Land tenure security, migration and farm performance in rural China

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Thesis

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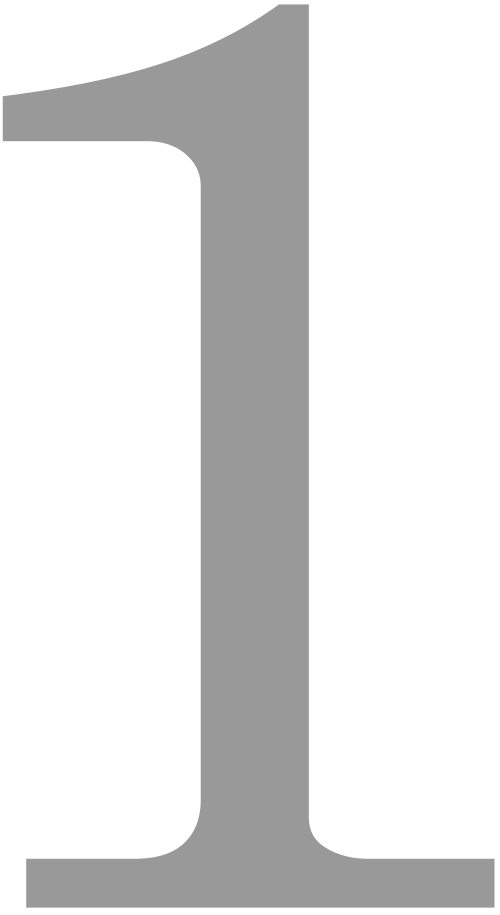
To my family

Contents

CHAPTER 1



Introduction

Chapter 1 Introduction

1.1 Problem statement

Land tenure security is an important precondition for the economic development and livelihood security of rural households. In China, the introduction of the household responsibility system (HRS) in 1978 marked the de-collectivization of agriculture and the first step of market-oriented economic reform. The land tenure reform granted individual households long-term land use rights, while the ownership of land remained at the village collective level. The reform resulted in spectacular agricultural growth in China and has lifted millions of the rural population out of poverty (Lin, 1992).

However, land tenure security under HRS could be undermined by land reallocations. Land reallocations are conducted by village collectives to preserve the equity of land holdings within villages. The central government, therefore, implemented several legal land tenure reforms after the second-round land contracting in 1998 (hereafter referred to as the 1998 land contracting round). Measures taken included very strict regulations on land reallocations within villages and the issuing of land certificates to farmers. However, local authorities still have much power over the enforcement of these reforms (Rao et al., 2017). Villages' decisions on land reallocations differ greatly across regions and many farm households continue to perceive their tenure as being insecure (Giles and Mu, 2018; Ma et al., 2013).

Despite the role of land tenure reforms in livelihood security, migration to off-farm sectors is a crucial livelihood strategy for rural households to reduce poverty and increase income. The number of rural migrants has increased significantly in China since the 1990s. In 2015, there were nearly 200 million migrants in China (National Bureau of Statistics, 2016). Migration for working purposes could improve households' income level, as value added per worker in the off-farm sector is much higher than that in agriculture in developing countries. Migration

also diversifies the sources of income and could improve the income security of rural households. Migration decisions are to a large extent shaped by the institutional arrangements, such as villages' land tenure arrangements. Land tenure insecurity caused by local institutional arrangements could be a major obstacle for migration. When households face a high risk of losing part or all of their rural land, potential migrant members may prefer to stay home instead of migrating to urban areas for work.

Another main livelihood strategy for rural households is on-farm production. Improved farm performance benefits not only the welfare of agricultural households, a nation's food security, but perhaps also the environmental quality when societies pursue sustainable agricultural growth. Both the economic and environmental performance of a farm are then of great importance when assessing farm performance. In contrast to developed economies, developing economies like that of China can face particular challenges in improving the performance of their farms. A notable challenge could be substantial labour force shifts from agriculture to off-farm sectors during the process of economic development. This process then makes it difficult for rural households to balance resource allocations between on-farm and off-farm activities. For example, a household with potential migrants should decide how much labour and money to invest in on-farm production and migration respectively.

Given the importance of land tenure security, migration and farm performance, and their interrelationships, this thesis provides a joint analysis of land tenure security, migration and farm performance.

1.2 Objectives and research questions

Land tenure security and migration play vital roles in rural development. Farm performance benefits not only a nation's food security, but also sustainable agricultural development. However, a full picture of the linkages is lacking.

Hence, the overall objective of this thesis is to conduct a joint analysis of land tenure, migration and farm performance in China. The thesis therefore addresses the following research questions:

First, what are the driving factors of persistence of land reallocations? Particularly, how do village democracy and households' knowledge of policy affect the persistence of land reallocations?

As individual villages were empowered to decide on their own arrangement of land reallocations, village democracy could play an important role in their decisions concerning land reallocations. Moreover, as the approval of two-thirds of villagers or villager representatives (hereafter referred to as the majority principle) became a crucial requirement after 1998, households' knowledge of policy might influence villages' decisions on land reallocations as well. It is crucial to include those factors related to village empowerment such as village democracy and villagers' knowledge of policy when investigating driving factors of persistence of land reallocations.

Second, how do land reallocations and two rounds of land certification affect households' perceptions of land tenure security?

Strict regulations on land reallocations within villages, and the issuing of land certificates to farmers are the main measures taken by Chinese central government to improve legal tenure security since the 1998 land contracting round. Since 2009, a new rural land certification programme has been implemented which aims to further increase land tenure security. The conduction of land reallocation and two rounds of land certification are likely to influence households' perception of land tenure security.

Third, how do actual and perceived land tenure security affect migration? Does land rental market development play a role in these effects?

Land tenure insecurity could be an important obstacle to migration. Empirical studies of tenure security and migration mainly focus on either existing land tenure arrangements (actual land tenure security) or households' perceptions of land tenure security (perceived land tenure security) (e.g. Giles and Mu, 2017; Mullan et al., 2011; De La Rupelle et al., 2008). Although perceived land tenure security is closely related to actual land tenure security, actual land tenure security may affect migration through channels other than households' perceptions. It is crucial to include both actual land tenure security and tenure security perceptions when analysing households' migration decisions. The impact of tenure security on migration is likely to depend on the degree of land rental market development (Deininger et al., 2014; Yang, 1997). Households that can rent out part or all of their land are more likely to be involved in migration if they have sufficient guarantees that they can cultivate their land again when needed.

Fourth, what is the impact of migration on farm performance?

Despite the significant role of migration in reducing rural poverty and inequality, migration might lead to decline in agricultural production. Farm performance could be measured by both economic and environmental behaviours. We use two specific measures for economic and environmental performance of farms, i.e. technical efficiency and fertilizer use efficiency. The former indicates the economic performance measured by the ability of farms to minimize input use given the output level (e.g. Kumbhakar and Lovell, 2003; Zhu and Oude Lansink, 2010) and the latter indicates the environmental performance of the farms measured by the ratio of the minimum feasible fertilizer use to the actually applied fertilizer use, given the level of output and other inputs (e.g. Reinhard et al., 1999; Skevas et al., 2018).

1.3 Concepts and theoretical framework

1.3.1 Land tenure security: a tripartite view

Van Gelder (2010) proposes a tripartite view of tenure security, under which a distinction between legal, actual and perceived tenure security is made. We apply this tripartite view of tenure security in our analysis. Legal land tenure security refers to "the legal status of tenure and its protection backed up by state authority" (Van Gelder 2010: 9), which is derived from formal institutions.

Actual land tenure security is based on tenure holders' "actual control of property, regardless of the legal status in which it is held" (Van Gelder 2010: 9). Actual land tenure security could be derived from formal and informal institutions. Actual land tenure security may vary from place to place due to variations in the enforcement of formal institution and location-specific differences in informal institutions (Van Gelder, 2009). Similar to other countries, land certification is a main means of improving land tenure security in China. Following the 1998 land contracting round, land certificates are expected to be issued to farmers. In 2009, a new-round land certification programme started. Land certificates might not always represent actual land tenure security, since another source of actual land tenure insecurity in China is land reallocations. Approval by two-thirds of villagers or village representatives and authorization by higher-level governments enables land to be reallocated by the village committee within the contract period specified in the land certificates.

Perceived land tenure security is defined as households' "own assessment of their tenure situation" and "expectations about state enforcement of property rights" (Broegaard, 2005: 850 & 845). Perceived land tenure security may vary among households in the same location facing similar actual tenure security (de Souza, 2001). Similar to actual land tenure security, we consider that perceived land tenure security could be derived from households' perceptions on the effectiveness of land certificates and expectations about land reallocations in the future.

1.3.2 Migration: New Economics of Labour Migration

According to New Economics of Labour Migration (NELM), migration decisions are made at the household level rather than the individual level. A household acts collectively not only to maximize income, but also to minimize risks and loosen constraints created by a variety of market failures, including missing or incomplete capital, insurance or labour markets. In this way, land tenure security can have an impact on migration. Land tenure security could facilitate migration by removing potential migrants' concerns about the risk of losing land.

Migration could in turn affect agriculture production. First, households with potential migrants make simultaneous decisions about allocation of labour and other inputs between migration and on-farm activities. Second, migration is a part of household strategies to raise income and diversify the sources of income. The potential remittances sent back by migrants release the credit constraints of investment on one hand, while improving the income security and stimulating households' adoption of risky but potentially productivity-improving technology on the other.

China's household registration system, which is known as the Hukou system, makes migration in China different from other countries. There are two types of Hukou (residence registrations): rural Hukou (in rural China) and urban Hukou (in urban China). Migrants can keep their Hukou in their original village and in this way they are still entitled to their land[1]. It is common for some members of a household to work outside the county and keep their Hukou at home while the others live in the village and perform the on-farm activities. In this thesis, migration is defined as the household that has at least one member living outside the county for at least six months for employment purposes.

[1] Migrated rural population can also choose to change their Hukou to an urban Hukou, if they are working in the city and satisfy the requirements of changing Hukou. After they change their Hukou, they can get access to various other rights (such as access to certain schools and public services for their family) but lose their land in the village. Most migrants prefer to keep their rural Hukou; because the price of land has increased rapidly in the last 20 years, rural Hukou has become more valuable, and it is almost impossible to change Hukou from urban to rural.

1.3.3 Farm performance: technical and fertilizer use efficiencies

Both economic and environmental performance are important aspects when assessing farms' activities. In this study, technical efficiency is used to represent the economic performance of a farm, while environmental efficiency measures the environmental performance. Technical efficiency refers to the ability to minimize input use given the output level (Kumbhakar and Lovell, 2003). Fertilizer use efficiency is defined as the ratio of the minimum feasible fertilizer to actually applied fertilizer given the levels of output and other inputs (Reinhard et al., 1999).

1.3.4 Theoretical framework

The overall theoretical framework of this thesis is based on the sustainable livelihood framework proposed by Scoones (1998) shown in Figure 1.1. Given a particular context of policy setting and socio-economic conditions, the combination of livelihood resources will result in certain formal and informal institutions. The formal and informal institutions determine households' livelihood strategies, which in turn lead to certain livelihood outcomes.

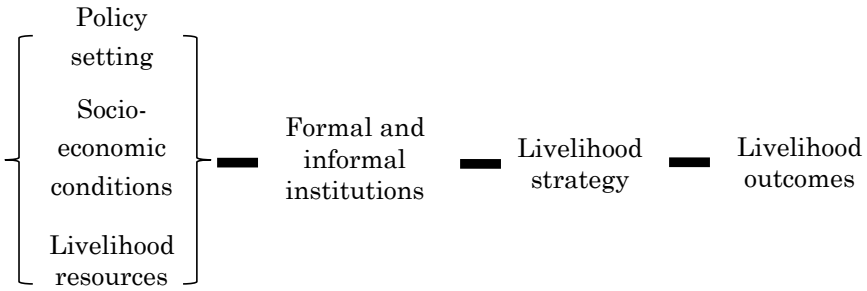


Figure 1.1 The sustainable livelihood framework of Scoones (1998) and Scoones (2009)

The overall theoretical framework of this thesis as shown in Figure 1.2, is based on this. The village democracy and households' knowledge of RLCL determine villages' choices of actual land tenure arrangements. Actual land tenure

arrangements, together with livelihood resources including natural capital, human capital, social capital and physical capital, influence households' perception of land tenure security. The levels of actual and perceived land tenure security will therefore result in households' livelihood strategies, in particular, whether or not to opt for migration. Migration and households' on-farm behaviour will in turn lead to certain outcomes, particularly farm performance.

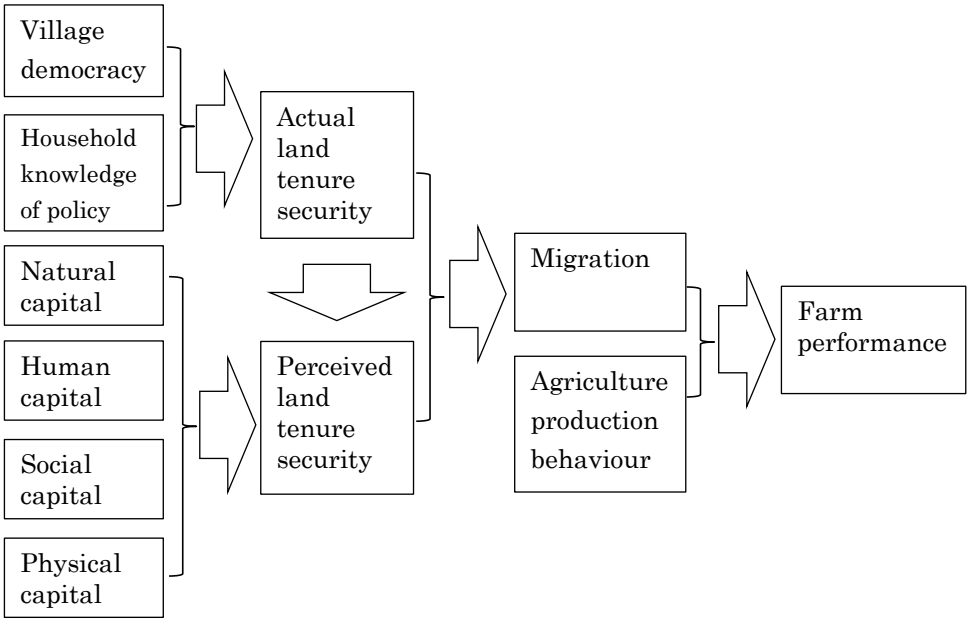


Figure 1.2 The overall theoretical framework for the joint analysis of land tenure security, migration and farm performance

1.4 Methodology

1.4.1 Sampling and data collection

The empirical analysis of the thesis (in Chapters 2 to 5) is based on the household and village data collected in 2015 and 2016 from three provinces and one

municipality in China. The selected provinces and municipality (Jiangsu, Jiangxi, Liaoning and Chongqing) are located in China's four major agro-ecological zones. We collected data of 124 villages, with 1486 households in total. The collected information covers land tenure, agricultural production, occupation activities, land transfer and related issues.

The sample villages and households were selected through a similar process in each province. Four counties were selected from each province, one from each quartile on the list of counties sorted according to the average grain yield (ton/thousand hectares) in the last three years. Counties with less than 10% arable land area in the total arable land area of the city where the county is located were excluded from the list. Random values generated by Excel were used for this purpose. Given the selected total number of sample villages and townships (i.e. 32 villages and 16 townships in each province), the number of townships selected in each county depends on the share of the county's arable land area with respect to the total arable land area of the four selected counties. Within each county, we selected townships by applying the same procedure as for county selection, using the arable land area of townships as the criterion. Two villages were then randomly selected in each township. Around ten households were randomly selected in each village. The villager leader and selected households were interviewed for the village survey and household survey, respectively.

1.4.2 Model selection

Based on the survey data, econometric models are used to address the four research questions specified in Section 1.2. In Chapter 2, we estimate the influencing factors of the persistence of land reallocations (research question 1). Particular emphasis is given to the impact of village democracy and households' knowledge of policy. Other socio-economic factors, including land endowment and fragmentation, social insurance, off-farm employment, land investment, physical capital, land rental market and regional dummies, are introduced as control variables. Persistence of land reallocations is a binary variable, defined as the

village's land reallocation choice after the 1998 land contracting round. A probit model is therefore used for the empirical analysis.

To examine the impact of land reallocations and certification on households' perceptions of land tenure security (research question 2), a probit model is applied in Chapter 3. Perceptions of land tenure security, measured by the household's expectation with respect to the occurrence of land reallocations within the next five years, is a binary variable. For this reason, a probit model is applied. Notably, according to the current laws in China, rural households should possess two land certificates, i.e. one issued in 1998 and the other issued after 2009. We therefore include both land certificates as explanatory variables. This allows us to examine whether these two types of certificates differ in their impact on tenure security perceptions. Moreover, in order to examine whether the impact of land certificates differs between villages that implemented land reallocations and those that did not, the interactive effects of land certification and land reallocations are estimated as well.

In Chapter 4, the impact of actual and perceived land tenure security on migration are examined (research question 3). The two-step control function approach is employed to address the potential endogeneity of perceived land tenure security (Wooldridge, 2014). A probit model is applied at the first stage to estimate the influencing factors of perceived land tenure security. At the second stage, a probit model is applied to estimate the model with the binary dependent variable, that is, a migration decision model and tobit models are applied to estimate models of two continuous dependent variables, i.e., the number of migrants and migration duration. The generalized residuals obtained from the first stage model are introduced in the second stage equation. As the impact of land tenure security might depend on the development of the land rental market (Mullan et al., 2011), the interaction terms between the land rental market and land tenure security are introduced.

The impact of migration on farms' technical efficiency and fertilizer use efficiency (research question 4) is investigated in Chapter 5. First, stochastic frontier analysis (SFA) with a Translog production function is conducted to estimate technical efficiency and fertilizer use efficiency. A Translog production function is a more flexible functional form than Cobb-Douglas due to the adding of the squared terms and interaction terms of inputs (Reinhard et al., 2000). SFA models offer a richer specification where agricultural production is stochastic due to unpredictable weather conditions and disease and pest infestation than a non-parametric approach such as data envelopment analysis (Zhu and Lansink, 2010). Second, propensity score matching (PSM) is then applied to estimate the causal effect of migration on technical efficiency and fertilizer use efficiency. PSM enables us to construct comparable treatment and control groups (Khandker et al., 2009). Specifically, the logit regression of migration is estimated to obtain the propensity score. The households in the treatment group (migration group) are then matched with those in the control group (non-migration group) based on the propensity score. We can thus obtain the technical efficiency and fertilizer use efficiency of matched treatment and control groups, and then the treatment effect of migration.

1.5 Relevance of the study

By conducting a joint analysis of land tenure security, migration and farm performance in China, the obtained insights of this thesis are relevant for the on-going land tenure reforms, migration policies and agricultural green development in China. A better understanding of the relationship between land tenure security, migration and farm performance will contribute to the win-win policies concerning land tenure reforms, migration and agricultural green development. Specifically, each chapter contributes to the literature.

Chapter 2 contributes to the debate on influencing factors of land reallocations in two aspects. First, we develop a more comprehensive theoretical framework,

taking into account village democracy and households' knowledge of policy. These are rarely considered in previous literature. Second, we conduct an empirical analysis on the factors explaining the persistence of land reallocations after the 1998 land contracting round. Little research has been done on the driving factors of the persistence of land reallocations after the 1998 land contracting round.

Chapter 3 provides an empirical test of the impact of actual arrangement of land tenure on households' perceptions of land tenure security. No studies have so far examined whether China's new-round land certification contributes to increased tenure security perceptions of rural households. Additionally, the interactive effects of land reallocations and land certification are seldom estimated. The thesis therefore contributes to the literature by differentiating the impact of land certification after the 1998 land contracting round and the new-round land certification and by examining the potential interactive effects of land reallocations and land certification.

