Ramishvili, 2018) also play a role in rent determination. Among these studies, land rent of grain production are affected by future profits from food crops or transaction cost of land lease. It should be noted that some special form of rental contract, i.e., 'social contract' , can exist due to the attribute of Chinese rural acquaintance society. In this regard, market mechanism is not the sole working

force and land rent can even drop to zero (Feng and Heerink, 2008; Tang et al., 2019; Tang et al., 2019).

While a large body of studies have focused on the driving force of increasing farmland rent, the effect of non-grain production has received less attention. Dating back to the early days when land transfer was allowed, food security was hardly maintained resulting from insufficient cereal provision. Under this circumstance, the use of farmland was strictly charged by the government. Restrictions on land use had been gradually removed when grain output experienced a continuous increase, along with rapid demand for diversified agricultural products. As market mechanism is an essential symbol of development of land transfer market (Coelli et al., 2002; Olagunju et al., 2022), non-grain production of farmland is par for the cause considering its higher return to land. Governments in some areas tacitly approve this land use change, some even encourages it (Wu et al., 2019; Qian et al., 2022; Shi, 2022). With the emergence of non-grain production, the land use has been expanded, hand in hand with the enhanced potential value (Lai et al., 2014;Qiu et al., 2021). Farmers need to pay higher rent to lend in the land, no matter how these plots are used (Tang et al., 2021).

Land is a key factor for production and the most important asset of livelihood. This is particularly true in China, where resources are distributed unequally between urban and rural areas. Farmland in China takes the role of social security, providing livelihood security, and employment security (Kan, 2021) (Sikorska, 2010). (Quinn et al., 2015) find that farmers report their attachment to farmland as due to their want for security; by developing a thriving economic business and leaving a family legacy. These characteristics are important concepts to note while studying land leasing markets. Leasing markets are accompanied with land rent and it is believed that the expected profit of land is regarded as key factor affecting land price or land rent.

Extensive and in-dept researches have been done concerning price formation in industrial land areas, whereas theories in farmland pricing are still limited. Marx in his theory first pointed out that land price was determined by the profit that land can create (Hirashima, 2008), which essentially manifested the capital value of land. This paper draws from the application of the Income Capitalization approach, which allowing investigators to estimate the value of land based on the income it generates. It's used by taking the net operating income (NOI) of the rent collected and dividing it by the capitalization rate. Expanded to farmland, land rent is a reflection of land price. Keeping in view the Marx, it is assumed that TR indicates the total land rent in the term of the land lease contract, and the land lease term is n years. At time t, expected profit of farmland is equal to ER_t, which may be influenced by farmland characteristics and grain price (indicated by a vector X), such as soil fertility, irrigation conditions, topography and so on and r_t represents the discount rate. So, the equation for land rent is as follows:

(1)

We modify the model by introducing the emergence of non-grain production into the above equation. With the relaxation of policy, land lease are able to adjust the agricultural planting structure based on consensus with the leaser. Whether produce grain or non-grain crops (such as horticultural products) have an impact on the expected profit of the farmland, and then have an effect on the land rent. Intuitively, it will lead to a higher profit when the farmland is leased out for non-grain production. In order to simplify the subsequent analysis, we hold the assumption that the profit from economic crops production is α times grain production.

Moreover, which species are planted depends on the opportunity cost of land (Hartwick, 1989; Renkow, 1993; Raiklin, 1998), and in turn, land rent may affect the choice of planted species. When land leaser no longer has a strong social security function, then it is not essential for landlord to lease the farmland either for grain production or non-grain production. The leaser ultimate goal is to maximize the income obtained from the farmland. In the existing researches, numerous scholars neglected the spillover effect of higher land rent for non-grain production on the surrounding land rent of grain production. Facing the higher land rent obtained by surrounding land leaser because of non-grain production, the leaser will also require a higher land rent even if the land is leased for grain production. Of course, not all farmland is suitable for non-grain production. When there is more non-grain production situation in the surrounding area, there are more opportunities for the leaser to lease farmland to the farmers who are engaged in non-grain production and

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there are also more opportunities to get higher land rent. Assuming there is a coefficient β between 1 and α, indicating the spillover effect of non-grain production on land rent of grain production (see Fig.1). Modified equation for land rent of grain production can be expressed as follows:

(2)

With the rapid development of the land transfer market, China's agricultural land transfer market is characterized by the relaxation of transfer use control. Based on the above analysis, we come up with two hypothesizes that need to be tested in the current study.