Chapter 4 examines the impact of actual and perceived land tenure security on migration, taking into account their interactive effects with the development of the land rental market. To our knowledge, there has been no research so far that has analysed the impact of both actual land tenure security and tenure security perceptions on household migration decisions. Thus, our major contribution is to provide a comprehensive theoretical framework differentiating the impact of actual and perceived land tenure security on migration and to further examine both effects empirically.

Chapter 5 investigates the impact of migration on technical efficiency and fertilizer use efficiency. Our study is closely linked to the previous literature on determinants of technical efficiency and fertilizer use efficiency. However, this literature either does not consider the impact of migration (e.g. Guesmi and Serra,2016) or reaches different conclusions on the impact of migration on technical efficiency (e.g. Sauer et al., 2015, Wouterse, 2010 and Yang et al., 2016). The impact of migration on fertilizer use efficiency is overlooked by available

literature. Moreover, the mechanism of migration's effect on technical efficiency has not been studied. Our first contribution is to estimate the impact of migration on fertilizer use efficiency. Our second contribution is to investigate the labour reduction effect of migration on technical efficiency and fertilizer use efficiency by examining the impact of migration intensity.

1.6 Outline of the thesis

Chapters 2 to 5 each answer one of the four research questions introduced in 1.3 (see Figure 1.3). Chapter 2 examines the socio-economic factors affecting the persistence of land reallocations, particularly the impact of village democracy and households' knowledge of policy. A comprehensive theoretical framework is developed explaining the driving factors of the persistence of land reallocations. The empirical analysis is conducted focusing on the impact of village democracy, households' knowledge of policy and other socio-economic factors on the persistence of land reallocations.

Chapter 3 investigates the impact of land reallocations and certification on households' perceptions of land tenure security. We discuss the relationships between legal, actual and perceived land tenure security. We then empirically test the impact of actual land tenure security on households' perceptions. Actual land tenure security is measured by 1998 land certification and new-round land certification. The interactive effects of the two rounds of land certification and land reallocations are also estimated in the empirical analysis.

Chapter 4 examines the impact of actual and perceived land tenure security on migration, considering their interactive effects with the development of land rental market. We first develop the theoretical frameworks of the actual and perceived land tenure security on migration, respectively, and clarify the role of land rental market development in these effects. We then test the impact of both land tenure security on migration empirically and take into account their

interaction terms with the development of land rental market. A control function approach is then conducted in the empirical analysis to deal with the potential endogeneity of perceived land tenure security.

Chapter 5 focuses on the causal effect of migration on the economic and environmental performance of farms, that is, technical efficiency and fertilizer use efficiency. The impact of migration on technical efficiency and fertilizer use efficiency is analysed theoretically and empirically. A Translog production function and stochastic frontier analysis are conducted to estimate technical efficiency and fertilizer use efficiency. Propensity score matching is then applied to estimate the causal effect of migration on technical efficiency and fertilizer use efficiency.

Chapter 6 discusses the main findings of previous chapters and highlights the general discussion and conclusion of the whole thesis. Limitations of this study and suggestions for future studies are also presented in this chapter.

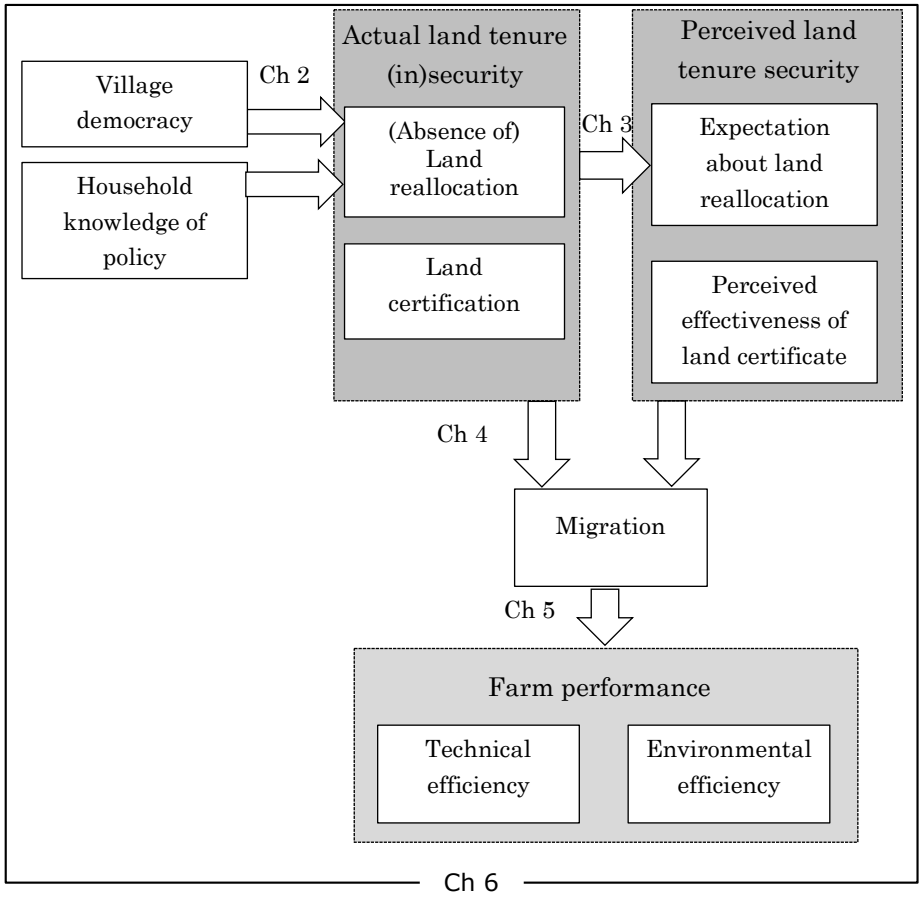


Figure 1.3 Structure of the thesis

CHAPTER 2

2

Persistence of land reallocations in Chinese villages: The role of village democracy and households' knowledge of policy

Chapter 2 Persistence of land reallocations in Chinese villages: The role of village democracy and households' knowledge of policy [1]

Abstract: Land reallocations have been severely restricted in rural China since 1998. Nevertheless, land continues to be reallocated in some regions. Little is known about the forces behind the persistence of land reallocations. In this paper we argue that village self-governance rules affect the implementation of national laws and regulations, and that the election of village leaders and villagers' knowledge of relevant policies are major forces in the use of village self-governance rules for land reallocations. Estimation results based on primary data collected from 124 villages in four provinces in 2015 and 2016 provide evidence that both village democracy and households' knowledge of the Rural Land Contract Law (RLCL) positively affect the incidence of land reallocations.

Keywords: China; households' knowledge of policy; land tenure security; land reallocations; village democracy

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2.1 Introduction

Since the collective farming system was replaced by the household responsibility system (hereafter referred to as HRS), the use right of land in rural China has been granted to individual households while the ownership remains "collective" at the village level. Collective ownership is maintained in the HRS with a primary consideration of equality across all households within the village (Wang et al., 2011). The initial land allocation under this system is primarily egalitarian, based upon either the family size or the number of adult labourers in a household, or both. Land reallocations to preserve equality within villages were carried out in response to demographic changes (Kong and Unger, 2013).

Land reallocations, however, undermine tenure security and households' incentives to invest in agricultural land, and consequently result in lower productivity (Gong et al., 2018; Ahmed et al., 2002; Prosterman et al., 1996). A high frequency of land reallocations makes households expect that some of their contracted plots may be reallocated in the future and make their perceptions of land tenure insecure (Ren et al., 2019; Broegaard, 2005; Holden and Yohannes, 2002; Kung, 2000). Such perceptions further discourage households' investment in their contracted land, especially in the longer term (Fenske, 2011; Li et al., 1998; Wen, 1995).

The Chinese central government realised that granting land use rights to households for a sufficiently long period of time is important for guaranteeing long-term investment in land (Feng et al., 2014). Since the second round of land contracting in 1998 (hereafter referred to as 1998 land contracting round), the Chinese central government has completely prohibited land reallocations in villages in response to demographic changes. In 2002, the Rural Land Contract Law (RLCL) mandated that land reallocations were only allowed under special conditions, such as natural disasters or land expropriation, and that formal

approval was needed from two-thirds of the villagers or villager representatives as well as authorization by higher-level governments (hereafter referred to as constrained rules of land reallocations). Hence, land reallocations were severely constrained and individual villages were empowered to determine their own arrangement of land reallocations (Zhong et al., 2012; Zhu and Prosterman, 2007; Yao, 2004).

Significant differences have been observed among villages in the implementation of the ban on land reallocations (Ma et al., 2017; Ma et al., 2015; Rao et al., 2017). Ma et al. (2015) found that land had been reallocated at least once since 1998 for 70% of the households in their study area in northeast Jiangxi Province but for only 6% of the households in Minle County in Gansu Province. Rao et al. (2017) found that 26% of the surveyed households in Xinjiang had experienced at least one land reallocation since 1998.

Several studies have identified factors affecting land reallocations before the 1998 land contracting round (e.g. Brandt et al., 2004; Yao, 2004; Kung, 2000; Rozelle and Li, 1998). Most studies consider land reallocations to be a result of competition between "economic efficiency" (e.g. maximization of households' investment incentives; minimization of administration costs) and "ensuring equitable land distribution" (Kung and Bai, 2011; Rozelle and Li, 1998). In other words, villages that place more importance on equitable land distribution than economic efficiency will tend to reallocate land more frequently. To our knowledge, however, little research has been done on the driving factors of the persistence of land reallocations after the 1998 land contracting round.

As individual villages were empowered to decide on their own arrangement of land reallocations, village democracy could play an important role in their decisions of land reallocations. Moreover, as the approval of two-thirds of villagers or villager representatives (hereafter referred to as the majority

principle) became a crucial requirement after 1998, households' knowledge of policy might influence villages' decisions on land reallocations as well. It is interesting to investigate the driving factors for the persistence of land reallocations, particularly those related to village empowerment such as village democracy and villagers' knowledge of policy.

The objective of this paper is therefore to investigate the socio-economic factors affecting the persistence of land reallocations in Chinese villages after 1998. Our first contribution is to develop a more comprehensive theoretical framework, taking into account village democracy and households' knowledge of policy. Our second contribution is to conduct an empirical analysis on the factors explaining the persistence of land reallocations after the 1998 land contracting round. For this purpose, data were collected through village and household surveys held in Jiangsu and Jiangxi provinces in 2015 and in Chongqing Municipality and Liaoning Province in 2016. A Probit model is applied to these data to obtain insights into the major determinants of villages' land reallocations.

The paper is organized as follows. Section 2.2 gives an overview of the land tenure reforms in China and develops the theoretical framework for explaining factors of land reallocations. Section 2.3 briefly describes the research area and the dataset, and presents the econometric model and variables used in the model. Section 2.4 deals with the descriptive statistics, discusses the estimation results of the econometric models and presents a robustness check. Conclusions are drawn in Section 2.5.

2.2 Land tenure reforms in China and theoretical framework

2.2.1 Land tenure reforms in China

The transformation from the collective system to the HRS began in 1979 and was

essentially completed by the end of 1983. The current land tenure system in China is to a large extent based on the HRS, under which land is owned by village collectives and use rights were allocated to the households in a village for a period of 15 years. Using egalitarian principles, the size of land assigned to a household was determined by the number of household members and/or labourers (Qu et al., 1995). This led to frequent land reallocations within villages in order to correct for demographic changes that occurred within the 15-year period. Based on a survey covering 215 villages in eight provinces in China, Brandt et al. (2002) found that land was reallocated 1.7 times on average per village from 1982 to 1995.

The second round of land reform (called second round of land contracting) started in 1998. In this round, the state extended the contract period of land use rights from 15 years to 30 years. The 1998 Land Administration Law (LAL) mandated that a written 30-year land use contract should be issued to all farmers to legally protect their land use right and that land reallocations should be limited or completely eliminated (Deininger and Jin, 2003). Land reallocations were further restricted by the Rural Land Contract Law (RLCL) issued in 2002, which specified constrained rules of land reallocations. The 2007 Property Law (PL) further indicated that land use rights should be retained and inherited when the 30-year period had passed. In 2008, the central government further extended the land contracted period from 30 years to an unspecified "long-term" period (Rao et al., 2017). In 2009, the central government started pilots of land registration and certification. The 19th National Congress of the Communist Party of China held in 2017 proposed that farmers' land use right contracts will be extended by another 30 years upon expiration. These series of reforms initiated by the central government (see Table 2.1 for an overview) aim to improve farmers' land tenure security.

Table 2.1 Legal rules on land tenure reform in China

Policy documents	Main content
No. 1 document (1982)	The central government affirmed the "Household Responsibility System", and implemented it across the country.
No. 1 document (1984)	Land use right should be granted to farmers for at least 15 years.
No. 1 document (1993)	Contract period of farmers' land use rights should be extended by 30 years upon contract expiration.
Land Administration Law (LAL) (1998)	Farmers' land use right should be extended by another 30 years after the first lease period of 15 years. Land reallocations within villages require acceptance by two-thirds of villagers or villagers' representatives and approval by higher-level governments.
Rural Land Contract Law (RLCL) (2002)	Land reallocations are prohibited in general; they are allowed in special cases such as natural disasters or land expropriation, and require approval by two-thirds of the villagers or villagers' representatives and by higher-level governments.
Property Law (PL) (2007)	Land reallocations are only allowed in the cases specified by the 2002 RLCL. Land use rights should be retained and inherited when the 30 years period has passed.
No. 1 document (2009)	Pilots of farmland use right registration should be carried out gradually; the size and spatial location of contracted farmland should be specified in land use rights certificates.
No. 1 document (2010)	Ensure the current land contract is stable for the long term; expand the range of pilots for registration of farmland use rights.
Report on the 19th National Congress of	Farmers' land use rights contracts will be extended by 30 years upon expiration.

the Communist Party
of China (2017)

2.2.2 Impact of village democracy and households' knowledge of policy

According to some researchers (Ma et al., 2015; Piotrowski, 2009), Chinese laws are often deliberately formulated in an ambiguous way so that their implementation can be adapted to the local environment in different regions. Significant differences exist among regions in the implementation of legal land tenure regulations in rural China, particularly in the implementation of bans on land reallocations (Ma et al., 2017; Ma et al., 2015). The extent to which bans on land reallocations are implemented at the local level depends on many factors. Below we discuss major factors that drive land reallocations (see also Figure 2.1).

Village self-governance is an important channel in the enforcement of legal rules. The Organic Law of the Villager Committees of the People's Republic of China (OLVC) stipulates that village committees should use village self-governance mechanisms to manage issues regarding land contracting. The OLVC specifies that village self-governance should be in accordance with national laws and regulations, but it does not specify how to avoid or how to deal with potential inconsistencies between self-governance rules and national laws (Ma et al., 2015). This allows villages to conduct land reallocations based on village self-governance rules even though these reallocations do not comply with existing land laws (Ma et al., 2015).

Whether land is reallocated through village self-governance may depend on the *degree of village democracy*. In villages with democratically elected leaders, land may be more likely to be reallocated through the village self-governance channel than in villages where the leaders are appointed by higher-level government. Village leaders appointed by higher-level governments are more likely to adhere

to the formal ban on land reallocations. On the other hand, democratically elected village leaders are generally more accountable to villagers and are therefore more likely to reallocate land when there is a high demand for it. In this case, villages with democratically elected leaders are less likely to conduct land reallocations (Brandt et al., 2004). The impact of the democratic election of village leaders on land reallocations could therefore be positive.

As the majority principle is one of the legal conditions for land reallocations, *households' knowledge of policy* might affect their demand for land reallocations. If the majority of villagers are willing to reallocate land, land reallocations can be organized by an appeal to village self-governance regulations (Ma et al., 2015). Households that are familiar with the RLCL are expected to be aware of the ban on land reallocations and the policy promoting land transfers through land rental markets, but they may also be more aware of the possibility to use a village's self-governance rules for land reallocations (Deininger and Jin, 2009). The impact of knowledge of related laws on land reallocations could therefore be either positive or negative.

2.2.3 Other factors affecting land reallocations in China

Apart from acting as a production factor, land also provides social security for rural households in China (Brandt et al., 2002). Land reallocations originally served to provide all households equal access to land resources for their livelihoods when *demographic changes* occurred in a village (Brandt et al., 2002). However, when social security improves, it can be expected that demand for such land reallocations falls (Yang, 2012). The social security of rural households depends largely on the possession of, or access to, land, social insurance and off-farm employment (Ma et al., 2015; Wang et al., 2013). Both land endowment and land fragmentation play important roles in households' demand for land reallocations. *Land endowment* is important for guaranteeing a minimum livelihood to households that lack other resources (Yang, 2012). When the land is

relatively abundant in a village, the need to reallocate land is not obvious. Similarly, *land fragmentation* may affect households' demand for land reallocations due to the different level of productivity of different plots (Kung and Bai, 2011). Demand for land reallocations will be lower in villages with less fragmented land.

With the improvement of *social insurance*, farmers will have fewer incentives to realign land resources for the changing demographic structure in a village. Publicly provided social insurance or safety nets in rural China include public health insurance and retirement insurance (Qin and Wang, 2016). The public health insurance, called the New Rural Cooperative Medical Insurance, was introduced in 2003 and covered all rural counties by 2008. It is intended to reimburse mainly catastrophic expenses (Cheng et al., 2015). The retirement insurance, known as New Rural Pension Insurance, was introduced in 320 pilot rural counties in 2009 and covered nearly all counties in 2012 (Cheng et al., 2016). Participants get a pension at age 60, including a non-contributory basic pension and a monthly payment from the individual account. The basic pension varies considerably across counties, with higher payments in relatively developed areas.

If households have access to *off-farm employment*, the contribution of inequality in land endowments to livelihood insecurity will be lower (Ma et al., 2015; Rozelle and Li, 1998; Kung and Liu, 1997). Hence, demand for land reallocations will be less in villages where a large share of the households participates in off-farm employment.

As land could act as a production factor, *investment in the improvements of land quality* may also affect households' demand for land reallocations. When households improve land quality through investment, these households are more likely to resist land reallocations if they are not sufficiently compensated for their

investment costs. Hence, land investment may reduce the possibility of land reallocations (Deininger and Jin, 2006; Sjaastad and Bromley, 1997; Besley, 1995).

Physical capital for cultivating land may also affect households' demand for land reallocations (Luo and Li, 2010). Households possessing machinery might prefer larger and less fragmented land holdings. Hence, they are more likely to support the consolidation of fragmented land holdings through land reallocations. Possession of machinery therefore increases households' demand for land reallocations.

Additionally, the formal enforcement of the *legal system* will reduce the possibility of land reallocations. As discussed in Section 2.1, land reallocations are prohibited unless special conditions prevail. In the latter case, they require formal approval at the village level and by higher-level government. Hence, the legal system has significantly reduced the options for reallocating land within villages.

In addition to the administrative procedures, land can also be reallocated through a market-based mechanism (i.e. the land rental market), which is highly promoted by the *legal system* (Brandt et al., 2017; Carter and Yao, 1993). In rural China, *land rental markets* increasingly serve as a substitute for administrative land reallocations through self-governance rules (Jin and Deininger, 2009). The legal system affects land reallocations both directly and, through the development of land rental markets, indirectly. Empirical evidence shows that land rental markets redistribute land to households with lower endowments and that they are more effective in doing so than administrative land reallocations by village leaders (Deininger and Jin, 2005). Hence, in villages with well-developed land rental markets, the likelihood that land will be reallocated is expected to be low.

Figure 2.1 illustrates the conceptual framework of our study. We expect that the degree of village democracy is likely to affect the occurrence of land reallocations. There may be a high demand for reallocations by households when households' knowledge of policy is high or low. On the other hand, there may be a high demand for reallocations by households when demographic changes have occurred in recent years, when land endowment is less abundant, when land is more fragmented, when social insurance is low, when more investments have been made in the land, and when there is a high level of possession of physical capital. Formal enforcement of the legal system will reduce the occurrence of land reallocations directly and through land rental market indirectly. The land rental market may serve as a substitute for land reallocations. "+" or "-" signs indicate the expected effect of a factor. The boxes and arrows with solid lines are tested in the empirical analysis, while those with broken lines are not due to lack of data.

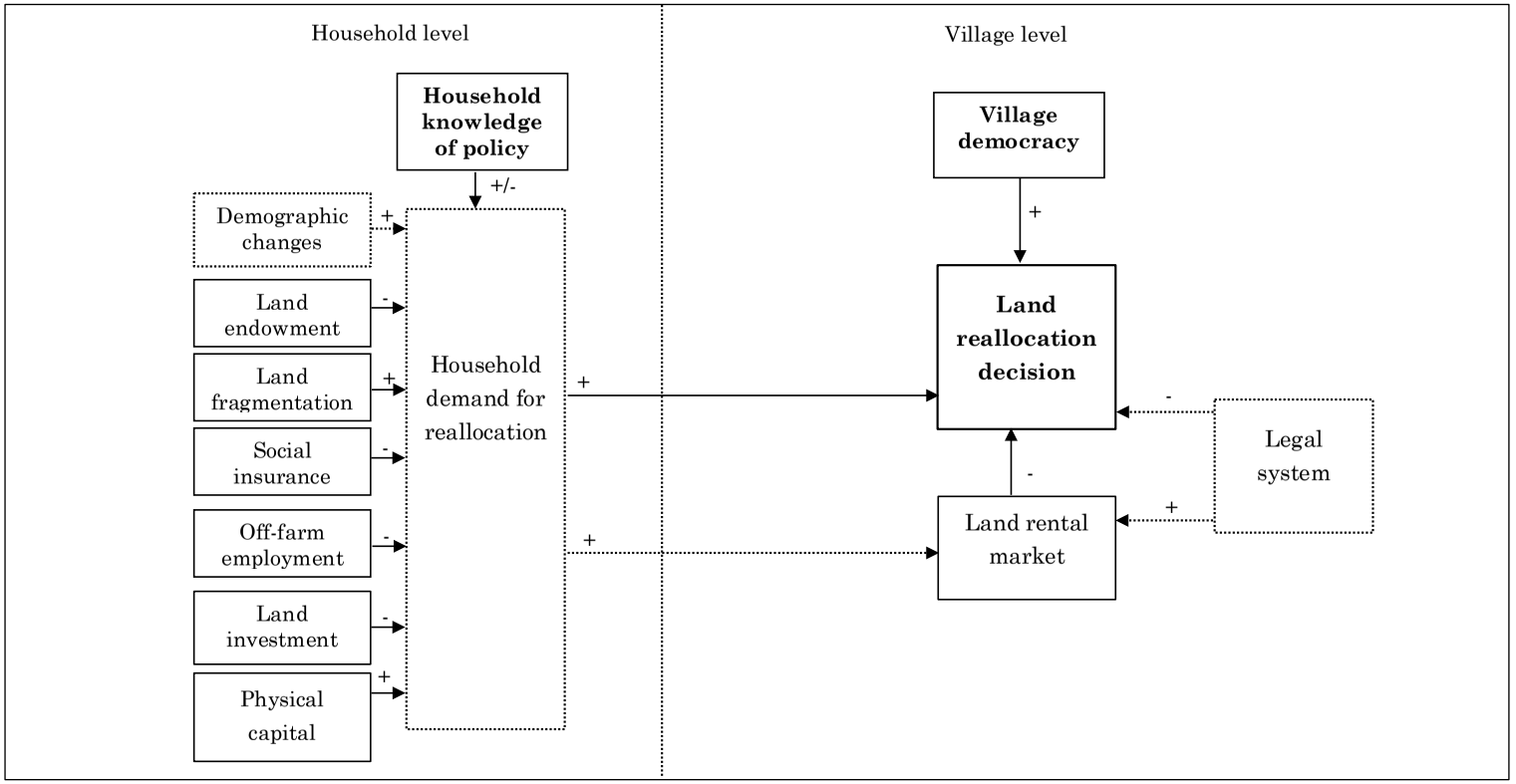

Figure 2.1 Conceptual framework of factors driving land reallocations

2.3 Methods

2.3.1 Study area and data source

To understand the impact of village democracy and households' knowledge of policy, we selected the provinces Jiangsu, Jiangxi, Liaoning and Chongqing as our study areas. They are located in China's four major agro-ecological zones. Figure 2.2 shows the locations of the selected provinces. We collected data by conducting both village and household surveys in Jiangsu and Jiangxi in 2015 and in Liaoning and Chongqing in 2016. The collected information covers land tenure, agricultural production, off-farm employment, land transfer and related issues.

Table 2.2 shows the sample composition. We collected data from 124 villages and 1486 households in total. The sample villages and households were selected through a similar process in each province. We ignored counties with less than 10% of arable land in the total arable land of the city in which a county is located. Four counties in each province were randomly selected from the list of counties arranged in decreasing order of the average grain yield (grain output/mu) in the previous three years, one from each quartile. For each quartile, random values generated by Excel were used for this purpose. Given the selected total number of sample villages and townships (i.e. 32 villages and 16 townships in each province), the number of townships selected in each county depends on the share of its arable land area to the total arable land area in the four selected counties. Within each county, we selected townships by applying the same procedure as used for county selection, using the arable land area of townships as the criterion. Two villages were then randomly selected in each township. Ten to fifteen households were randomly selected in each village.

Table 2.2 Sample sizes of villages and households and sampled counties by province

	Jiangsu	Liaoning	Chongqing	Jiangxi	Total
Number of villages	28[1]	32	32	32	124
Number of households	298	416	376	396	1486
Sampled counties	Zhangjiagang	Zhangwu	Jiangjin	Anyi	
	Jiangdu	Xinmin	Banan	Gaoan	
	Dongtai	Zahuanghe	Wanzhou	Yujiang	
	Jinhu	Fengcheng	Wulong	Shangrao	

[1]. We initially selected 32 villages in Jiangsu but we did the survey only in 28 villages, because the other four villages were mainly engaged in agri-tourism rather than conventional agriculture.

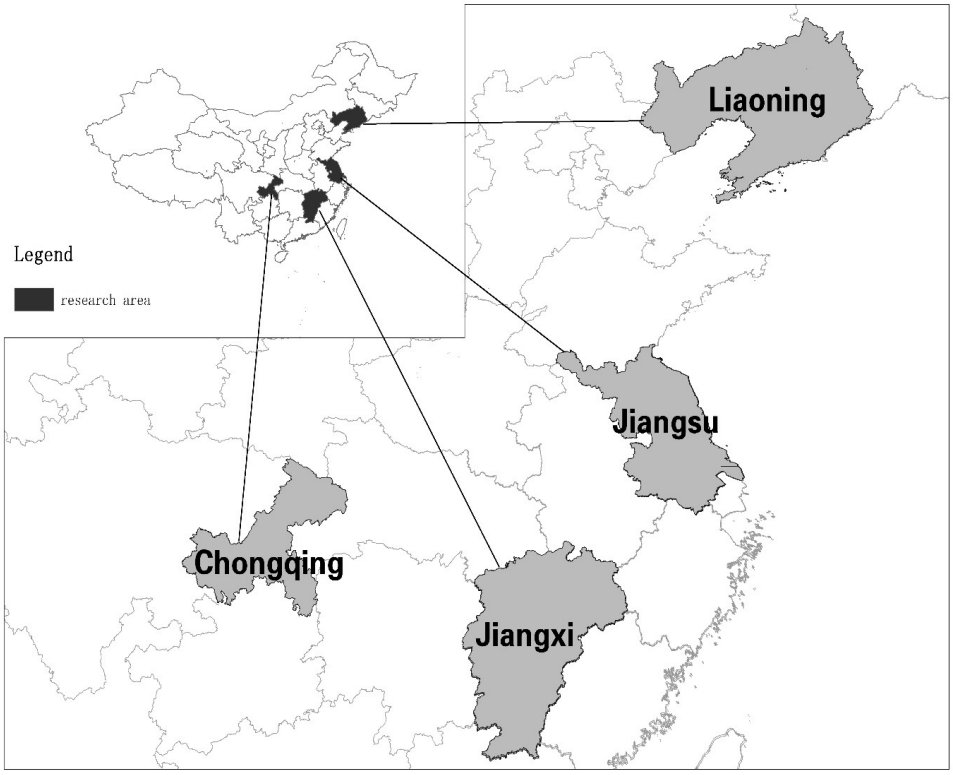

Figure 2.2 Study area location

Data source: National Catalogue Service for Geographic Information (2017).

2.3.2 Model specification

Several factors may affect the occurrence of land reallocations, as illustrated in Figure 2.1. We do not include the legal system among the explanatory variables, because it is the same for all villages. We do not include demographic changes either, because our survey only covered the demographic situation at the time of the survey. The demand for land reallocations by households is the underlying mechanism, which is not included among independent variables. Thus, we specify the following model to analyse which factors influence land reallocations at the village level:

$$R_i = \alpha_0 + \alpha_1 D_i + \alpha_2 K_i + \alpha_3 E_i + \alpha_4 F_i + \alpha_5 S_i + \alpha_6 O_i + \alpha_7 I_i + \alpha_8 P_i + \alpha_9 L_i + \alpha_{10} G_i + \varepsilon_i \quad (1)$$

where

R_i denotes the land reallocation choice of village i. D_i denotes village democracy of village i. K_i represents households' knowledge of policy. E_i, F_i, S_i, and O_i represent land endowment, land fragmentation, social insurance and off-farm employment of village i respectively. I_i denotes investment in improving land quality in village i. P_i represents the physical capital of village i. L_i indicates the degree of land rental market development in village i. G_i represents regional characteristics of village i. α are unknown coefficients; and ε_i are residuals.

2.3.3 Definition of variables

Table 2.3 presents the definitions of the variables used in the model. The dependent variable takes the value 1 if the village reallocated land at least once after the 1998 land contracting round, and 0 otherwise. Village democracy (*D*) is indicated by the occurrence of the democratic election of the villager leader. We include two variables for households' knowledge of policy (*K*), i.e., households disagreeing with bans on land reallocations, and familiarity with the RLCL. As

the majority principle is a prerequisite condition for land reallocations, a larger share of households disagreeing with bans on land reallocations does not necessarily result in land reallocations. However, if more than two-thirds of households disagree with bans on land reallocations, the village is more likely to decide to reallocate land. Therefore, we use a dummy variable, which takes the value 1 if more than two-thirds of surveyed households in a village disagree with the policy that farmland should not be reallocated within 30 years, and the value 0 otherwise. As discussed in 2.2, the impact of knowledge of the RLCL could be either positive or negative as households might be aware of different specific aspects of RLCL. Unfortunately, we do not have detailed data on household knowledge of specific aspects of the RLCL, so we can only test the overall impact of knowledge of the RLCL. Thus households' familiarity with the RLCL is measured by the ratio of surveyed households in a village that had heard of the RLCL.

Land endowment (*E*) is measured by the average farmland area per capita in a village, whereas land fragmentation (*F*) is measured by the average number of contracted land plots of surveyed households in a village. Social insurance, i.e. public health insurance and retirement insurance, may vary due to different levels of economic development. As we do not have data on the level of social insurance in the village, we include average village income per capita as a proxy for social insurance (*S*) in the model. Off-farm employment could be measured by either share of off-farm labour (e.g. Yao, 2004; Scott and Li, 1998) or share of income from off-farm sources (e.g. Kung, 2000). Villages with a large share of labourers involved in off-farm employment are likely to have a lower share of villagers demanding land reallocations. This may not necessarily be true for villages with large shares of incomes earned outside agriculture, namely in cases where some villagers were earning disproportionately large off-farm incomes. We therefore use share of the village labour force working off-farm to measure off-farm employment (*O*). To reflect the medium- to long-term access to off-farm

employment, the share of households in the village having at least one family member with training for non-agricultural occupations is included.

Investment in land quality (*I*) is measured by the share of surveyed households in the village applying organic fertilizers or planting green manure. Other fixed investments in land, such as terracing, irrigation and drainage, are not included in the model, because these fixed investments are rarely made by Chinese households (Jacoby et al., 2002). Physical capital (*P*) is measured by the average number of machines per unit contracted land of surveyed households in a village. The development of the land rental market (*L*) is measured by the ratio of land transfer, which is the ratio of transferred farmland to the total area of farmland of the village. It is derived from village leaders' responses to the question "what share of the farmland in the village has been transferred?". Finally, three dummy variables (*G*) are included to control for unobserved factors, such as enforcement by province-level governments, which may differ across the four provinces in our sample.

It should be noted that income per capita may depend on land investment in a village and hence on the land tenure insecurity arising from land reallocations. Likewise, development of the off-farm labour market, development of the land rental market, and investment in soil quality improvements may to a certain degree be affected by land reallocations (Ma et al., 2016; Xu et al., 2014; Deininger and Feder, 2011; Jacoby et al., 2002). Following Ma et al. (2017) and Mullan et al. (2011), we use the average value of these variables (i.e., income per capita, off-farm employment ratio, investments in the improvement of land quality and ratio of land transfer) of the other sampled villages in the same county as proxy variables to minimize the potential endogeneity bias.

Table 2.3 Variables in the empirical model of land reallocations at village level

Variable	Definition	Source
Dependent variable		
Land reallocations	=1 if the village reallocated farmland at least once after the 1998 land contracting round[2], =0 otherwise	Village surveys
Independent variables		
Village democracy (*D*)		
Democratic election of village leader	=1 if the village leader is elected by villagers, =0 otherwise	Village surveys
Households' knowledge of policy (*K*)		
Households disagree with bans on land reallocations	=1 if more than two-thirds of surveyed households disagree with bans on land reallocations, =0 otherwise	Household surveys
Households familiarity with RLCL	Share of surveyed households knowing RLCL in the village	Household surveys
Land endowment (*E*)		
Land endowment per capita	Per capita land endowment of the village (mu/capita)	Village surveys
Land fragmentation (*F*)		
Number of contracted land plots	Average number of contracted land plots of surveyed households	Household surveys
Social insurance (*S*)		
Income per capita[1]	Average income per capita (yuan)	Village surveys
Off-farm employment (*O*)		
Off-farm employment ratio[1]	Share of village labour force involved in off-farm employment	Village surveys
Ratio of households	Share of surveyed households in the	Household

with non-agricultural skill	village having at least one member with training for a non-agricultural occupation	surveys
Land investment (*I*)		
Investments in the improvement of land quality[1]	Share of surveyed households who invested in improving land quality through applying organic fertilizers or planting green manure	Household surveys
Physical capital (*P*)		
Number of machines per unit land	Average number of machines per unit land (mu) of surveyed households in the village	Household surveys
Land rental market (*L*)		
Ratio of land transfer[1]	Share of transferred contracted farmland in the total farmland	Village surveys
Regional characteristics (*G*)		
Jiangsu	=1 if the village is located in Jiangsu province, =0 otherwise	Village surveys
Liaoning	=1 if the village is located in Liaoning province, =0 otherwise	Village surveys
Chongqing	=1 if the village is located in Chongqing municipality, =0 otherwise	Village surveys

[1]. Variables are measured as the average value of the other sampled villages within the same county to minimize the potential endogeneity bias (hereafter the same).

[2]. Land reallocations in our sample are mainly periodical land reallocations (e.g. every three years) correcting for demographic changes and one-time land reallocations after land expropriation.

2.4 Results and discussion

2.4.1 Descriptive statistics

Table 2.4 shows the descriptive statistics of the dependent and independent variables. We observe that in our sample, 33% of the villages reallocated land after the 1998 land contracting round. There are large differences among the four provinces. In Jiangxi 66% of the sampled villages reallocated land, whereas this share was just 9% in Chongqing.

In 77% of the villages the leader was elected by the villagers. There are 14 villages (about 11% of the surveyed villages) with more than two-thirds of the households disagreeing with bans on land reallocations. On average, 56% of the surveyed households had heard about the RLCL.

The mean land endowment per capita is 2.26 mu. It ranges from 0.14 mu to 10.6 mu for the villages in our sample. Notably, the average farm size of households in the sample villages for Liaoning province (4.74 mu) is much larger than for the other three provinces (1.53, 1.48 and 1.18 mu respectively). The average number of contracted plots per household is 7.89, ranging from 1.3 to 20.7 between villages. A large difference can be observed among the four provinces. The average number of contracted plots per household is 13.85 in Chongqing, while it is only 3.04 in Jiangsu.

The mean value of income per capita is 10,826 yuan, which is almost equal to the national average per capita rural household income in 2015 (10,772 yuan) (NBS, 2016). The income per capita of sampled villages in Jiangsu province (18,006 yuan) is much higher than the national average.

The share of the village labour force working off-farm equals 48%. It shows a large variation over the villages in the sample. There is one village in Jiangxi

with no labourers engaged in off-farm employment, while all labourers participate in off-farm employment in two villages in Jiangsu and one village in Jiangxi. The share of surveyed households having at least one member with training for non-agricultural occupations is only 0.13.

As much as 45% of the surveyed households invested in improving land quality in the survey year. For the villages in Chongqing, this share was as high as 77%. The average number of machines per mu of contracted land equals 0.02. There are 64 villages in the sample that do not possess any machinery.

The ratio of transferred contracted land is 21% on average. This is lower than the national average of transferred land (33%) in 2015 (MOA, 2016). There is one village in Jiangsu in our sample where all the land has been transferred.

The villages in the sample are almost equally distributed over the four provinces: 23% of the villages are located in Jiangsu, 26% in Liaoning, 26% in Chongqing, and 25% in Jiangxi.

Table 2.4 Descriptive statistics of variables included in the model

Variable	Mean					Std. Dev.[1]	Min[1]	Max[1]
	Jiangsu	Liaoning	Chongqing	Jiangxi	Average			
Dependent variable								
Land reallocations	0.29	0.28	0.09	0.66	0.33	0.47	0	1
Independent variables								
Village democracy								
Democratic election of village leader	0.61	0.72	0.91	0.81	0.77	0.43	0	1
Households' knowledge of policy								
Households disagree with bans on land reallocations	0.14	0	0	0.31	0.11	0.32	0	1
Households' familiarity with RLCL	0.70	0.61	0.51	0.42	0.56	0.22	0.09	1
Land endowment								
Land endowment per capita (mu/capita)	1.53	4.74	1.48	1.18	2.26	2.11	0.14	10.63
Land fragmentation								
Number of contracted land plots	3.04	5.65	13.85	8.42	7.89	4.95	1.3	20.7
Social insurance								
Income per capita	18,006	11,221	8,241	6,731	10,826	6,625	1,400	30,000
Off-farm employment								

Off-farm employment ratio	0.60	0.25	0.52	0.57	0.48	0.27	0	1
Ratio of households with non-agricultural skills	0.20	0.11	0.11	0.08	0.13	0.11	0	0.5
Land investment								
Investments in the improvement of land quality	0.32	0.43	0.77	0.29	0.45	0.29	0	1
Physical capital								
Number of machines per unit land	0.01	0.00	0.01	0.04	0.02	0.09	0	1
Land rental market								
Ratio of land transfer	0.35	0.09	0.23	0.20	0.21	0.24	0	1
Regional characteristics								
Jiangsu					0.23	0.42	0	1
Liaoning					0.26	0.44	0	1
Chongqing					0.26	0.44	0	1

Source: Village-level surveys and household-level surveys.