H1: The emergence of farmland use transition to non-grain production has a positive spillover effect on the land rent of grain production.

H2: With the higher land rent of non-grain production, the land rent of the plots around which is leased for grain production will also rise.

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Fig. 1. Spillover effect of non-grain production on land rent

Methodology

3.1 Study cites

The study was conducted in Jiangsu Province, a major agricultural production area of China. Lying between latitude 30-35° and longitude 116-121°, it covers 4.58 million hm^2 of arable land, with 0.057 hm^2 of arable land per capita. Dominated by a subtropical humid climate, the region enjoys four distinct seasons with abundant rainfall and sunshine. The average annual temperature ranges from 13-22, average rainfall is between 760-1215mm, and annual sunshine is 2000-2600h. Rich in diversified microorganisms, soil quality in this area ranks at a priority level and 79% of the arable land is plain. Given the favourable farming conditions, Jiangsu is not only a key player in traditional grain production, such as wheat, rice, and rape, but also has natural advantage in producing cash crops and vegetables. In 2018, the total grain production of this province reached 36.6 million tons, accounting for 5.56% of the total national output and ranking the sixth nationwide. Owing to the rapid growing land rent market, farmland use transition to non-grain production is common accompanied by frequent land transfers. As it exemplifies non-grain production in rural China, Jiangsu was selected to comprehensively explore this phenomenon.

3.2 Sampling and participants

The data used in this study was gathered from the field survey conducted in 2018 (see Fig.2). A multi-stage sampling method was adopted to select the participants in the middle and northern areas. At the first stage, Yangzhou, Taizhou and Suqian were chosen at the city level considering they make major contributions to the provincial grain production. In the next move, Gaoyou, Jiangdu, Jiangyan, Xinghua, amd Sihong were selected at the county level keeping in view with the conditions regarding the farmland rent market. Among each county, two townships were randomly selected while 8-10 large-scale farmers were chosen at the last step. The questionnaire comprises information concerning farmland rent, agricultural production input and output, personal traits and household demographic characteristics. With information gathered from both household and plot, 88 respondents were included and 273 plots were obtained.
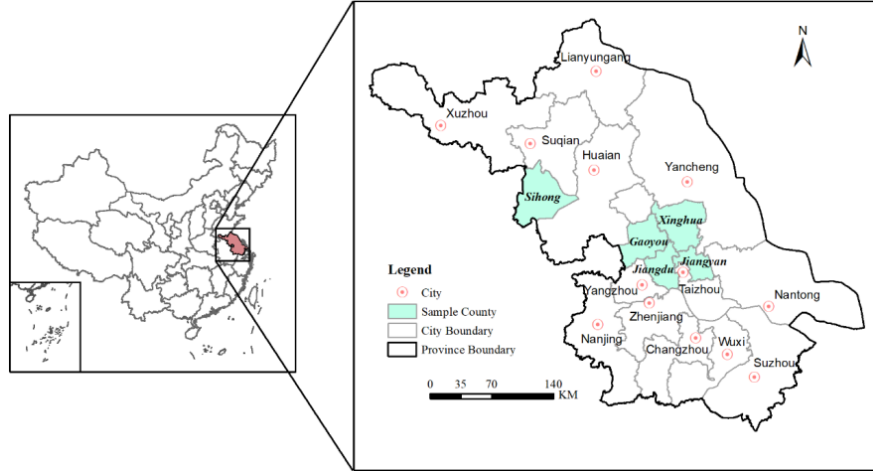
Fig. 2. Map of the study area

It is necessary to point out that the reliability of interpretation from empirical results can be hardly adversely affected by the limited farmer observation. Firstly, this study focuses on the plot level and the observations from plot can provide sufficient information. Additionally, the total area of sampled farmland approaches to 30 thousand *mu* , making our sample a representative one. Table 1 elicits distribution and detailed information of sampled farmland. The majority plots comes from Gaoyou (n=84) while the minority plots were from Sihong (n=28). Correspondingly, the highest plots of per household can be found in Gaoyou (n=4.42) and Sihong witnesses the lowest plots per household owned (n=2.00). On average, each farmer owns 3.1 plots, with 1 plot as the minimum value and 9 plots as the maximum. The average area of plot is 108.53 *mu.*