[1]: Values of “Std. Dev.”, “Min” and “Max” refer to the whole sample of 124 villages.

2.4.2 Factors influencing decisions on land reallocations in the villages

A Probit model was used to estimate equation (1). The regression results are shown in Table 2.5. The most notable finding is that village democracy and households' knowledge of policy encourages land reallocations. We find that villages with elected leaders are more likely to have experienced land reallocations. This finding contradicts the conclusion of Brand et al. (2004) that the democratic election of village leaders leads to fewer land reallocations between 1982 and 1995. Our outcome provides supportive evidence of the crucial positive role played by village democracy in reallocating land after the 1998 land contracting round in China. We also find that villages with more households that have heard of the RLCL are more likely to conduct land reallocations after the 1998 land contracting round. This finding suggests that households that have heard of the RLCL might positively affect land reallocations through improving households' awareness of the possibility of reallocating land through self-governance rules.

We further find that per capita land endowment in a village does not significantly affect the occurrence of land reallocations. A similar result was found by Kung (2000) for 80 villages in four Chinese provinces, i.e. Zhejiang, Henan, Jilin and Jiangxi. Neither do we find a significant impact on the occurrence of land reallocations of income per capita, number of contracted plots and physical capital. Several other factors that we expect to affect the demand for land reallocations (see Fig. 1), however, do seem to play a significant role in land reallocations.

With regard to off-farm income sources, it is not the current level of off-farm employment that affects the demand for land reallocations, but the medium- to long-term access to off-farm employment as proxied by the possession of non-agricultural skills. As expected, the latter variable is found to have a significant negative impact (at 10% testing level) on the occurrence of land reallocations.

This is consistent with the finding in Kung (2000) that the share of income from off-farm sources has a negative effect on land reallocations.

As expected, investment in land quality improvements has a significant negative impact (at 10% testing level) on land reallocations. This supports the proposition that land investment reduces the likelihood of land reallocations and improves tenure security, which is consistent with the findings from the study of Braselle et al. (2002) for Burkina Faso.

Development of the land rental market is found to have a significant negative effect on land reallocations. This finding re-confirms the substitution relationship between land transfers and land reallocations found by Deininger and Jin (2005) for three other Chinese provinces, i.e. Guizhou, Hunan and Yunnan.

The estimated coefficients for the provincial dummies do not significantly differ from zero. In other words, the large differences in the frequency of land reallocations between Jiangxi Province on the one hand and Jiangsu, Liaoning and Chongqing on the other hand almost completely disappear when differences between these provinces in the values of the explanatory variables are taken into account.

Table 2.5 Regression results for land reallocations, Probit model[1]

Independent Variables	*Coef.*[2]	*Robust Std. Err.*	*VIF*[3]
Village democracy			
Democratic election of village leader	0.74**	0.34	1.21
Households' knowledge of policy			
Households disagree with bans on land reallocations	0.89	0.56	1.50
Households familiarity with RLCL	2.59***	0.75	1.58

Land endowment			
Ln(Land endowment per capita)	0.70	0.53	3.32
Land fragmentation			
Number of contracted land plots	0.01	0.07	3.31
Social insurance			
Ln(Income per capita)	0.24	0.45	4.77
Off-farm employment			
Off-farm employment ratio	2.51	1.67	4.77
Ratio of households with non-agricultural skills	-2.39*	1.43	1.45
Land investment			
Investment in the improvement of land quality	-3.70*	1.94	10.30
Physical capital			
Number of machines per unit land	2.12	1.88	1.09
Land rental market			
Ratio of land transfer	-4.00**	1.96	4.42
Regional characteristics			
Jiangsu	-1.07	0.93	8.18
Liaoning	-1.13	0.75	7.98
Chongqing	-0.19	1.03	11.57
Constant	-3.59	3.66	--
Observations	124		--
Pseudo-R^2	0.31		--
Log likelihood	-54.17		--

[1]: The Pearson $\chi 2$ statistic is 109.1 (P=0.4795), which suggests we cannot reject the model.

[2]: * 10% significance level; ** 5% significance level; *** 1% significance level.

3: To test the magnitude of multicollinearity between independent variables, we presented the Variance Inflation Factors (VIF) of all independent variables. The mean VIF is 4.61, while two variables have VIF values that are slightly

higher than 10. But the VIFs of the explanatory variables on our focus (e.g. village democracy and households' knowledge of relevant policies) are between 1.2 and 1.6. In other words, the main conclusions that we draw from the empirical analysis are not affected by potential interactions between some of the other explanatory variables.

2.4.3 Robustness check

To examine the robustness of our results we also applied a linear probability model. The results presented in Table 2.A.1 show some minor differences. First, the dummy variable indicating that more than two-thirds of the surveyed households disagree with bans on land reallocations becomes significant, while it was insignificant (with a P-value of 0.110) in the Probit model. Second, the land investment and land rental market variables no longer have statistically significant effects in the linear probability model (with P-values of 0.140 and 0.108, respectively). We employed the Akaike information criterion (AIC) and Bayesian information criterion (BIC) to compare the goodness of fit between the Probit model and the linear probability model (Table 2.A.2). Both criteria suggest that the Probit model fits better. The main conclusions that we draw from our analysis, however, do not depend on choice between these models.

2.5 Conclusions

This study examines factors driving land reallocations as a source of land tenure insecurity. Based on data collected from village and household surveys in Jiangsu and Jiangxi in 2015 and Liaoning and Chongqing in 2016, we find that the democratic election of the village leader and households' knowledge about the Rural Land Contract Law (RLCL) encourage land reallocations, while investment in improvement of land quality, stability of off-farm employment and development of the land rental market reduce the occurrence of land

reallocations.

Some important implications for policy-making can be drawn from our results. *Firstly*, households' knowledge of the RLCL and the democratic election of villager leaders positively affect the likelihood of land reallocations. A possible explanation of these findings is that, although the RLCL prohibits land reallocations in general, households that have some knowledge of the law are in particular more aware of the possibility of reallocating land through self-governance rules than the policy of restricting land reallocations and promoting land transfers through land rental markets. This points to the need for improved information dissemination. A better understanding of national laws and regulations by households can improve their acceptance of bans on land reallocations and weaken their demand for land reallocations.

Secondly, bans on land reallocations may lead to inequity across rural families. The emerging land rental and labour markets partly reduce this problem through the substitutional effect of land renting and the social security provided by off-farm employment. Well-functioning land rental and labour markets encourage division of labour. Families with higher agricultural productivity can gain access to additional land and thereby increase their operational farm size. Others, who participate in off-farm employment, can rent out their land and find employment in the manufacturing or service sectors in surrounding cities. Stimulating the development of land rental and labour markets is therefore expected to decrease the occurrence of land reallocations, and contribute to increased farm incomes and lower overall inequality.

Thirdly, investments in improving land quality play an important role in protecting land use rights. Villages where households make more investment in improving land quality are less likely to reallocate land, because this investment will decrease households' willingness to reallocate land. Measures to stimulate

households to invest in improving land quality can therefore reduce land reallocations in villages and thereby contribute to improved land tenure security.

A number of limitations of our study need to be pointed out. The empirical analysis is based on cross-sectional data, implying that we could not include information about demographic changes and land investments that were made in the periods before land reallocations took place. Moreover, only rough proxies were used as indicators of the stability of off-farm employment and social security. Panel data sets with more accurate off-farm employment and social security indicators should preferably be used in future studies to test the robustness of our main conclusions. Additionally, the focus of our study is on the impact of village democracy and households' knowledge of relevant policies on the persistence of land reallocations. Other factors, like issues of fairness, commitment and tradition, might also play a role, but the surveys that we used for our study did not include questions on those aspects. Researchers with a background in other social sciences would be better qualified to perform this.

Appendix

Table 2.A.1 Regression results using linear probability model

Independent Variables	*Coef.* [1]	*Robust Std. Err.*
Village democracy		
Democratic election of village leader	0.18**	0.08
Households' knowledge of policy		
Households disagree with bans on land reallocations	0.26*	0.15
Households familiarity with RLCL	0.56***	0.20
Land endowment		
Ln(Land endowment per capita)	0.18	0.13
Land fragmentation		
Number of contracted land plots	0.001	0.02
Social insurance		
Ln(Income per capita)	0.10	0.14
Off-farm employment		
Off-farm employment ratio	0.68	0.45
Ratio of households with non-agricultural skill	-0.70*	0.41
Land investment		
Investment in the improvement of land quality	-0.87	0.59
Physical capital		
Number of machines per unit land	0.34**	0.16
Land rental market		
Ratio of land transfer	-0.84	0.52
Regional characteristics		
Jiangsu	-0.36	0.30
Liaoning	-0.32	0.23
Chongqing	-0.11	0.32
Constant	-0.73	1.21
Observations	124	
Pseudo-R^2	0.34	

[1]: * 10% significance level; ** 5% significance level; *** 1% significance level.

Table 2.A.2 AIC and BIC of Probit and OLS model

	AIC	BIC
Probit model	138.35	180.65
Linear probability model	142.70	185.00

CHAPTER 3

3

Perceptions of land tenure security in rural China: The impact of land reallocations and certification

Chapter 3 Perceptions of land tenure security in rural China: The impact of land reallocations and certification [1]

Abstract: Tenure security is commonly recognized as an important factor in stimulating long-term investments in land. Recent studies suggest that a distinction between legal, actual and perceived tenure security needs to be made in analyzing tenure security. This study discusses the relationships between legal, actual and perceived land tenure security in rural China, and empirically examines the impact of actual on perceived land tenure security by applying Probit models to household and village survey data collected in four provinces. Using household expectations about the absence of land reallocations within the next five years as the dependent variable, we find that tenure security is positively affected by the possession of land certificates in villages that periodically reallocated land but not in villages that did not do so. The estimated impact is larger for land certificates issued in the new round of land certification than for land certificates that were issued earlier.

Keywords: Household perceptions; land certificates; land tenure security; probit model; rural China

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3.1 Introduction

Tenure security is recognized as important for stimulating long-term investments in land and its productivity (Ahmed et al. 2002; Besley 1995). Empirical tests of the impact of land tenure security on investment (e.g. Deininger and Jin 2003; Jacoby et al. 2002), land rental market participation (e.g. Deininger and Jin 2005), agricultural productivity and poverty reduction (e.g. Jayne et al. 2003; Place and Hazell 1993), however, have provided mixed results.

Variations in the definition and measurement of tenure security at least partly explain the mixed empirical results (Ma et al. 2015; Fenske 2011). Tenure security can be defined as an assurance concept (e.g. uncertainty of rights, probability or perceived probability of losing all or part of rights held and uncertainty in contract extension or renewal) or according to the substance of rights (e.g. duration of rights, legal title to land and renewability of rights) (Arnot et al. 2011). These differences in definitions have led researchers to adopt a wide variety of measures of tenure security.

Recent studies suggest that a distinction between legal (*de jure*) tenure security, actual (*de facto*) tenure security and perceived tenure security needs to be made in analyzing tenure security (Van Gelder 2010, 2009; Broegaard 2005; Schlager and Ostrom 1992). Legal tenure security, which is derived from formal institution, refers to "the legal status of tenure and its protection backed up by state authority" (Van Gelder 2010: 9). Actual tenure security, which could be derived from both formal and informal institutions, is based on tenure holders' "actual control of property, regardless of the legal status in which it is held" (Van Gelder 2010: 9). Perceived tenure security refers to tenure holders' "subjective evaluation of their current tenure security as it relates to their possession or lack of (different types of) land titles as well as expectations about (state) enforcement of property rights" (Broegaard 2005: 845). Actual tenure security may vary from

place to place due to variations in the enforcement of formal institution (i.e. legal rules), but also due to location-specific differences in informal institutions (Van Gelder 2009; Coles-Doghi 1993). Perceived tenure security may vary among households within the same location facing similar actual tenure security; it depends on who perceives it, what is perceived as secure, how the tenure has been gained, and which actors have been involved in securing the tenure (de Souza 2001: 28-29).

China's farmland tenure system offers an interesting case for an empirical study on the relationships between legal, actual and perceived tenure. Since the end of 1990s, the central government implemented several legal land tenure reforms aiming to improve legal tenure security. Measures taken include the extension of the duration of use rights, very strict regulations on land reallocations within villages, and the issuance of land certificates to farmers (see e.g. Ma et al. 2015). Since 2009, a new rural land certification program has been implemented which intends to further increase both actual and perceived tenure security. However, procedures for implementing legal tenure arrangements remain unclear and local authorities still have much power over the enforcement of these reforms (Rao et al. 2017). Thus actual land tenure security differs greatly between regions and many farm households continue to perceive their tenure as insecure (Ma et al. 2013).

Perceived tenure security is considered to be crucial for increasing agricultural productivity through investments, land rentals and increased input use (e.g. Kung 2000; Ma et al. 2013). Most empirical studies on tenure security and agricultural productivity use indicators of actual and/or perceived tenure security indicators in their analysis (see overview in Arnot et al. 2011: Table 2). Little attention, however, has been paid so far in the literature to the impact of actual land tenure security on household perceptions of tenure security. An exception is the study by Deininger et al. (2011) on the impact of a land

certification program in Ethiopia which found that land certification significantly reduced household fear of land loss by some 10 percentage points. In a study on China, Kung (2000) found that the frequency of land reallocations within villages had a significant positive effect on farmers' perceptions that they are likely to lose their land during the tenure period. No studies have so far examined whether China's new rural land certification program contributes to increased tenure security perceptions of rural households. Household recent experiences with land reallocations may affect such perceptions as land certificates can serve as an instrument to oppose future reallocations.

The objective of this paper is therefore to examine the impact of actual land tenure security, measured by possession of land certificates and recent experiences with land reallocations, on perceived land tenure security of rural households in China. Special attention will be paid to the tenure security attached to new certificates that were issued since 2009, as compared to older certificates, and to the combined effects of land certificates and land reallocation experiences. The empirical analysis is based on a data set collected through village and household surveys in Jiangsu and Jiangxi province in 2015 and in Chongqing and Liaoning province in 2016.

The paper contributes to the debate in literature about the relationships between legal, actual and perceived security of farmland tenure in China. It extends the theoretical and statistical analysis of integrating legal, actual and perceived land tenure security in China (Ma et al. 2015) by providing an empirical test of the impact of recent policies aimed at enhancing actual land tenure security on perceived land tenure security in China. In particular, we differentiate the impact of land certificates issued after the second-round land contracting and land certificates issued after the new-round land certification program, and take the potential interactive effect of land certificates and land reallocations into account.

The paper is organized as follows. Section 3.2 discusses the relationships between legal, actual and perceived land tenure security. Section 3.3 presents the econometric models and gives a description of the research area. Section 3.4 discusses descriptive statistics of variables used in the empirical model and the estimation results. Conclusions are presented in Section 3.5.

3.2 Land tenure: legal, actual and perceived security

3.2.1 Legal land tenure security

The current land tenure system in China is to a large extent based on the Household Responsibility System (HRS), which started in 1979 and was effectively completed by the end of 1983. Under the HRS, farmland was collectively owned but use rights were assigned to individual farm households for an initial period of 15 years. As farmland is the main source of livelihood security in poor rural areas, egalitarian principles were applied in land allocation (Kong and Unger 2013; Yang 2012). The size of farmland assigned to households was determined by the number of household members and/or adult laborers in a household (Qu et al. 1995). Since land use rights have been allocated, land reallocations were periodically conducted within villages in order to correct for demographic changes that had occurred.

Land reallocations ensure equal access to land resources for households living in the same village. But they also undermine land tenure security and cause concerns about land investments and long-term soil fertility (Feng et al. 2014; Kung and Bai 2011; Yao 2004). To enhance tenure security, the state extended the contract period of land use rights from 15 years to 30 years after the second-round land contracting in 1998, while land reallocations were restricted through the 2002 Rural Land Contracting Law (RLCL) and the 2007 Property Law (PL).

These restrictions implied that land could only be reallocated in special circumstances such as a natural disaster or land expropriation, and with acceptance of two-thirds of villagers or representative villagers and approval of higher-level governments (Ma et al. 2015).

The 1998 Land Management Law (LML) stipulates that a written 30-year land use contract (certificate) should be issued to farmers. The 2002 RLCL reaffirmed the importance of issuing land certificates to farmers. However, possession of land certificates could hardly provide protection to their holders against illegal reallocations when the land registration system is insufficient and the legal system is ineffective (Zhu and Prosterman 2007). As specified in the No. 1 document in 2009, pilots should be carried out of land use right registration and new land certificates which specify the spatial location and the size of contracted land should be issued. The No. 1 document in 2013 further indicated that the land certification program should be completed within five years. As indicated by "Opinions on properly conducting land registration and certification works regarding rural land contracting and management rights" of the Ministry of Agriculture in 2015, the new-round land certification program will (1) specify the size of contracted plots, demarcate the land boundaries and identify the spatial location; (2) establish a land registration system covering the transfer, exchange, change and mortgage of land contracting and management rights; (3) establish an information platform of land management contracts and certificates and make the information publicly available. The area covered by pilots of the new-round land certification program was expanded gradually. The program was first piloted in eight villages in 2009, and then piloted in three provinces (i.e. Shandong, Sichuan and Anhui) and in 27 counties in other provinces in 2014. It was expanded to nine more pilot provinces, including Jiangsu and Jiangxi, in 2015. The pilot provinces expanded to 22 in 2016, 28 in 2017, and the program was expected to be finished in 2018.

3.2.2 Actual land tenure security

Actual land tenure security refers to the actual control of land (Van Gelder 2010). It mainly depends on "the extent to which legal rules are effectively enforced at the local level" (Ma et al. 2015: 297). Under the HRS, many villages periodically reallocated land to ensure the equal access of households to land. Using data from a survey held in 215 villages in eight provinces in China, Brandt et al. (2002) found that between 1982 and 1995, land was reallocated 1.7 times per village on average. Villages also started the issuance of 15-year land use contracts, but these contracts remained verbal and provided little protection against administrative land reallocations (Brandt et al. 2002).

After the second-round land contracting (1998), the state has been aware that granting land use rights to households for a sufficiently long period of time is important for stimulating long-term investments in land holdings (Feng et al. 2014). Several laws and regulations aimed at improving land tenure security have come into effect. However, procedures for implementing legal tenure arrangements have remained unclear. This has left local authorities with much power over the enforcement of these reforms (Rao et al. 2017; Rozelle and Li 1998). Thus incomplete implementation of bans on land reallocations and incomplete issuance of land certificates persist. For example, based on a survey of 1617 households in 1617 different villages in over 350 counties located in seventeen provinces in China in 2001, Schwarzwalder et al. (2002) found that 17.9% of the villages had reallocated land after the second-round contracting, while 56.0% of the villages had taken measures to continue land reallocations during the 30 year term; they further found that only 44.9% of the villages had issued land certificates to farmers. The degree of actual farmland tenure security can vary significantly between regions. Ma et al. (2015) found that 70% of the 526 rural households interviewed during a survey held in the northeast Jiangxi province in 2010 answered that their land was reallocated at least once since 1998 and 67% of the households answered that did not possess a land certificate.

In a similar survey held in 2009 among 315 households in Minle County, Gansu province, merely 6% of interviewed households replied that they experienced a land reallocation after 1998 and only 3% of the interviewed households did not possess a land certificate (Ma et al. 2015).