Table 1. Description of the sampled plots

	Num. of plots	Num. of plots per farmer owned Average	Num. of plots per farmer owned Max	Num. of plots per farm Min
Full sample	273	3.10	9	1
Gaoyou	84	4.42	9	1
Jiangdu	40	2.11	4	1
Jiangyan	44	2.59	6	1
Xinghua	77	4.05	9	1
Sihong	28	2	5	1

3.3 Empirical strategy

To estimate the relationship between farmland use transition to non-grain production and rent, the following equation is introduced based on theoretical analysis in Eq. (2):

(3)

where R is the outcome variable, denoting the rent of farmland;indicated the phenomenon of farmland use transition to non-grain production;represents the interaction term of and its rent;is the vector of farmer's characteristics;indicates the vector of farmland information;represents the vector of land rental conract;is the erro term. are the coefficients to be estimated.

In the empirical analysis, we begin with a series of benchmark models using OLS estimate method. In Model 1-1, only key independent variable and interaction term are included. In the second step, Model 1-2

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is extended by introducing farmer's individual and household information. To account for plot-level heterogeneity, we employ variables to control the natural endowments of farmland and rental contract variation. The specification in Eq. (3) is also estimated by a Quantile method in order to check the robustness of the results. This method enables us to estimate the effect of farmland use transition on rent at different sites.

As the above specifications may eliminate farm-invariant characteristics, we can not estimate whether different types of farms exhibit different effects of rental. To investigate this, we therefore split the full sample according to the following traits: (i) farm with small, medium and large size. We order contracted land scale and group them into three categories equally. Each group is named small, medium and large size, respectively ; (ii) origin of the tenured farmland (from relatives or from other farmers).

Land tenure market in China is largely affected by the local government. As the ownership of farmland belongs to the community, transfer of land is not determined by the market equilibrium. In some areas, the ceiling price and floor price of rent is set by local governments or village committee. Keeping this external background in mind,we also introduce variables to evaluate government's effect in land rent.

3.3.1 Outcome variable

Land rent can be calculated in two ways. The first method is the annual rent approved by two parties as the contract is an cash payment one. Another measurement is an indirect way. In this case, land rent is relevant to a certain amount of cereal and converted to cash according to the minimum supportive price set by the central government (Zhang et al., 2019). In order to make the empirical results comparative, following Renkow (1993), we use the actual payment as the proxy for land rent.

3.3.2 Explanatory variables

The primary explanatory variable is farmland use transition for non-grain production. This is a dummy variable in our study whose value equals to '1' when there is the non-grain production while '0' is assigned when there is no such phenomenon. It is essential to identify the scope of non-grain production in practice as the spillover effect could be too weak to recognize when distance increases. So, respondents were asked 'if there is non-grain production in the farmland within the village they live' during the field research (Tongwei et al., 2020).

We also consider other factors and introduce them as control variables. Demographic characteristics are presented using age, gender, education background, training experience, leadership in community, and farming experience (Tratnik et al., 2009; Koemle et al., 2019). Plot-level factors are characterized by quality of farmland and distance between land and house (Qian et al., 2020). Characteristics of land rental contract include areas of land, relationship between the contract parties, duration or renewal expectation of contracts, whether contracts are written or oral, whether contracts are fixed, contract payment (by cash or by crop-sharing), timing of rent payment, etc (Olagunju et al., 2022).

4. Results and discussion

4.1 Descriptive statistics

Table 2 depicts the traits of farmers and their agricultural production. Overall, Majority of the study participants are male (82%), have an average middle school education (8.37), in their fifties (50.46), without any official position in the rural community (84%) and their average annual income sourcing from agriculture is 35, 300 *yuan.*The number of labor force per household is averaged at 4.67. The results also indicates that respondents had rich experience in producing cereal crops as 80% of them are trained before and they stayed in farming for 7.67 years on average.