3.2.3 Perceived land tenure security: the role of legal and actual land tenure security

Farmers' perceived land tenure security is assumed to be "influenced by their subjective understanding of their legal tenure situation, their general expectations regarding government enforcement and equality of the law, as well as their assessment of their access to the government institutions they might need in case of a land conflict" (Broegaard 2005: 850-851). Legal land tenure reforms and their actual implementation therefore affect households' perception of tenure security. In the case of China, both legal constraints on land reallocations and formal regulations on issuing land certificates are expected to enhance farmers' perceptions of land tenure security.

Actual land tenure security, the implementation of legal arrangements, may improve households' perceived land tenure security in two major ways. Firstly, possession of official land documents can increase perceived tenure security. The issuing of land certificates implies that information about property rights, including boundaries of parcels and the identity of the holder of a specific parcel, is collected and recorded, and that the holder is connected with the relevant state agencies (Rao et al. 2017; Broegaard 2005). Land certificates also provide a basis for legal protection against rights infringement and a structure for dispute solution. A well-developed registration system and efficient implementation of the legal system are needed to ensure the effectiveness of land documents in promoting tenure security. Without the support from a trustworthy and efficient implementation system, a land document or a certificate becomes nothing more than a nominal land use guideline (Ho and Spoor 2006; Brandt et al. 2004).

According to the current laws in China, rural households should possess two land certificates, i.e. one issued after the second-round land contracting in 1998 and one issued during the new-round land certification program that started its stepwise implementation in 2009 (see Section 3.2.1). The new certificates are with more accurate information about land (i.e. boundaries, size and spatial location), a more developed registration system managing land transfer, mortgage and so on, and come with information platforms available for all rural households. Compared to new certificates, the old certificates are with basic information about land, but without registration system and without public information platforms. Besides, as the new-round land certification program is mentioned in every year's No.1 document since 2009 and supporting regulations are made to ensure the proper implementation of the land certification program, the new certificates program is probably implemented more efficiently than the old one and are expected to have a larger impact on households' perceived land tenure security.

A second major way in which actual arrangements may enhance households' perceived land tenure security is through the implementation of bans on land reallocations. Although land reallocation is restricted by formal regulations, land could still be reallocated through village self-governance (Ma et al. 2015). Land reallocations through village self-governance are more likely to occur when households demand such land reallocations in response to demographic changes and to a lack of other resources for their livelihoods, and when land rental markets are underdeveloped (Kong and Unger 2013; Yang 2012; Jin and Deininger 2009). Households that experienced one or more land reallocations in the recent past are more likely to expect land reallocations in the future than those whose land has never been reallocated (Kung 2000).

3.3 Method and materials

3.3.1 Model specification

The dataset that we use for the empirical analysis (see Section 3.3.2) was collected among households facing the same legal system. As a consequence, there is no variation in legal tenure security among the units of observation. We therefore confine our empirical analysis to estimating the impact of actual land tenure security on perceived land tenure security. We specify the following model to that purpose:

$$P_i = \alpha_0 + \alpha_1 C_i + \alpha_2 N_i + \alpha_3 R_i + \sum \alpha_{4j} X_{ji} + \mu_i \quad (1)$$

P_i denotes perceived land tenure security for household i, as measured by the household's expectation with respect to the occurrence of land reallocations within the next five years. Actual land tenure security is measured by possession of land certificates and by prior experience of land reallocations. Regarding land certificates, we include a dummy variable that indicates the possession of land certificates issued after the second-round land contracting (C_i) and a dummy variable reflecting the possession of land certificates issued after the new-round land certification (N_i). This allows us to examine whether these two types of certificates differ in their impacts on tenure security perceptions. R_i is a dummy variable reflecting household i's experience of land reallocations after the second-round land contracting. X_{ji} is a set of control variables for household i. Following the available literature (Rao et al. 2017; Ma et al. 2013; Holden and Yohannes 2002), we include trust attitude, opinion about legal arrangements, possession of land transfer rights, land imbalance, land fragmentation, possession of physical capital, household characteristics, survey year (dummy) and province (dummy). Parameters α are the unknown coefficients to be estimated, and μ is the error term. A probit model with village-level clustered standard errors is used for

estimating equation (1).

3.3.2 Study area and data set

To estimate equation (1), we use household and village survey data collected in 2015 in Jiangsu and Jiangxi and in 2016 in Liaoning province and Chongqing municipality. The surveys aimed at collecting information about land tenure, agricultural production, off-farm employment, farmland transfer and related issues. Jiangsu province is located in east China, Jiangxi province in central-south China, Liaoning province in northeast China and Chongqing municipality in southwest China (see Figure 3.A.1). These three provinces and one municipality are located in the four major agro-ecological zones of China. Another reason for choosing these locations are our established relationships with local officials, which greatly facilitated the fieldwork. Jiangsu province started the pilot of land certification program at county level in 2009 and expanded it to provincial pilot in 2015. Jiangxi also became a pilot province of the land certification program in 2015. Liaoning started its land certification program in 2013 and became a pilot province in 2016. Finally, Chongqing started its certification pilot in 2010 and expanded it to a province-level pilot in 2017.

Table 3.A.1 shows the sample composition. The sample villages were selected by a similar process in each province. We dropped counties with less than 10% arable land area in the total arable land area of the city where the county is located. Then four counties were selected from each province, one from each quartile on the list of counties ordered based on the average grain yield (ton/thousand hectares) in the last three years. Random values generated by Excel were used for this purpose. Within each county, we selected townships[1] by applying the same procedure as used for county selection, using the land area of townships as the criterion. Two villages were then randomly selected in each township and around ten households were randomly selected in each village.

3.3.3 Definition of variables

Table 3.1 shows the definition of variables used in the empirical model. Perceived land tenure security is measured by the households' expectation regarding land reallocations within the next five years. It takes the value of 1 if a household expects no land reallocation within the next five years and equals 0 otherwise.

Table 3.1 Variables in perceived land tenure security model at household level

Variable[1]	Definition[2]
Perceived land tenure security	
Expectation w.r.t. land reallocations	=1 if household expects no land reallocations within the next five years, =0 otherwise
Actual land tenure security	
Possession of old land certificates	=1 if the land certificates were issued after second-round land contracting, =0 otherwise
Possession of new land certificates	=1 if the land certificates were issued after new-round land certification program, =0 otherwise
Past experience of land reallocations	=1 if farmland was not periodically reallocated (e.g., every three years) after the second-round land contracting, =0 otherwise
Control variables	
Trust to other villagers	Trust to other villagers in the same village, 1= totally distrust, 2= distrust, 3= no opinion, 4= trust, 5= fully trust
Trust to kinship	Trust to kinships, 1= totally distrust, 2= distrust, 3= no opinion, 4= trust, 5= fully trust
Opinion about legal arrangements	=1 if a household agrees with the ban on land reallocation, =0 otherwise
Land transfer right	=1 if a household thinks that land could be transferred freely within village
Imbalance of land	=1 if a household's contracted farmland per capita

endowment	exceeds village-level farmland per capita by 50%, =0 otherwise
Number of contracted land plots	Number of plots allocated to farm households in second-round land contracting
Machinery to contracted land ratio	Number of machines/ area of contracted farmland
Household head age	Age of household head (years)
Household head education level	Education level of household head, 1= below primary school, 2= primary school, 3= junior high school, 4=senior high school, 5= technical secondary school, 6= college or above
Village official	=1 if the head of household is/was village official, =0 otherwise
Year	=1 if the household was surveyed in 2016, =0 otherwise
Jiangsu	=1 if the household resides in Jiangsu, =0 otherwise
Liaoning	=1 if the household resides in Liaoning, =0 otherwise
Chongqing	=1 if the household resides in Chongqing, =0 otherwise
Jiangxi	=1 if the household resides in Jiangxi, =0 otherwise

[1] 'Opinion about legal arrangement' is measured as the average value for the other sampled households within the same village (hereafter the same).

[2] Data on the actual land tenure security variables are obtained from the village surveys; data for the other variables come from the household surveys.

Actual farmland tenure security is measured by three variables, i.e. possession of land certificates issued after second-round land contracting, possession of land certificates issued after the new-round land certification program and experience

of land reallocations. Possession of both land certificates are obtained by asking whether the village committee issued land certificates to households (=1 if yes; =0 otherwise). Experience of land reallocations takes the value of 1 if a household lives in a village that did not reallocate land periodically after the second-round land contracting and 0 otherwise. Information about the number of land reallocations has also been collected in the surveys, but its quality is doubtful. For villages that experienced reallocations, its distribution shows three different modes, at values of 1, 3 and 5, while two villages have missing observations and another village reports as many as 16 reallocations. We therefore used the land reallocation dummy as the dependent variable in the empirical analyses. We assume that possession of both types of land certificates has a positive impact on perceived land tenure security, while households with experience of land reallocations are more likely to expect a land reallocation in the near future.

Several other factors are expected to affect household perceptions of tenure security, including trust attitude, opinion about legal arrangements, possession of land transfer rights, land imbalance, land fragmentation, possession of physical capital, household characteristics, year of observation and regional characteristics. Trust attitude is measured by the household head's trust in other households living in the same village and head's trust in relatives, using a Likert scale with value 1 (=totally distrust) to 5 (=fully trust). Household heads with a low level of trust may believe that land will eventually be reallocated at some future point in time regardless of whether they experienced land reallocations in recent years or not (Tu et al., 2011; Kung, 2000). Thus we expect that households with a high level of trust also perceive a high level of tenure security. A household head's opinion about legal arrangements is measured by a dummy variable which takes a value of 1 if a household agrees with bans on land reallocations, and 0 otherwise. Households that agree with bans on land reallocations tend to have more confidence in legal arrangements that restrict

land reallocations than households that do not agree. We therefore presume that they are less likely to expect land reallocations in the future and perceive a higher level of tenure security. The land transfer rights variable takes a value of 1 if a household answers that they can transfer their farmland freely within the village, and 0 otherwise. Land rental markets serve a substitute for land reallocations (Deininger and Jin 2005). Households who can freely transfer their farmland within a village are therefore less likely to expect a land reallocation in the near future.

The imbalance of land endowments is measured by a household's contracted farmland per capita as compared to the village-level average. If it substantially exceeds the village-level average, they are more likely to expect that their land will be reallocated in the near future (Ma et al. 2013). We use by 50% more per capita farmland as the cut-off point. Land fragmentation is measured by the number of land plots allocated to a household in the second-round land contracting. Households with a large number of plots are more likely to expect that at least one of their plots will be reallocated and consolidated into fewer and larger plots.

The machinery to contracted land ratio is used as an indicator of physical capital. It is measured by the ratio of the number of machines (not including the ones purchased in the survey year and the year before) to the contracted land area. Households with higher machine – land ratios are more likely to exact that their land will be reallocated and consolidates. But they may expect fewer land reallocations if their land has already been consolidated. So the impact of physical capital can have either sign.

Household characteristics may also affect perceived land tenure security (Holden and Yohannes 2002). We include age and education of the household head, and whether the household head is/was a village official or not as household

characteristics. The latter variable takes a value of 1 if the household head is or was a village official, and 0 otherwise. An older household head may worry more about land reallocations than a younger one because of past experience with uncertain policies. A better-educated household head will probably have better access to information on current policies and their stability, and thus is more likely to perceive a secure land tenure. The same argument holds for household heads who are, or having been, a village leader.

A dummy variable for the survey year is introduced to control for unobserved factors that affect perceptions of tenure security, at given levels of actual tenure security and control variables, and that may differ between the years 2015 and 2016. Finally, two provincial dummy variables are introduced to control for unobserved factors that differ across the four provinces. One dummy variable will control for differences in such unobserved factors between Jiangsu and Jiangxi in the year 2015, the other for such differences between Liaoning and Chongqing in the year 2016.

It should be noted that a household's opinion about the ban on land reallocations may to a certain degree depend on the household's perceived land tenure security. Following Mullan et al. (2011) and Ma et al. (2017), we use the average value of this variable for the other sampled households within the same village as a proxy to minimize the potential endogeneity bias. Similarly, responses of households to the questions about possession of land certificates and experience of land reallocations may be affected by their land tenure security perceptions and by household-specific characteristics. However, these random misreporting errors in household responses are expected to cancel out when aggregated to the village level. As a result, village-level data on possession of land certificates and occurrence of land reallocation will more effectively reflect actual village-level informal institutions than household-level data. Following Deininger et al. (2014), Kung and Bai (2011) and Kung (2000), we therefore use data from

village-level survey as indicators of the actual land tenure security variables.

3.4 Results and discussion

3.4.1 Descriptive statistics

Table 3.2 shows the descriptive statistics of the variables used in the perceived land tenure security model. We observe that 83% of the surveyed households expected that land reallocations would not take place in five years. A large difference existed in perceived land tenure security between the four provinces. Perceived land tenure was most secure in Chongqing municipality, where 96% of the interviewed households did not expect land reallocations in five years; while it was most insecure in Jiangxi province, where 39% of the interviewed households expected the occurrence of land reallocations in five years.

Table 3.2 Descriptive statistics of variables in perceived land tenure security model

Variables	Mean					*Std. Dev.*[1]	Min[1]	Max[1]
	Jiangsu 2015	Jiangxi 2015	Liaoning 2016	Chongqing 2016	Average			
Perceived land tenure security								
Expectation w.r.t. land reallocations	0.84	0.61	0.91	0.96	0.83	0.38	0	1
Actual land tenure security								
Possession of old land certificates	0.65	0.36	0.67	0.95	0.70	0.46	0	1
Possession of new land certificates	0.21	0.06	0.03	0.58	0.18	0.39	0	1
Past experience of land reallocations	0.72	0.33	0.72	0.91	0.66	0.47	0	1
Control variables								
Trust to other villagers	3.77	3.68	3.79	3.96	3.80	0.78	1	5
Trust to kinship	4.13	4.15	4.20	4.29	4.19	0.72	1	5
Opinion about legal arrangement	0.54	0.39	0.61	0.66	0.55	0.21	0	1

Land transfer right	0.58	0.86	0.73	0.68	0.73	0.45	0	1
Imbalance of land endowment	0.15	0.16	0.15	0.16	0.16	0.36	0	1
Number of contracted land plots	3.06	8.23	5.66	14.10	8.00	7.16	1	50
Machinery to contracted land ratio	0.07	0.07	0.06	0.13	0.08	0.24	0	6
Household head age	59.84	56.27	55.17	58.54	57.17	10.48	23	91
Household head education level	2.95	2.53	2.90	2.44	2.69	1.00	1	6
Village official	0.40	0.28	0.18	0.19	0.25	0.43	0	1
Year	0	0	1	1	0.54	0.50	0	1
Jiangsu					0.18	0.39	0	1
Liaoning					0.29	0.45	0	1
Chongqing					0.25	0.43	0	1
Jiangxi					0.28	0.45	0	1

Source: Household-level surveys and village-level surveys.

[1]. Values of "S*td. Dev.*", "Min" and "Max" apply to the average of whole sample.

We further observe that 70% of the surveyed households possessed land certificates issued after the second-round land contracting, but only 18% of the interviewed households possessed the new land certificates that were issued after the new-round land certification. As regards the other actual tenure security variable, 66% of the surveyed households reported that they experienced no periodical land reallocations since the second round land contracting. Large differences also exist between the four survey provinces in these actual land tenure security indicators. It was again most secure in Chongqing municipality where as much as 95% of interviewed households possessed land certificates issued after the second-round land contracting (and 58% possessed certificates issued after the new round land certification) and as much as 91% of the households did not experience periodical land reallocations after 1998. A possible reason is that Chongqing is more efficient in implementing policies promoting land tenure security. For instance, Chongqing started the pilot of new-round land certification program already in 2010. Actual tenure security was again lowest in Jiangxi, except for possession of new land certificates (which was even somewhat lower for the interviewed households in Liaoning).

Descriptive statistics of the other control variables used in the model are also shown in Table 3.2. The level of trust to kinship (4.19) was higher than that to other households living in the same village (3.80). The share of interviewed households agreeing with bans on land reallocations was 55% on average; it ranged from 39% in Jiangxi to 66% in Chongqing. Regarding land transfer rights, 73% of the households in our sample reported that they could be freely transferred within the village. For Jiangxi, this ratio was as high as 86%, while it was lowest for Jiangsu (58%). For 16% of the households in our sample, land per capita exceeded the village level by 50%. The number of contracted plots was 8.0 on average, and ranged from 3.1 on average in Jiangsu to 14.1 on average in Chongqing (and from 1 to as much as 50 for the households in our sample). The ratio of the number of machines to the area of contracted land was highest on

average in Chongqing (0.13 as compared to 0.08 for the sample as a whole). The average age of the household head was somewhat higher on average in Jiangsu (59.8) and Chongqing (58.5) as compared to Liaoning (55.2) and Jiangxi (56.3), while the mean education level of the household head was highest in Jiangsu and Liaoning, the two richest provinces in the sample. One quarter of the interviewed household heads was, or had been, a village official; it was relatively high (40%) in Jiangsu province.

3.4.2 Factors influencing perceived land tenure security

The second and third column of Table 3.3 report the estimation results of model (1). The most notable finding is that possession of land certificates issued after the new-round land certification has a significantly positive impact on perceived land tenure security, whereas possession of land certificates issued after the second-round land contracting does not have a significant impact on perceived land tenure security. This finding provides further empirical support for the conclusions in Ho and Spoor (2006) and Brandt et al. (2004) that lack of a well-developed legal system and an inefficient implementation system made the land certificates issued after the second-round land contracting no more than a nominal land use guideline. But their conclusion does not seem to hold for certificates issued since the new round of land certification. The positive and statistically significant coefficient estimate for possession of new land certificates indicates that tenure security perceptions of the interviewed households are significantly enhanced by land certificates containing detailed specifications of plot size and locations that are backed up by a land registration system and an information platform on land management contracts and certificates.

Table 3.3 Probit regression results[1] for perceived land tenure security, basic model and interactive effects model

Explanatory	Expectation w.r.t.	Expectation w.r.t.

Variables	land reallocations		land reallocations	
	Coef.	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*
Actual land tenure security				
Possession of old land certificates	0.17	0.16	--	--
Possession of new land certificates	0.42**	0.20	--	--
Possession of old land certificates (Land was not reallocated periodically=1)	--	--	-0.18	0.25
Possession of old land certificates (Land was reallocated periodically=1)	--	--	0.39*	0.21
Possession of new land certificates (Land was not reallocated periodically=1)	--	--	0.16	0.25
Possession of new land certificates (Land was reallocated periodically=1)	--	--	0.70***	0.21
Past experience of land reallocations	0.36**	0.15	0.76***	0.27
Control variables				
Trust to other villagers	-0.05	0.07	-0.06	0.07
Trust to kinship	0.15**	0.08	0.15**	0.07
Opinion about legal arrangement	1.64***	0.42	1.66***	0.41
Land transfer right	0.07	0.11	0.09	0.11
Imbalance of land endowment	0.10	0.13	0.11	0.13
Number of contracted land plots	-0.02***	0.01	-0.03***	0.01
Machinery to contracted land ratio	-0.27**	0.12	-0.27**	0.12

Household head age	-0.002	0.005	0.00	0.00
Household head education level	-0.07	0.05	-0.07	0.05
Village official	0.11	0.12	0.12	0.12
Year	0.64**	0.25	0.81***	0.27
Jiangsu	0.14	0.19	0.15	0.19
Liaoning	-0.13	0.22	-0.30	0.24
Constant	-0.52	0.45	0.19	0.52
Observations	1348		1348	
Pseudo-R^2	0.23		0.23	
Log likelihood	-480. 08		-480.32	

[1]. Standard errors clustered at village level.

*: 10% significance level; **: 5% significance level; ***: 1% significance level.

We further find that past experience of land reallocations has a significant positive impact on household expectations regarding land reallocations within the next five years. This implies that households with experience of land reallocations tend to feel more tenure insecure as compared to households without such experiences. This is consistent with previous findings based on a survey held in 80 villages in Zhejiang, Henan, Jilin and Jiangxi province (Kung 2000).

In order to examine whether the impact of land certificates differs between villages that implemented land reallocations and those that did not, we replaced the two land certificate variables, i.e. C_i and N_i in (1), by interaction terms of these two variables and the land reallocation dummy variable, i.e. $C_i*R_{i,}$, $N_i*R_{i,}$, $C_i*(1-R_{i,})$, and $N_i*(1-R_{i,})$. The results, which are reported in the last two columns of Table 3.3, provide some interesting new insights. Land certificates, whether they are old or new types, have a significant positive impact on perceived land tenure security in villages that reallocated farmland periodically; they do not have a significant impact in villages that did not reallocate farmland after the

second-round land contracting. Hence, land certificates seem to matter for tenure security especially in villages with a (recent) history of land reallocations. Our results suggest that land certificates do provide protection against future land reallocations in such villages, or at least enhance household beliefs that land reallocations will no longer occur. The estimated coefficient for possession of new land certificate in villages with land reallocation experiences (0.70) is almost twice as large as the coefficient estimate for the older type of land certificates in such villages (0.39). This finding reconfirms that the new type of land certificates has a stronger impact on tenure security perceptions as compared to certificates issued after the second round land contracting.

Estimation results for the control factors provide a few other interesting insights. Trust towards kinships has a significant, positive relation with a household's perceived land tenure security. This finding is consistent with findings for rural Xinjiang in northwest China reported by Rao et al. (2017). We also find that households that agree with the ban on land reallocations are less likely to expect land reallocations within the next five years. This supports our presumption that households with more confidence in legal arrangements tend to perceive a higher degree of tenure security. It is consistent with findings of Ma et al. (2015) in Gansu, China. We do not find a significant effect of the land imbalance variable on tenure security perceptions. This indicates households with high land-labor ratios do not feel more tenure insecure than households with lower ratios. The rapid recent development of land rental markets, which can serve as a substitute for equalizing land-labor ratios, may explain this finding. On the other hand, the number of plots allocated to farm households is found to exert a negative impact on perceived land tenure security. Hence, it is not so much land size per se, but the number of plots allocated to households, that affects tenure security perceptions. This suggests that land consolidation programs that unite scattered, small plots into fewer large plots and redistribute them over village households are a major source of tenure insecurity. The significant negative impact of the

machinery to contracted land ratio provides additional support for this conjecture. In an additional regression analysis, we replaced the number of plots with interaction terms of the number of plots and provincial dummies in order to account for the large differences between provinces in the mean number of contracted plots per household (see Table 3.2) and in land consolidation programs carried out in these provinces. The results, which are shown in Table 3.A.2 in the supplement, indicate that the significant negative impact is only observed for Jiangxi province.[2] Finally, we find significant differences in tenure security perceptions (for given levels of the other explanatory variables) between the two survey years; households surveyed in 2016 are significantly more likely to expect that land reallocations will not take place in the near future as compared to households surveyed in 2015. This suggests that other policy measures taken to enhance security of land tenure, such as the "three rights separation" (Wang and Zhang 2017), play a role in addition to the measures examined in this study. But it may also reflect differences in (relatively constant) unobserved factors between households living in the two provinces interviewed in 2016 (Liaoning and Chongqing) and those living in the provinces that were interviewed one year before (Jiangsu and Jiangxi).

3.4.3 Robustness checks

We performed three robustness checks to check whether the main conclusions of our research hold when (meaningful) alternative model specifications are used. In the first robustness check we deleted all control variables from the model that, according to the results reported in Table 3.4, do not exert a statistically significant effect on tenure security perceptions. The results are reported in Table 3.A.3 in the supplement. As can be seen from that table, the main conclusions of our analysis do not change. The estimated coefficients for the land certificate variables are slightly larger than the ones estimated with all control variables included.

In the second robustness check, we ran separate regressions for two subsamples, i.e. Jiangsu and Jiangxi (2015), and Liaoning and Chongqing (2016) to reduce the impact of unobserved time-dependent factors. The results are reported in Table 3.A.4. The main conclusions of our analysis do not change for the subsample of Jiangsu and Jiangxi. The possession of old land certificates has a significant positive impact on perceived tenure security for households that experienced land reallocations since the second round land distribution. The possession of new land certificates again exerts a positive, and stronger, impact on tenure security perceptions. For the subsample of Liaoning and Chongqing, however, the fit of the model is much lower and only few significant explanatory variables are found. None of the actual tenure security variables is found to exert a significant impact in that subsample. A potential explanation is the lower variability in the Liaoning and Chongqing subsample. The standard deviation of the dependent variable, i.e. expectations regarding land reallocations, equals 0.38 for the whole sample and 0.46 for the Jiangsu and Jiangxi subsample, but only 0.25 for the Liaoning and Chongqing subsample. The standard deviations of two of the main explanatory variables, possession of old certificates and recent occurrence of land reallocations, are also substantially lower for the Liaoning and Chongqing subsample (0.40 for both variables) as compared to the Jiangsu and Jiangxi subsample (0.50 and 0.49 respectively). As a consequence, the variance of the coefficient estimates is considerably larger for the Liaoning and Chongqing subsample.

In the third robustness check, we ran regressions with the trust variables excluded from the model. Household trust levels may be endogenous, as households who experienced fewer land reallocations may show higher levels of trust to other villagers and, perhaps even, more trust to kinship. To examine whether the inclusion of potentially endogenous risk variables affects our findings, we ran our two main models with the two trust variables excluded. The regression results are presented in Table 3.A.5 in the supplement. As can be seen

from that table, the main conclusions of our analysis still hold when the trust variables are omitted.

3.5 Conclusion

This study discusses the relationships between legal, actual and perceived land tenure security and examines the impact of actual land tenure security and other factors on households' perceived land tenure security. Based on data collected through a household and village leader survey in Jiangsu and Jiangxi in 2015 and Liaoning and Chongqing in 2016, we found that both land certificates issued after the second-round land contracting ('old certificates') and land certificates issued after the new-round land certification ('new certificates') contributed to higher levels of perceived land tenure security of households living in villages which periodically reallocated land. On other hand, we found that land certificates did not significantly affect tenure security perceptions of household living in villages where no land reallocations took place since the second round land contracting.

Our results have a few important implications for policy making and future study. *Firstly*, land certificates are found effective instruments to increase land tenure security in villages where land was periodically reallocated since the second-round land contracting. As a consequence, land certification programs should preferably give a high priority to villages where land was reallocated periodically since 1998.

Secondly, we find that the new land certificates have a larger impact on tenure security perceptions (in villages where land has been reallocated since 1998) than the old certificates. This finding shows that a detailed specification of the size and location of the plots, combined with an adequate land registration

system and a public information platform, are important components of land certification programs that aim to enhance land tenure security.

Thirdly, we find that existing opinions (aggregated at the village level) regarding the ban on land reallocations significantly affect a household's land tenure security perceptions. Our descriptive data (presented in Table 3.3) show considerable spread in this variable, ranging from 0.39 on average in Jiangxi to 0.66 in Chongqing on a scale of 0 (= all households disagree) to 1 (= all households agree). These findings suggest that feelings of tenure security may be notably enhanced by disseminating information about current land laws and regulations and their underlying rationale, as a way to affect existing opinions about the ban on land reallocations, particularly in regions where the policy still meets with much resistance.

In this study we use cross-sectional data for estimating model (1). A major limitation of this approach is that some unmeasured household and/or village characteristics may affect both our dependent variable and some of the explanatory variables, and may thereby cause biased results. The main conclusions of our analysis should therefore be treated with care. Panel data analysis (e.g., using household fixed effect models) should preferable be used in future research on this topic to further test the robustness of our main conclusions.

Notes:

1. The number of townships selected in each county depends on the ratio of its arable land area to the total arable land area of the four selected counties.
2. For Chongqing, the province with the largest average number of plots, the estimated coefficients are negative and significant at an 11% testing level.

Appendix

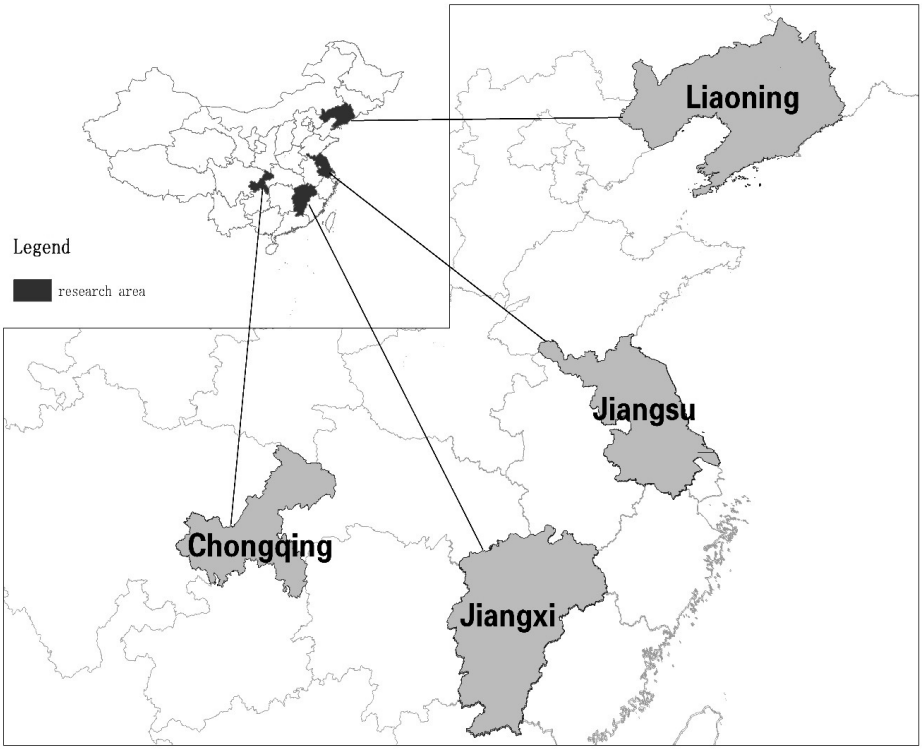

Figure 3.A.1 Study area location

Data source: National Catalogue Service For Geographic Information (2017).

Table 3.A.1 Sample size of households and villages and sampled counties by province

	Jiangsu 2015	Liaoning 2016	Chongqing 2016	Jiangxi 2015	Total
Number of households	298	416	376	396	1486
Number of villages	28[1]	32	32	32	124
Counties	Zhangjiagang Jiangdu	Zhangwu Xinmin	Jiangjin Banan	Anyi Gaoan	

Dongtai	Zhuanghe	Wanzhou	Yujiang
Jinhu	Fengcheng	Wulong	Shangrao

1. We initially selected 32 villages in Jiangsu. We did not survey four selected villages because they mainly depend upon agri-tourism instead of conventional agriculture.

Table 3.A.2 Probit regression results[1], with interactive terms for plot numbers and provinces

Explanatory Variables	Expectation w.r.t. land reallocations		Expectation w.r.t. land reallocations	
	Coef.	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*
Actual land tenure security				
Possession of old land certificates	0.17	0.16	--	--
Possession of new land certificates	0.42**	0.20	--	--
Possession of old land certificates (Land was not reallocated periodically=1)	--	--	-0.18	0.24
Possession of land certificates (Land was reallocated periodically=1)	--	--	0.39*	0.22
Possession of new land certificates (Land was not reallocated periodically=1)	--	--	0.16	0.24
Possession of new land certificates (Land was reallocated periodically=1)	--	--	0.70***	0.22
Past experience of land reallocations	0.38**	0.15	0.77***	0.27
Control variables				

Trust to other villagers	-0.05	0.07	-0.05	0.07
Trust to kinship	0.15**	0.08	0.15**	0.07
Opinion about legal arrangement	1.65***	0.41	1.66***	0.40
Land transfer right	0.06	0.11	0.08	0.11
Imbalance of land endowment	0.10	0.13	0.11	0.13
Number of contracted land plots× Jiangsu	-0.08	0.07	-0.08	0.07
Number of contracted land plots× Jiangxi	-0.03**	0.02	-0.03**	0.01
Number of contracted land plots× Liaoning	0.01	0.02	0.01	0.03
Number of contracted land plots× Chongqing	-0.02	0.01	-0.02	0.01
Machinery to contracted land ratio	-0.27**	0.12	-0.27**	0.12
Household head age	-0.002	0.005	-0.002	0.005
Household head education level	-0.07	0.05	-0.07	0.05
Village official	0.12	0.12	0.13	0.12
Year	0.48	0.32	0.63*	0.36
Jiangsu	0.25	0.29	0.24	0.29
Liaoning	-0.22	0.33	-0.37	0.36
Constant	-0.47	0.46	-0.55	0.47
Observations	1348		1348	
Pseudo-R^2	0.23		0.24	
Log likelihood	-478.30		-473.01	

[1]. Standard errors clustered at village level.

*: 10% significance level; **: 5% significance level; ***: 1% significance level.

Table 3.A.3 Probit regression results[1], deleting insignificant control variables

Explanatory Variables	Expectation w.r.t. land reallocations	Expectation w.r.t. land reallocations

	Coef.	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*
Actual land tenure security				
Possession of land old certificates	0.21	0.14	--	--
Possession of new land certificates	0.47***	0.17	--	--
Possession of land old certificates (Land was not reallocated periodically=1)	--	--	-0.10	0.23
Possession of land old certificates (Land was reallocated periodically=1)	--	--	0.43**	0.20
Possession of new land certificates (Land was not reallocated periodically=1)	--	--	0.32	0.21
Possession of new land certificates (Land was reallocated periodically=1)	--	--	0.73***	0.20
Past experience of land reallocations	0.38**	0.15	0.75***	0.26
Control variables				
Trust to kinship	0.12*	0.07	0.12*	0.07
Opinion about legal arrangement[2]	1.70***	0.41	1.73***	0.40
Number of contracted land plots	-0.02***	0.01	-0.02***	0.01
Machinery to contracted land ratio	-0.26**	0.12	-0.24**	0.12
Year	0.45***	0.15	0.46***	0.15
Constant	-0.82***	0.31	-0.94***	0.32
Observations	1348		1348	
Pseudo-R^2	0.22		0.23	

Log likelihood	-482.62	-478.27

[1]. Standard errors clustered at village level.

*: 10% significance level; **: 5% significance level; ***: 1% significance level.

Table 3.A.4 Probit regression results[1], using subsamples

Explanatory Variables	Expectation w.r.t. land reallocations (Jiangsu and Jiangxi)		Expectation w.r.t. land reallocations (Jiangsu and Jiangxi)		Expectation w.r.t. land reallocations (Liaoning and Chongqing)		Expectation w.r.t. land reallocations (Liaoning and Chongqing)	
	Coef.	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*
Actual land tenure security								
Possession of land old certificates	0.32	0.21	--	--	-0.02	0.19	--	--
Possession of land old certificates (Land was not reallocated periodically=1)	--	--	-0.38	0.34	--	--	0.02	0.21
Possession of land old certificates (Land was reallocated periodically=1)	--	--	0.52**	0.25	--	--	-0.11	0.38
Possession of new land certificates[2]	0.93***	0.28	0.89***	0.25	0.23	0.20	0.22	0.20
Past experience of land reallocations	0.86***	0.21	1.45***	0.33	-0.32	0.22	-0.40	0.31

Control variables								
Trust to other villagers	-0.26**	0.10	-0.27***	0.10	0.09	0.08	0.09	0.08
Trust to kinship	0.16	0.12	0.16	0.12	0.15*	0.09	0.15	0.09
Opinion about legal arrangement	1.84***	0.57	1.87***	0.56	0.23	0.49	0.23	0.50
Land transfer right	0.39***	0.14	0.41***	0.14	-0.14	0.20	-0.15	0.20
Imbalance of land endowment	0.06	0.17	0.08	0.18	0.16	0.20	0.16	0.20
Number of contracted land plots	-0.04**	0.02	-0.04***	0.01	-0.02*	0.01	-0.02	0.01
Machinery to contracted land ratio	-0.26**	0.13	-0.27**	0.13	-0.19	0.31	-0.19	0.31
Household head age	0.002	0.006	0.002	0.006	-0.02**	0.01	-0.02	0.01
Household head education level	-0.10*	0.06	-0.10*	0.06	-0.05	0.09	-0.04	0.09
Village official	0.19	0.15	0.19	0.16	0.004	0.21	0.01	0.21
Jiangsu	-0.11	0.22	-0.03	0.22	--	--	--	--
Liaoning	--	--	--	--	-0.45**	0.22	-0.45**	0.22
Constant	-0.47	0.64	-0.48	0.65	2.22***	0.75	2.28***	0.76
Observations	618		618		730		730	
Pseudo-R^2	0.26		0.27		0.06		0.06	

Log likelihood	-277.86	-274.04	-168.16	-168.12

[1]. Standard errors clustered at village level.

[2]. We did not include interaction terms of new certificates and land reallocation, because (1) all households that possessed new land certificates did not experience land reallocations in the subsample of Jiangsu and Jiangxi; (2) all households with new land certificates that experienced land reallocations in the subsample of Liaoning and Chongqing indicate that they expect no land reallocations (i.e., the dependent variable is predicted perfectly for these observations).

*: 10% significance level; **: 5% significance level; ***: 1% significance level.

Table 3.A.5 Probit regression results[1], without trust variables

Explanatory Variables	Expectation w.r.t. land reallocations		Expectation w.r.t. land reallocations	
	Coef.	*Robust Std. Err.*	*Coef.*	*Robust Std. Err.*
Actual land tenure security				
Possession of old land certificates	0.18	0.16	--	--
Possession of new land certificates	0.41**	0.20	--	--
Possession of old land certificates (Land was not reallocated periodically=1)	--	--	-0.18	0.25
Possession of land certificates (Land was reallocated periodically=1)	--	--	0.40*	0.21
Possession of new land certificates (Land was not reallocated periodically=1)	--	--	0.16	0.25
Possession of new land certificates (Land was reallocated periodically=1)	--	--	0.67***	0.22
Past experience of land reallocations	0.36**	0.15	0.77***	0.27
Control variables				
Opinion about legal arrangement	1.64***	0.42	1.66***	0.41
Land transfer right	0.07	0.11	0.09	0.11
Imbalance of land endowment	0.10	0.13	0.11	0.13
Number of contracted land plots	-0.02***	0.01	-0.03***	0.01
Machinery to contracted land ratio	-0.30**	0.13	-0.29**	0.13

Household head age	0.00	0.00	0.00	0.00
Household head education level	-0.07	0.05	-0.07	0.05
Village official	0.09	0.12	0.10	0.12
Year	0.65**	0.25	0.81***	0.27
Jiangsu	0.13	0.19	0.14	0.19
Liaoning	-0.15	0.23	-0.31	0.24
Constant	-0.08	0.40	-0.18	0.40
Observations	1348		1348	
Pseudo-R^2	0.22		0.23	
Log likelihood	-482.24		-476.86	

[1]. Standard errors clustered at village level.

*: 10% significance level; **: 5% significance level; ***: 1% significance level.