In terms of farmland and land rental contract characteristics, the quality of farmland in the study area is not much better than the provincial average. 60.44% of the respondents evaluate their farmland as the medium level while only 26.37% of them confirmed their land of high quality. The average distance between a plot and the farmhouse is about 2 kilometers. The overall farmland rent is averaged at 772.25 yuan per *mu* . However, the rent is much higher and reached to 935.17 yuan per *mu* where use of farmland are more

diversified other than cereal crops. This result reveals that non-grain production mediating the farmland rent by increasing the promising output of land. As land rental market enables farmers enlarge their farming scale, the rental contract is dominated by a written one (95%) whereas only a small proportion contract was agreed on oral. A large share of the contacts are fixed in the duration (91%). Only a small number of farmers rent in farmland from their relatives (7%) , which implying a developed tenure market in the study regions and less possibility of the 'social contract'. Most of the rent is paid in cash (92%) while time of payment varies across contracts. 76.19% farmers choose a annual cash payment upfront at the time of contract agreement while 12.82% of sampled farmers pay the rent after harvest. The proportion of the farmers who paid the whole contract rent at once is only 10.99%.

Table 2

Descriptive statistics of the respondent and their land

Items	Definition	Num.	Mean	Mean	Std.
Outcome variable					
Land rent of grain production	*yuan/mu*	273	772.25	229.37	229.37
Key variables					
Non-grain production nearby	0= no; 1= yes	273	0.13	0.34	0.34
Non-grain production*land rent	*yuan/mu*	35	935.17	155.61	155.61
Demographics					
Gender	0= female; 1= male	273	0.82	0.39	0.39
Age	year	273	50.46	7.04	7.04
Education	year	273	8.37	3.10	3.10
Leadership in community	0= no; 1= yes	273	0.16	0.36	0.36
Training experience	0= no; 1= yes	273	0.80	0.40	0.40
Experience in farming	year	273	7.67	4.54	4.54
Income from agriculture	10,000 yuan	273	3.53	6.26	6.26
Family labor	person	273	4.65	1.48	1.48
Land quality					
Higher quality		72	26.37%	26.37%	26.37%
Medium quality		165	60.44%	60.44%	60.44%
Low quality		36	13.19%	13.19%	13.19%
Distance between plot and home	kilometers	273	2.04	2.63	2.63
Farm size	*mu*	273	108.53	143.78	143.78

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Contract characteristics					
Form of rental contract	0= written; 1= oral	273	0.05	0.23	0.23
Fixed contract duration	0= no; 1= yes	273	0.91	0.28	0.28
Relationship between contract parties	0=no personal contact; 1=relatives or friends	273	0.07	0.26	0.26
Rental payment	0= other means; 1=by cash	273	0.92	0.27	0.27
Timing of payment					
Paid once during contract duration		30	10.99%	10.99%	10.99%
Once per year, before production		208	76.19%	76.19%	76.19%
Once per year, after production		35	12.82%	12.82%	12.82%

Figure 3 gave an overview of correlation between farmland use transition and its rent. The Boxplot was characterized by statistics value such as mean, median, upper quartile and lower quartile. The vertical coordinate was decomposed by two groups, farmland with use transition to non-grain production and without use transition. As the figure showed, it was obvious that the rent of farmland where there was no use transition was lower than that in areas that was occupied by other crops. This result indicated that our hypothesis may stand that non-grain production can improve farmland rent by changing the opportunity cost of land.

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Fig. 3. Box diagram of land rent of grain production

4.2 Regression results of baseline model

A series of OLS regression analysis were conducted as the benchmark models. Personal traits, household characteristics, farmland information and rental contract characteristics were stepwise introduced into Model 1-1 to Model 1-4. The results confirmed our first hypothesis H1 that farmland use transition to non-grain production has a positive spillover effect on the land rent of grain production. Rental price will increase by 222.02 *yuan/mu* as long as there is non-grain production in the area. Additionally, rental price of the land with grain production will increase by 0.14 *yuan/mu* if the rental price of land with non-grain production rise 1*yuan/mu*.

The coefficient on farmers' characteristics showed statistical significance indicating that personal traits did influence the rental price. As shown, education and skill training both have positive effects on farmland

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rental price. This indicate that farmers with higher education and training experience tend to be less vulnerable faced with agricultural risks and thus are more willing to take higher land rental price. This results are aligned with Feng et al. (2010), who also find similar relationship between farmer's involvement in agricultural production and land rent. Moreover, farmers' age and family labors negatively affected farmland rental price.