CHAPTER 4

4

Land tenure and migration in rural China – the roles of actual and perceived tenure security

Chapter 4 Land tenure and migration in rural China – the roles of actual and perceived tenure security [1]

Abstract: Migration can make an important contribution to rural poverty reduction and overall productivity increases, but it may be limited by prevailing rural land tenure arrangements. Since 1998, the Chinese government has implemented a number of land tenure reforms with the aim of improving the tenure security and the transferability of land. Although these reforms enhanced legal tenure security, it is not clear to what extent they remove existing land tenure bottlenecks in migration. Both actual tenure security, i.e. local implementation of laws that warrant tenure security, and household perceptions of tenure security are likely to play a role. In this paper we examine the impact of actual and perceived tenure security on migration decisions in China, taking into account the degree of development of land rental markets. We argue that actual and perceived tenure security can have both positive and negative effects on migration decisions and that the presence of land rental markets may modify these effects. A two-step control function approach that controls for endogeneity of tenure security perceptions is applied to household and village-level data collected in Jiangsu, Jiangxi, Liaoning province and Chongqing municipality. We find that both actual and perceived tenure security affect migration, but the impact of perceived tenure security as measured by land reallocation expectations is much stronger and is positive, whereas the separate impact of actual tenure security is negative. Households perceiving a low risk of losing land when one or more

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members migrate are more inclined to migrate, independent of the availability of land rental markets in their villages. Actual tenure security, as measured by absence of land reallocations and possession of land certificates, has a separate negative effect on migration only in villages with less-developed land rental markets.

Key words: migration; land tenure security; local implementation; household perceptions; land market

4.1 Introduction

Migration can play an important role in reducing rural poverty and improving overall productivity at a national level (Au and Henderson, 2006; Rozelle et al., 1999). First, migration can absorb surplus family labour that cannot be fully employed on the farm (Bowlus and Sicular, 2003; Woldenhanna and Oskam, 2001). It thereby increases and diversifies the income of rural households (Atamanov and Van den Berg, 2012; De Brauw et al., 2002). Second, land may be rented by more efficient farmers when less efficient farmers migrate (Ma et al., 2017). Third, in areas lacking a well-functioning credit market, migrant remittances can provide cash for investing in agricultural production (De Brauw and Rozelle, 2008; Matshe and Young, 2004) and are therefore expected to increase agricultural productivity. Moreover, the insurance effect of more diversified household incomes may shift farm production towards riskier but also more profitable crops and thereby raise the incomes of smallholder farmers (Taylor and Martin, 2004; Gehrke, 2009).

Rural land tenure insecurity can be an important obstacle to migration (De La Rupelle et al., 2008; Yang, 1997). When households face a high risk of losing part or all of their rural land, potential migrant members may prefer to stay at home instead of migrating to urban areas for work (Ma et al., 2016). Empirical studies on the impact of land tenure security on migration in China find evidence supporting this relation. Giles and Mu (2012) and De La Rupelle et al. (2008) find that land tenure insecurity, caused by the threat of periodical land reallocations within villages, has a significant negative impact on migration. Deininger et al. (2014) find that the recognition of land rights through land certificates encourages temporary migration of rural labour.

The impact of tenure security on migration is likely to depend on the degree of land rental market development (Deininger et al., 2014; Yang, 1997). Households that can rent out part or all of their land are more likely to be involved in migration if they have sufficient guarantees that they can cultivate their land again when needed. Empirical evidence for rural China provides support for this assertion. Mullan et al. (2011) find that greater perceived land tenure security tends to increase migration when renting land is permitted, while it reduces migration when renting land is restricted. Ma et al. (2016) find that household perceptions of land tenure security significantly affect migration decisions in villages where the land rental market is underdeveloped.

Empirical studies on land tenure security and migration in China focus either on household perceptions of tenure security (so-called 'perceived tenure security'), like the two studies mentioned (Mullan et al., 2011 and Ma et al., 2016), or on existing land tenure arrangements (so-called 'actual tenure security'), such as the frequency of land reallocations and the recognition of land rights through land certificates. Studies in the latter group commonly use indicators of actual tenure security as proxies for tenure security perceptions that drive rural household migration decisions. But existing land tenure arrangements may also affect migration through channels other than tenure security perceptions. In villages where no land reallocations take place, households may have invested more in land quality and thereby have fewer incentives to migrate. Moreover, actual possession of land certificates is likely to have an independent effect on migration in addition to the perceived importance attached to such documents.

To our knowledge, there has been no research so far that has analysed the impact of both actual and perceived land tenure security on household

migration decisions. The objective of this paper is therefore to examine the effects of actual and perceived land tenure security on migration in China, taking into account the degree of development of land rental markets. The Chinese government implemented a set of major reforms in legal land tenure arrangements and has stimulated the development of land rental markets in recent years. As the degree of implementation of these policies differs greatly between different regions in China (Ma et al., 2015), this provides a major opportunity to empirically analyse the impact of changes in land tenure security and land rental activity on migration. We aim to contribute to the available literature in this field by empirically estimating the impact of both actual and perceived tenure security on the migration of household members.

A household survey data set containing data on tenure security, land rental markets, households' participation in migration and other relevant variables in four different regions is used for the empirical analysis. The data were collected through four surveys held among 1,486 households in Jiangsu province and Jiangxi province in 2015 and in Liaoning province and Chongqing municipality in 2016. A two-step control function (2SCF) approach is applied to address the potential endogeneity of perceived land tenure security.

The paper is organized as follows. Section 4.2 describes the land tenure system and its reforms in rural China. Section 4.3 discusses the mechanisms through which actual and perceived land tenure security are expected to affect household migration decisions, and explains why the effects are likely to depend on the development of the land rental market. Section 4.4 describes the dataset, presents the model specification and estimation strategy, and provides the definitions of variables used in the empirical analysis and their summary statistics. Section 4.5 summarizes

and discusses the estimation results, while Section 4.6 presents conclusions.

4.2 Land tenure reforms and tenure security in China

From 1979 to 1983, the collective farming system in China was gradually replaced by the Household Responsibility System (HRS) in which farmland is owned by village collectives and contracted to individual households for a period of 15 years. Although written land contracts indicating the contractual relationship between households and the collective were issued, land could still be reallocated periodically during the contract period in response to demographic changes in households or for other reasons.

When the initial 15-year contract expired around 1998, land use rights were assigned to rural households for another 30 years during the so-called second-round land allocation (hereafter called '1998 land allocation'). During this 30-year period, the central state issued a number of laws and regulations to strengthen household land tenure security. Land certificates were required to be issued to all rural households. Full-scale land reallocations, under which "all farmland in the village was given back to the collective and redistributed among village households", were completely prohibited (Ma et al., 2015: 294). Partial land reallocations, which affect only a share of the households in a village, were permitted only "in case of a natural disaster, land expropriation or other special circumstances", and needed "acceptance by two-thirds of villagers' representatives and approval by higher-level authorities" (Ma et al., 2015: 295).

These laws and regulations were not always implemented by lower level governments. Due to contradictions with village self-governance rules, limited knowledge of national policies, differences between regions in local resource endowments, levels of economic development and other relevant contextual factors, land reallocations were still implemented in some regions, while the possession of land certificates and their contents also differ between regions (Ma et al., 2015, 2019, Ren et al. 2019a). A survey of 115 villages in six provinces of China indicated that 42% of surveyed villages reallocated land between 1998 and 2008 (Wang et al., 2011). Another national survey covering six provinces in China showed that approximately one-third of the surveyed households lacked a land certificate until 2008 and more than one-third of the households experienced land reallocations between 1978 and 2008 (Deininger et al. 2014).

Households' perceptions of land tenure security remain weak in some regions. For instance, a survey held in rural Xinjiang province of China in 2008 showed that 40% of the surveyed households worried about losing land in the future (Rao et al., 2017). A survey held in two other provinces in China, i.e. Gansu in 2010 and Jiangxi in 2011, found that only 40% (33%) of the interviewed households in Gansu (Jiangxi) expected that land would not be reallocated within five years (Ma et al., 2019).

Since 1984, the central government has been continuously encouraging rural households to participate in the land rental market via the No. 1 Document. But the land rental market initially remained virtually inactive. Just 3% of contracted land was transferred to other households in 1995 (Kung, 2002). The 2002 "Rural Land Contract Law" and 2007 "Property Law" specifies rural households' rights to transfer, rent and exchange contracted land. Market-based land transfers have been

propagated in each year's No. 1 Document since 2008. Since then, the incidence of land transfers has increased rapidly. The share of transferred land to the total area of household contracted land rose from 12% in 2009 to 33% in 2015 (MOA, 2016). In 2015, the central government indicated that China was planning to legally separate land use rights into operational rights and contracting rights while maintaining collective ownership. Under this "three rights separation" regulation, operational rights can now be freely transferred (Huang and Ding, 2016; Wang and Zhang, 2017). Land contracting rights, however, cannot be transferred; they belong to the rural households that reside in the village and originally received them from the collective. Both the contracting rights of leasers and the operational rights of tenants are legally protected. This institutional change is expected to further facilitate land transfers.

4.3 Theoretical framework

Following Van Gelder (2010) and Ma et al. (2015), we make a distinction between legal, actual and perceived tenure security. Legal tenure security "sees tenure security as a legal construct" and "equates formal property rights with tenure security"; actual tenure security "is based on the actual control of property, regardless of the legal status in which it is held"; perceived tenure security "refers to household perceptions of tenure security" (Ma et al., 2015: 293). Most empirical studies on tenure security and migration in China use indicators of actual land tenure security, such as household past experiences with land reallocations and possession of land certificates. These studies implicitly assume that migration decisions depend on household tenure security perceptions, which are strongly related to actual tenure security. We will first discuss the different mechanisms through which tenure security perceptions may affect

migration, then explain why actual security may have some independent effects on migration that are not related to tenure security perceptions and/or changes therein, and finally discuss the role of land rental markets in shaping some of the relationships between tenure security and migration.

4.3.1 Impact of perceived land tenure security

Three possible ways in which rural household migration decisions might be affected by perceived land tenure security can be distinguished. First, perceived land tenure security has a positive impact on migration through reducing the risk of land reallocations (hereafter called 'risk-reducing effect'). Migration entails a decrease in household size if one or more members migrate and the others remain in the village. Due to land scarcity and incomplete implementation of the policy that restricts land reallocations, migration may encourage the village leader to reallocate some of a household's land to other households (Ma et al., 2016). Thus, households perceiving a relatively high risk of losing land may refrain from migration (Da la Rupelle et al., 2009; Mullan et al., 2011).

Second, perceived land tenure security may have a negative investment effect on migration. Higher perceived land tenure security tends to stimulate land investments (Brasselle et al., 2002). Households making investments in land usually spend more time working on the land and thus participate less in migration (Mullan et al., 2011). The higher incomes earned from agriculture reduce the need for earning off-farm income.

Third, perceived land tenure security has a positive land renting-out effect on migration. Greater perceived land tenure security promotes household incentives to rent out land, because it reduces the risk of land not being

returned to the lessor after the rental period ends. The additional income earned from renting out land may be used to finance the transportation, living, job-hunting costs and other start-up costs of migration (De Janvry et al., 2015; Yang, 1997). Thus higher perceived land tenure security may encourage credit-constrained households to rent out land and migrate simultaneously (Benjamin and Brandt, 2002).

In summary, perceived land tenure security has a positive risk-reducing effect, a negative investment effect and a positive land renting-out effect on migration. These effects are shown schematically in Figure 4.1, with the names in ovals indicating the mediating effects. The net effect of perceived land tenure security on migration is inconclusive, given that the magnitudes of the three effects are unknown.

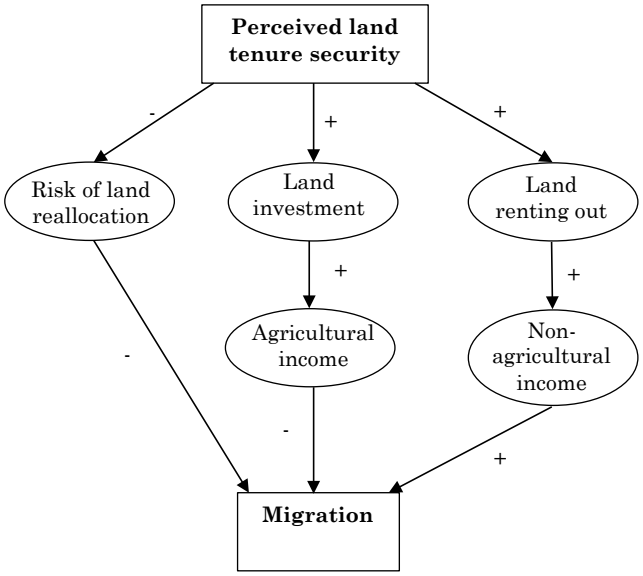


Figure 4.1 Conceptual framework for impact of perceived land tenure security on migration

4.3.2 Impact of actual land tenure security

Actual land tenure security might influence household migration in at least three different ways. First, it affects migration through the land tenure security perceptions of households. When actual tenure security is high, household perceptions of their tenure security will generally be high as well. Two major aspects of actual tenure security in China are the occurrence of land reallocations and the possession of land certificates. Households that experienced one or more land reallocations since the 1998 land allocation are more likely to expect additional land reallocations to occur in the future, and are less likely to believe that land certificates protect their land rights than those whose land has never been reallocated (Kung, 2000). Land certificates provide a basis for legal protection against illegal land occupation and land conflicts. Households that possess land certificates will generally perceive their land tenure to be relatively secure.

But different mechanisms may exist through which actual tenure security can affect migration. One such mechanism is the negative land quality effect. Households with relatively high actual land tenure security are expected to have better quality land because they have made more land investments. In the case of China, households that have not experienced land reallocations since the 1998 allocation and that possess land certificates are more likely to have invested in improving land quality (Deininger et al., 2011). Households with higher quality land can generate more income from agriculture, and hence have a lower need to earn off-farm income.

In addition, actual land tenure security may have a positive impact on migration through land rentals. When no land reallocations take place in a village, inequality among households in per capita land holdings tends to increase due to changes over time in household sizes; land rentals may be

used to reduce this inequality (Deininger and Jin, 2015). The income earned from renting out land might ease liquidity constraints on migration. The opposite holds for renting in land. Similar effects may occur with possession of land certificates. It is not only the tenure security derived from land certificates that matters for land rental decisions, but also the actual possession of certificates. When the effectiveness of land certificates in protecting land rights is perceived as similar, land rentals are more likely to occur in villages that issued land certificates as compared to villages that did not do so.

The three effects discussed above are shown schematically in Figure 4.2, with the names in ovals again indicating the mediating effects. Apart from the impact of actual land tenure security through perceived land tenure security, actual land tenure security has a negative land quality effect and an indeterminate land renting effect on migration. Empirical research is needed to provide quantitative estimates of the sign (positive or negative) and magnitude of the net effect of actual tenure security on migration.

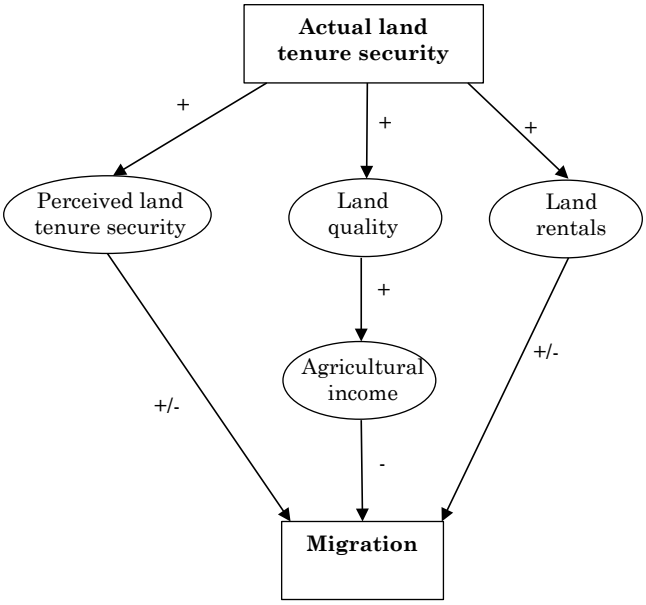


Figure 4.2 Conceptual framework for impact of actual land tenure security on migration

4.3.3 The role of land rental market development

The degree of land rental market development can play an important role in several of the pathways shown in Figure 4.1 and Figure 4.2. The positive risk-reducing effect of higher perceived tenure security will be weaker in villages with active land rental markets as land rentals enable land to be transferred from households with large per capita land holdings to households with smaller land holdings and hence decrease the risk of land reallocations within villages (Deininger and Jin, 2005). The positive land renting-out effect of higher perceived tenure security on migration will be stronger, because a more developed land rental market allows more households with (potential) migrants to rent out land, and to use the income from land rentals to cover costs of migration. For similar reasons,

the (indeterminate) land renting effect of actual land tenure security on migration is expected to be stronger in villages with a more developed land rental market.

4.4 Data and empirical strategy

4.4.1 Data collection

The data were collected in 2015 in Jiangsu province and Jiangxi province and in 2016 in Liaoning province and Chongqing municipality, China. These four areas are located in each of China's four major agro-ecological zones. The survey obtained information on land tenure arrangements, labour allocation, development of land rental markets, and basic village and household characteristics, using structured village leader and household questionnaires and face-to-face interviews. The data set covers 124 villages and 1,486 households. A detailed description of the sampling process can be found in Ren et al. (2019b). Omitting 216 households that either did not have working age household members or had missing information on one or more of the variables used in our analysis, we use the survey data of 1,270 households for the empirical analysis.

4.4.2 Model specification

Our objective is to examine the impact of actual and perceived land tenure security on migration, taking into account the degree of development of land rental markets. To this end, we specify the following model:

$$M = \alpha_0 + \alpha_1 A + \alpha_2 L * A + \alpha_3 P + \alpha_4 L * P + \alpha_5 L + \alpha_6 X + \varepsilon, \quad (1)$$

where M represents household participation in migration; A and P denote actual land tenure security and perceived land tenure security

respectively; L represents land rental market development; X is a set of control variables, including natural capital, physical capital, human capital, social capital, demographic factors, local conditions and regional characteristics; α_i are the coefficients to be estimated (i= 1,...,6); ε is an error term with standard properties. Interaction terms between L and A and between L and P are included in the model to examine the impact of the degree of land market development on the relation between (actual and perceived) tenure security and migration.

No data are available in the data set on most of the mediating effects discussed in Section 4.3. We therefore focus our empirical analysis on the estimation of the net effects of actual and perceived tenure security. In the case of actual tenure security, the estimated effect reflects its separate impact at given levels of perceived tenure security because perceived tenure security is one of the explanatory variables included in the model. In other words, the coefficient estimate for actual tenure security indicates the net impact of the (negative) land quality effect and the (indeterminate) land renting effect (see Figure 4.2).

4.4.3 Variable definitions and expected effects

Table 4.1 shows the variable definitions and descriptive statistics. Household participation in migration is measured by three different indicators, namely migration decision, number of migrants and migration duration. Following the definition used by the National Bureau of Statistics of China, a migrant is defined as an individual who lived outside the home county for employment purposes for at least six months during the calendar year before the survey (De La Rupelle et al., 2008). Migration decision takes a value of 1 if at least one household member migrated, and 0 otherwise. Number of migrants is the number of migrants in the household. Migration duration is total months spent on migration by

migrated household members. In the sample that we use for the empirical analysis, 39% of the households have at least one migrant, the average number of migrants is 0.57, and the migration duration is 6.36 months on average (see Table 4.1).

Actual land tenure security is measured by absence of land reallocations and possession of land certificates. To avoid misreporting errors in households' responses to these questions, we use data from village leader surveys as indicators of the actual land tenure security of households (Deininger et al., 2014; Kung and Bai, 2011; Kung, 2000). Absence of land reallocations equals 1 if the land was not reallocated since the 1998 land allocation in the village in which the household lives, and 0 otherwise. Possession of land certificates takes a value 1 if the village issued land certificates to households during the 1998 land allocation, and 0 otherwise. Land reallocations have been conducted at least once since 1998 for 65% of the households in the sample, whereas land certificates were issued during the 1998 land allocation round in 70% of the villages in which the surveyed households live (see Table 4.1).