Keeping in view with characteristics at the plot level, rental price of high-quality farmland is 54.83 *yuan/mu* higher than that of low-quality land. It is clear that high-quality farmland are more productive and profitable.Surprisingly, The coefficients of the indicator variable 'distance between home and plot' showed unexpected sighs: the longer distance between the plot and farmer's house, the higher the land rental price. This results contradicts with our common sense. It is widely believed that the plots adjacent with farmers' house usually lead to higher rental price as transport manure or other inputs across large distance is costly and time-consuming (Leonhardt et al., 2019). What's more, the did not statistic significance.

In terms of rental contract characteristics, the contracted land area (i.e., the size of plot) showed a significant positive effect on rental price. Large farming size is conductive to economics of scale (Lowder et al., 2016). Therefore, lessees have a higher willingness to pay for rented-in land with adjacent large plots. Concerning the contract form, the price of rent set by a written contract is 176.39 *yuan/mu*higher than that of an oral contract. Also, a higher rental price of 142.37 *yuan/mu* can be found in the contract which is terminable at a fixed notice (1 year or two growing seasons) than a open-ended one. Usually, a written contract is more formal and has more regulations on the parties than a oral contact do. Beyond the contract format and duration, social ties of the partners also play a role. When the rental transaction is conducted between acquaintances, such as relatives, friends or familiar villagers, the rental price tends to be higher. As the results unveil, lessees get a 20.84 *yuan/mu* lower advantaged price if they have a kin or geographical relationship with the lessors. This result is consistent with existing studies arguing that a close social tie brings the lessees price discount (Tang et al., 2019). Regrading rental payment method, lessors prefer a cash payment rather than a crop payment. Thus, rent paid by cash is 98.25 *yuan/mu*lower compared with other payment method. Though this results correspond with common believes, a notable fact that payment by crop would be overestimated with using national purchasing price should raise our concern. In terms of timing of payment, the rental price will raise 70 to 80 *yuan/mu* if paid annually compared with paying by once. It makes no statistical difference if the rent is paid before or after.

Table 3

Regression results of baseline model

Items	Land rent of grain production Model1-1	Land rent of grain production Model1-2	Land r Model
non-grain production nearby	238.94***	204.78**	215.84
	(89.251)	(86.119)	(85.63
xrent	0.15	0.15*	0.16*
	(0.095)	(0.092)	(0.091
gender		-47.78*	-44.80
		(25.244)	(25.42
age		-2.47**	-2.44**
		(1.176)	(1.176
education		5.11*	5.89**
		(2.947)	(2.944
leadership in community		-95.98***	-91.45
		(20.422)	(20.95
training experience		66.28**	57.92*
		(28.912)	(28.96
experience in farming		1.47	0.87

			(1.999)
income from agriculture			-1.08
			(1.406)
household labor			-6.64
			(5.639)
land quality-high			52.70*
			(17.10
land quality-medium			35.29
			(23.04
distance between plot and home			1.48
			(2.917
farm size			
form of rental contract			
fixed contract duration			
relationship between contract parties			
rental payment			
timing of payment-once a year, before production			
timing of payment-once a year, after production			
region	Controlled	Controlled	Contro
R-squared	0.734	0.776	0.784

Notes: is the cross term of and the land rent of non-grain production.

*p<0.1,**P<0.05,***p<0.01.

4.3 Robustness check with Quantile regression

The impact of non-grain production on rental price has been tested with a OLS specification. To a considerable extent, we need to know if this spillover effects maintains the same intensity with variation of outcome variable. In Table 4, empirical method was substituted with the Quantile regression. The results depicted that the phenomenon of non-grain production has a significant positive effect on rental price at the lower quantile and mean level. For each quantile level, the emergence of non-grain production will increase farmland rental price by $440.77 yuan/mu$ and 286.17 $yuan/mu$, respectively. As the rental price reached at a high level, the significant effect of non-grain production can still be found. In general, the marginal effect of non-grain production on land rent is decreasing. The results of Quantile regression indicate that our conclusion is valid, with the empirical strategy is replaced.

Table 4

Regression results from Quantile model

Items	Land rent of grain production QR_25	Land rent of grain production QR_50	Land rent of grain produc QR_75
non-grain production nearby	440.77*	286.17*	144.91
	(236.177)	(153.676)	(121.898)
xrent	-0.07	0.05	0.23*

	(0.268)	(0.176)	(0.139)
farmer-specific characteristics	Controlled	Controlled	Controlled
plot-specific characteristics	Controlled	Controlled	Controlled
rental contract-characteristics	Controlled	Controlled	Controlled
region	Controlled	Controlled	Controlled

Notes: *p<0.1,**P<0.05,***p<0.01.

4.3 Heterogeneity analysis

Looking at difference in the farming scale, statistically and economically significant effects can be found in Table 5. Among the three subgroups, the spillover effect of non-grain production on rental price is not prominent for small scale farmers. However, for farmers with medium and large scale, non-grain production shows a increasingly enhanced spillover effect. With the expansion of farm size, this effect became stronger. A possible explanation may lie in the bargaining power of the lessors. As large contracted areas can bring economies of scale, it is in lessors' favor if their rental land are adjacent and with large plots. When rent of nearby farmland is high due to the profitability from non-grain production, lessors tend to raise their rent as well.

Table 5

Heterogeneity analysis with control for farm size

Variables	Land rent of grain production Small scale	Land rent of grain production Medium scale	Land rent of grain produc Large scale
non-grain production nearby	222.08	321.11*	330.00**
	(285.014)	(183.231)	(124.581)
xrent	0.26	0.02	0.001
	(0.328)	(0.338)	(0.122)
farmer-specific characteristics	Controlled	Controlled	Controlled
plot-specific characteristics	Controlled	Controlled	Controlled
rental contract-characteristics	Controlled	Controlled	Controlled
region	Controlled	Controlled	Controlled

Notes: *p<0.1,**P<0.05,***p<0.01.

Contract parties are essential elements determining the actual or shadow land rent. A notable fact in rural China is that a large amount of farmland was transferred among relatives or kin relationships and the rent is lower than it should be on the market equilibrium. In some extreme cases, land rent can even drops to zero. Under such circumstances, rent is no longer the reflection of the endowment of plots, but a combination of complex social ties. Table 6 showed regression results decomposed by different contract parties. The source of rented land has been divided into two categories, one is with kin relationship, and the other is without kin relationship. The coefficients of the two subgroups clearly showed that the existence of non-grain production has a greater impact on the farmland rent if transaction parties are not blood related. It is observed in the literature that personal ties between contract parties can bring lessors rental security. And joint measure shall be taken to avoid potential risk concerning the farmland (Tang et al., 2019).

Table 6

Heterogeneity analysis on relationship between contract parties

Items	Land rent of grain production Relative or friends	Land rent of grain production No personal contact

non-grain production nearby	229.63***	583.29***
	(75.375)	(166.056)
xrent	0.14*	0.01
	(0.079)	(0.011)
farmer-specific characteristics	Controlled	Controlled
plot-specific characteristics	Controlled	Controlled
rental contract-characteristics	Controlled	Controlled
region	Controlled	Controlled

Notes: *p<0.1,**P<0.05,***p<0.01.

4.4 Effects of governmental regulation on rental market

Guided rental price has been provided by local governments in formal or informal ways since 2010 to promote farmland transfer. We introduced a cross-term dummy variable, kind*GGP11GGP indicates whether the government-guided land rent is higher then the average land rent in practice. GGP equal to 1 means government-guided land rent is higher, equal to 0 means government-guided land rent is lower. to measure the effect of government's price intervention. Results in Table 7 implied that if government guided price is higher than the actual land rent, non-grain production can lift rental price by 222.62 *yuan/mu* . On the contrary, the rental amplification is only 63.45 *yuan/mu* when government guided price is lower than the market price. The results questioned the findings of Barton (2011) and Zhang et al. (2019). As revealed in their studies, guided price set by the government tends to serve as a floor price, which is always higher than the market price. It protected incomes of lessors while boosting the rent of grain production. Data and empirical analysis of this study exposed that the variation of government's guided price in different regions is served as a mediator, especially when the land market is too hot.

Table 7

Heterogeneity analysis on government's intervention

Variables	Land rent of grain production
kind = 0 & GGP = 0 (based)	0
	(0)
kind = 0 & GGP = 1	186.90***
	(22.572)
kind = 1 & GGP = 0	63.45***
	(29.061)
kind = 1 & GGP = 1	409.52***
	(123.309)
xrent	0.13
	(0.101)
farmer-specific characteristics	Controlled
plot-specific characteristics	Controlled
rental contract-characteristics	Controlled
region	Controlled

Notes:*p<0.1,**P<0.05,***p<0.01.

5. Conclusion and policy implications

5.1 Conclusions

Farmland is the basic resource for grain production and the guarantee for food security. Constraint by

the limited land resources, China has a highly stringent farmland use policy and is especially sensitive to its use transition. With rapid development and urbanization, increasing demand for diverse agricultural products induced the booming expansion of non-grain production activities, placing pressures on farmland resources. This phenomenon has received considerable attention in academic literature, as well as policy analysts. Existing studies have proved that non-grain production has greatly influenced crop acreages and structure. However, due to the correlation on the rental market and product market, the effects of farmland use transition may not be limited to the quantity level. Moreover, the morphology change of farmland alters shadow price of this factor. From the perspective of opportunity cost of farmland, this study is conducted to explore the spillover effect of non-grain production on rental market and investigate under which circumstances this effect works. Results of this study have provided a panoramic view of the non-grain production trend.

First, research findings reveal that non-grain production increases the land rent of grain production by improving its opportunity cost. Where there is land transferred for non-grain production nearby, the rent for grain production will significantly increase. However, this spillover effect virtually weakens once land rent reaches a high level. This means the relationship is non-liner and stronger at the lower distribution of the rent, which was also confirmed by the robustness check with Quantile regression.

Second, the spillover effects may vary once plot and farmer heterogeneity were accounted for. In this regard, contacted plot areas and social relationship of contracted parties were introduced into the analysis. In terms of contracted farm size, large plots were usually accompanied with economies of scale. As a result, leasers who rent out large adjacent plots have greater bargaining power over the rental contact and may exert price control. This is most notably when there is non-grain production nearby as the potential profitability of the farmland has been lifted. Besides, our study showed that many lessors and lessees have close personal contact. Thanks to the social ties, contracted parties tend to take joint measures to resist risks, i.e., the increasing land rent driven by non-grain production.

Third, the visible role of the government is shown to be pivotal in moderating the farmland rental market. By observing how changes in the government guided price in different regions affects rental price, this paper contributes to the farmland pricing theories. Our findings confirm that government regulations may indeed be an important mechanism mitigating a potential positive effect of non-grain production on farmland rent. In particular, when guided rent set by the government is lower than the local rent, the formal price served as an indicator and hindered the rental price raising too much.

5.2 Limitations

Although the case of China offers unique insights for comparative research on the farmland use transition on rental market, the current study still has limitations. Data used in this study was limited in Jiangsu province, which was not a big sample size. In spite of this, the calculation is sufficient to prove our hypothesis. More complicated evaluation on rental spillover effect can be conducted with more data source available. As s concluding reflection, this paper highlights the need for future research to investigate the unfolding impact of non-grain production on comprehensive production cost in terms of cost efficiency. From this perspective, further in-depth analysis can be made on how might the non-grain production affect farmers' factor allocation.

5.3 Policy implications

The conclusions of this study have certain policy significance for regulating farmland transfer market and maintaining food security. It is alarming for governments to monitor the non-grain production trend, especially in the granary areas, i.e., North-eastern provinces and Yangtze River regions. Farmland use should be properly planned in accordance with the principal of providing sufficient grain and main staples domestically. However, the balance between food security and economic growth should be accounted for at the same time. Considering the spillover effect of non-grain production on lifting land rent, a possible selection is to gather the plots with non-grain production together, as shown in Fig. 4. In this regard, the effect can be constraint in a limited areas. Applying this implication into practise, Jiashan County, located in the north-east

of Zhejiang province, constructed a complex holding the non-grain production. This approach effectively control the diffusion of increasing rent on farmland. Also, government guided price is needed when land rental market becomes more market-oriented. The ceiling rental price set officially is an effective mediator in eliminating the negative effect of non-grain production. Last but not least, informal land transfer among farmers with close personal connections should be allowed as this format can reduce transaction cost and is resilient to external shock.

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Fig. 4. Graphical representation of policy implications.

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