Perceived land tenure security is represented by household-level variables indicating that no land reallocations are expected, and the perceived effectiveness of land certificates. No land reallocations expected takes a value of 1 if a household expects its land will not be reallocated within the next five years, and 0 otherwise. Perceived effectiveness of land certificates takes a value of 1 if the household believes that land certificates can protect its land rights, and 0 otherwise. About four-fifths of the surveyed households do not expect their land to be reallocated within five years (82%) and believe that their land certificates can protect their land rights (81%). As discussed in Section 4.3, the impact of actual

and perceived land tenure security can be either positive or negative, depending on the relative strength of the different underlying mechanisms.

A dummy variable, obtained from the village leader surveys, is introduced to measure *land rental market development* in the village. Its value equals 1 if the share of transferred land in the village exceeds the average national level of 2015 (33%), and 0 otherwise. Apart from its interactive effects with tenure security, discussed in Section 4.3.3, the degree of land rental market development itself is also expected to affect migration decisions. A more developed land rental market allows prospective migrants to rent out land and reduces the opportunity costs of migration (De Janvry et al., 2015; Yang, 1997). But it also allows other households to rent more land and thereby stimulates them to remain in the village. Thus, the standalone land rental market development variable has an indeterminate impact on migration. Land rental markets are less developed on average in our research areas, since only 22% of the sample households live in villages where the share of transferred land exceeds the national average. Substantial differences exist across the four regions. In Jiangsu province, 46% of the surveyed households live in villages with the share of transferred land exceeding the national average, whereas the ratio is merely 5% for the surveyed households in Liaoning province.

Several control variables are included in the model. *Natural capital* is represented by the contracted land area per capita and the number of contracted land plots. Large per capita land endowments decrease a household's probability of migration (Atamanov and Van den Berg, 2012). Number of land plots is used as an indicator of land fragmentation. On the one hand, fragmented land causes an increase in travel time and difficulties in management. Households will therefore obtain lower agricultural incomes as compared to households with similar land sizes

and fewer plots, and are more likely to migrate. On the other hand, land fragmentation allows households to gain access to land with different quality at different locations and thereby spread the risk of loss from natural disasters (Tan et al, 2006). In summary, the effect of fragmentation on farm income – and therefore migration – could be either positive or negative. Contracted land per capita is 2.76 mu[1] on average and the mean number of plots equals 8.04 for the households in our sample. Land endowment is the scarcest and most fragmented for the surveyed households living in Chongqing, with an average of 1.23 mu per capita and 14 plots per household.

Physical capital is measured by a household's possession of machinery and houses. Households possessing machinery are more likely to focus on farm production rather than migration as a livelihood strategy. Thus the impact of possession of machinery is expected to be negative. Households with more houses are generally wealthier and therefore better able to cover the costs of migration. On the other hand, wealthier households may be less motivated to increase family income through migration. Thus the number of houses is expected to have either a positive or negative impact on migration. Around one-third of the surveyed households (35%) possessed at least one machine for agricultural production in the year before the survey. The mean number of houses owned by households equals 1.19.

Human capital is represented in the model by the average age, education level, and off-farm experience of labourers. Younger household members generally have more opportunity to migrate than older members (Hare, 1999). Consequently, the average age of labourers is expected to have a negative impact on migration. Education level is measured by the ratio of

[1] Fifteen mu equals one hectare

labourers with at least junior high school to all labourers in a household. More educated individuals generally have more opportunities to find a relatively stable job in urban areas (De Brauw et al., 2002). Thus, the impact of education level is expected to be positive. Off-farm employment experience is measured by the ratio of labourers with off-farm experience in the year before last to all labourers in a household. It is expected to have a positive impact on migration because of lower transaction costs in finding off-farm employment. As can be seen in Table 4.1, the average age of labourers in our sample is around 46. About two-thirds of the labourers in our sample attended junior high school or higher, while 60% of the labourers have off-farm employment experience.

Social capital is represented by a dummy variable indicating whether the household head is, or has been, a village official. We define village official in a broader sense, including members of village committees and leaders of natural villages. Village officials may have better access to employment information and are therefore more likely to migrate, but village officials may also tend to combine local off-farm employment with work for the village committee. Thus, the impact of the village officials dummy on migration is ambiguous. One quarter of the household heads in our sample are, or have been, a village official.

The impact of *demographic factors* on migration is controlled by including the number of labourers, the dependency ratio and the female labour ratio in a household in the model. The number of labourers reflects a household's labour availability. When there are more labourers in a household, it is more likely that at least one of them will migrate. The dependency ratio is defined as the share of household members aged over 65 or below 16 in a household. On the one hand, dependents require care by other household members, reducing the likelihood of migration

(Deininger et al., 2014). On the other hand, the share of income spent on education, health care and food will be relatively high in households with high dependency ratios. This may increase the pressure to migrate. The dependency ratio therefore has a mixed impact on migration. Female labourers are less likely to participate in migration than males because of their traditional roles in rural families (Shi et al., 2007). In our sample, the mean number of labourers is 2.92, and ranges from one to eight. The dependency ratio equals 0.22 on average, whereas the female labour ratio equals exactly 0.50 on average.

Local conditions included in the model comprise the presence of large-scale farming and the distance to the town. Large-scale farming is defined as the presence of agribusinesses, family farms, land cooperatives or other large-scale farms in the village. The competition for land by large-scale farms reduces on-farm income earning opportunities and thereby stimulates migration. But it may also provide households with opportunities for local off-farm employment, thereby reducing migration incentives. The distance to the town is included in the model to indicate market access. It is measured by the distance from the village to the township centre. A longer distance to the township centre generally implies higher transportation and other costs for migrants, but may also imply a lower availability of local off-farm employment opportunities that would compete with migration. Thus, the effects of large-scale farming and distance to town on migration are both ambiguous. About one-third of the households in our sample (35%) live in villages with large-scale farming. The distance from the village to the township centre is 5.56 km on average and ranges from 0 to 26 km in our sample.

Regional characteristics, represented by dummy variables for three of the four regions, are introduced to control for agro-climatic or other

unobserved factors that differ between the four regions in which the villages in our sample are located and which may affect migration.

Table 4.1 Definitions and Summary Statistics of Variables Included in the Regression Analysis

Variable	Description	Mean	S. D.	Min	Max	Expected sign
Migration variables						
Migration decision	=1 if the household has at least one migrant (= member living outside the county for employment purposes for six months or more); =0 otherwise	0.39	0.49	0	1	--
Number of migrants	Number of migrants in a household	0.57	0.83	0	4	--
Migration duration	Total months spent on migration by migrated household members	6.36	9.32	0	48	--
Actual land tenure security						
Absence of land reallocations	=1 if the village has not reallocated farmland since 1998 land allocation; =0 otherwise	0.65	0.48	0	1	+/-
Possession of land certificates	=1 if the village issued land certificates to households in 1998 land allocation; =0 otherwise	0.70	0.46	0	1	+/-
Perceived land tenure security						

No land reallocations expected	=1 if the household expects their land will not be reallocated within the next five years; =0 otherwise	0.82	0.38	0	1	+/-
Perceived effectiveness of land certificates	=1 if the household believes that land certificates can protect its land rights; =0 otherwise	0.81	0.40	0	1	+/-
Land rental market						
Land rental market development	=1 if the share of transferred land in the village exceeds the average national level of 2015 (33%); =0 otherwise	0.22	0.41	0	1	+/-
Natural capital						
Land area per capita	Area of contracted land per capita (mu)	2.76	3.60	0.1	45	-
Number of land plots	Number of contracted land plots	8.04	7.08	1	50	+/-
Physical capital						
Machinery	=1 if the household possessed at least one machine the year before last year; =0 otherwise	0.35	0.48	0	1	-
Houses[1]	The number of houses the household owned the year before last year	1.19	0.45	0	6	+/-
Human capital						
Average age of labourers	Average age of labourers (household members aged between 16 and 65 years old, excluding students)	46.14	8.13	24	65	-
Education level of	Ratio of labourers taken junior high school or higher to all	0.66	0.35	0	1	+

labourers	labourers in the household					
Off-farm experience of labourers	Ratio of labourers with off-farm experience the year before last year to all labourers in the household	0.60	0.34	0	1	+
Social capital						
Village official	=1 if the household head is/was village official; =0 otherwise	0.25	0.43	0	1	+/-
Demographic factors						
Number of labourers	Number of household members aged between 16 and 65 years old, excluding students	2.92	1.07	1	8	+
Dependency ratio	Number of household members aged over 65 or below 16 divided by household size	0.22	0.19	0	0.8	+/-
Female labour ratio	Ratio of female labourers to all labourers in the household	0.50	0.17	0	1	-
Local conditions						
Large-scale farming	=1 if there is large-scale farming in the village; =0 otherwise	0.35	0.48	0	1	+/-
Distance to town[2]	Distance from the office of village committee to township centre (km)	5.56	4.20	0	26	+/-
Regional characteristics						
Jiangsu	=1 if the household is from Jiangsu; =0 otherwise	0.18	0.38	0	1	+/-
Liaoning	=1 if the household is from Liaoning; =0 otherwise	0.29	0.45	0	1	+/-
Chongqing	=1 if the household is from Chongqing; =0 otherwise	0.25	0.43	0	1	+/-

Instrument variables						
Mean household opinions about policy	Ratio of other households in the village agreeing with land stabilizing policy	0.55	0.21	0	1	--
Village land area per capita	Area of farmland in the village per capita (mu)	2.47	2.33	0.14	10.63	--

Source: Data on actual land tenure security variables, land rental market variable and local conditions variables have been obtained from the village leader surveys and data for the others from household surveys.

Note: [1] The minimum value is zero because four households in our sample do not own houses. Rural households in China can sell their own house built on the construction land assigned to them and live in a rented house. [2] The minimum value is zero because two villages in our sample border on the township centre.

4.4.4 Estimation method

Land tenure security perceptions may be endogenous, because they may be affected by households' migration decisions (Ma et al., 2016; Mullan et al., 2011; Brasselle et al., 2002). Households with migrants may perceive a higher risk of land reallocations and may attach a lower value to land certificates as devices that can protect land rights. Given that the perceived land tenure security indicators are binary variables, and that the dependent variables include one binary variable (i.e., migration decision), one integer (i.e., number of migrants) and one continuous variable (i.e., months spent on migration), we use a two-step control function (2SCF) approach to produce consistent coefficient estimates (Liu et al., 2017; Wooldridge, 2014).

In the first step of 2SCF, probit models of perceived land tenure security are estimated:

$$P = \gamma_0 + \gamma_1 A + \gamma_2 L + \gamma_3 X + \gamma_4 Z + \mu, \quad (2)$$

where Z represents instrumental variables that affect perceived land tenure security (P), but do not affect migration (M) directly, and μ is the error term.

The generalized residuals R of Eq. (2) are obtained from the first step as:

$$R = P\lambda(\gamma_1 A + \gamma_2 L + \gamma_3 X + \gamma_4 Z) - (1 - P)\lambda(-\gamma_1 A - \gamma_2 L - \gamma_3 X - \gamma_4 Z), \quad (3)$$

where $\lambda(\cdot) = \phi(\cdot)/\Phi(\cdot)$ is the inverse Mills ratio; $\phi(\cdot)$ denotes the standard normal density function; and $\Phi(\cdot)$ is the standard normal cumulative distribution function. A Wald test over the joint significance of instruments in Eq. (2) is performed to test the strength of the instruments.

In the second step, the obtained generalized residuals R are introduced in the migration equation (1):

$$M = \alpha_0 + \alpha_1 A + \alpha_2 L * A + \alpha_3 P + \alpha_4 L * P + \alpha_5 L + \alpha_6 X + \alpha_7 R + \epsilon, \quad (4)$$

A probit model is applied to estimate the migration decision model and tobit models are applied to estimate the models with the number of migrants and migration duration as dependent variables. A Wald test over the joint significance of generalized residuals can be applied to test the null hypothesis that perceived land tenure security is exogenous (Liu et al., 2017; Brasselle et al., 2002). Re-estimation of (4) with instrumental variables Z included as explanatory variables may be used to test over-identification of instruments (see Eq. (5)) (Abdulai et al., 2011; Lee, 1992):

$$M = \alpha_0' + \alpha_1' A + \alpha_2' L * A + \alpha_3' P + \alpha_4' L * P + \alpha_5' L + \alpha_6' X + \alpha_7' R + \alpha_8' Z + \epsilon', \quad (5)$$

If instruments (Z) are not jointly significant in Eq. (5), they can be excluded from Eq. (4), and there is no over-identification problem of instruments. To address the possible correlation of errors for households living in the same village, we use cluster standard errors at the village level.

We include two instrumental variables in the empirical analysis: (i) mean opinion about land-stabilizing policy of the other surveyed households in the same village; and (ii) land area per capita in the village. These variables are assumed to affect a household's perceived land tenure security and to have no direct effect on a household's migration decision. When more households agree with the policy that land cannot be reallocated within 30 years in the village, a household is less likely to expect a land reallocation and more likely to expect that land certificates do protect land rights (Ma et al., 2013). Agreement with the policy by other households in the same village is unlikely to have a direct effect on a household's migration decision. The land endowments of a village are closely related to village land reallocation decisions (Kung and Bai, 2011). Villages with relatively abundant land are more likely to choose stable land tenure arrangements. Households in villages with more land per capita are therefore less likely to expect a land reallocation and more likely to believe that land certificates will

protect land rights. Migration decisions of a household are unlikely to have a direct relationship with the total land endowments of the village in which the household lives.

4.5 Results and discussion

4.5.1 Results

To account for potential endogeneity, we first estimated the equation explaining perceived land tenure security, i.e. Eq. (2). Detailed estimation results for the two perceived tenure security indicators are reported in Table 4.A.1 in the Appendix. In both models, the *p*-values of χ^2-statistics for the joint significance of the instruments indicate that they significantly affect perceived land tenure security. Mean household opinions about the policy of no land reallocations (for the other interviewed households in the same village) have a statistically significant positive effect at a 1% testing level. This is consistent with results found for other parts of China (Ma et al., 2013).

Table 4.2 shows the estimation results of Eq. (4) for each of the three dependent variables, i.e. migration decision, number of migrants and migration duration. The test results for the over-identifying restrictions, presented in the last row of the table, do not provide evidence that the hypothesis that the instruments affect migration only via perceived land tenure security should be rejected. The test results for the vector of generalized residuals derived from the first-stage estimations, presented in the penultimate row, show that the coefficients of generalized residuals are jointly significantly different from zero in all equations. We therefore reject the null hypothesis that the coefficients of the perceived land tenure security variables would be the same if we do not control for potential endogeneity.

We also estimated a standard probit model for migration decision, and tobit models for the number of migrants and migration duration, ignoring potential

endogeneity. There are significant changes in results (Table 4.A.2) compared to Table 4.2, indicating a bias if the endogeneity is not adequately dealt with.

The regression results presented in Table 4.2 show that the estimated coefficients of all interaction terms are not significant. Care should be taken, however, in interpreting this finding, as the interpretation of interaction terms in nonlinear models is controversial (Ai and Norton, 2003). To obtain more insight into the effect of land tenure security under different levels of land rental market development, we calculate the average marginal effect of the land tenure security variables following Karaca-Mandic et al. (2012). The results are presented in Table 4.3.

The presented marginal effects indicate that both actual and perceived land tenure security significantly affect migration decisions. As regards actual tenure security, both the absence of land reallocations and the possession of land certificates have significant negative effects on each of the three migration indicators in villages with less-developed land rental markets. The impact of actual tenure security is insignificant in villages where land rental markets are more developed. These results suggest that the overall effect of the (negative) land quality effect and the (indeterminate) land renting effect tends to be negative in villages with less-developed land rental markets. In other words, when renting land out is not a real option, households tend to invest more in land when actual tenure security is high and are therefore less likely to be involved in migration. The marginal effects of the absence of land reallocations are -0.09, -0.34 and -3.59 for migration decision, number of migrants and migration duration, respectively. Similarly, the marginal effects of possession of land certificates are -0.10, -0.43 and -4.92 for the three dependent variables, respectively.

With regard to perceived land tenure security, we find that households that expect no land reallocations in the near future are more likely to migrate. The estimated effects are significant for all three migration variables and are

independent of the degree of land rental market development. This means that the positive effect of higher perceived tenure security on migration through a lower risk of land reallocation is stronger than the negative effect through higher land investments, whereas the (positive) effect through renting land out seems negligible. Household perceptions regarding the importance of land certificates do not significantly affect the three migration variables. Hence, the actual possession of land certificates seems to play a more important role (see above) than perceptions attached to these documents. The estimated marginal effects for expectations regarding land reallocations are relatively large. For example, households are 40% more likely to have a migrant member when they do not expect a land reallocation within the coming five years.

Land rental market development as a standalone variable does not significantly affect migration. In other words, development of land rental markets does not affect migration on its own. This is consistent with findings for forest land in China in Mullan et al. (2011). Although the option to rent out land may stimulate migration, this finding indicates that the renting of land by other households in the village has a roughly similar negative effect on migration. The development of land rental markets only affects migration when the degree of actual tenure security changes as the significant interaction term with actual tenure security suggest.

We find significant impact for some of the other control variables. Among the two natural capital variables, land area per capita has a significant negative impact on all three migration variables, while the estimated coefficients for number of plots do not differ significantly from zero. This finding confirms earlier findings that households with larger land holdings are less likely to migrate (Zhao, 1999a,b; Zhu, 2002). Land fragmentation, however, is not found to significantly affect migration decisions.

As for physical capital variables, the possession of machinery has a significant negative impact (at a 10 percent testing level) on the number of migrants and

migration duration, but not on the migration decision itself. This finding provides some evidence supporting the finding of Deininger et al. (2014) that lack of machinery motivates households to migrate. Possession of houses is found to have no statistically significant impact.

Two of the human capital variables have a significant impact on migration. As expected, the average age of labourers has a negative effect on all three migration variables, while the off-farm experience of labourers has a positive effect. However, the education level of labourers does not have a significant effect. Mixed effects are found in the available literature for the impact of education on migration (e.g. Ma et al., 2016; Meng and Zhao, 2018). The education variable in our model is the share of labourers with junior high school or higher; it does not consider differences in schooling for those without junior high school and those who graduated from junior high school.

Social capital, as measured by a dummy variable indicating whether the household head is or has been a village official, negatively affects all three migration variables. This finding suggests that village officials tend to work more on-farm or participate in local off-farm employment, which is easier to combine with working for village committee.

Among the three demographic factors, only the number of labourers is found to have a significant impact on migration. The positive coefficient estimated in all three equations confirms the results of earlier studies that households with more members of working age are more involved in migration (Deininger et al., 2014). The dependency ratio and the female labour ratio do not have significant effects.

The two local conditions variables are both found to play a significant role in migration. The negative coefficient for large-scale farming suggests that large-scale farms provide households living nearby with increased opportunities to work on these farms or to generate more local off-farm employment and thereby reduce incentives to migrate. Distance to town is found to have a positive impact

on migration, as found also by Ma et al. (2016) in Gansu, China. A possible explanation for this finding is that households living nearer to the township centre have better access to local off-farm work.

The coefficient estimates for the three regional dummy variables do not differ significantly from zero. This finding indicates that there are no unobserved factors affecting migration that differ significantly between the four provinces where we held the survey.

Table 4.2 Regression Results for Migration Model (eq. 4), 2nd Stage of Control Function Approach[1, 2]

	Migration decision	Number of migrants	Migration duration
Actual land tenure security			
Absence of land reallocations	-0.31**	-0.34**	-3.59**
	(0.12)	(0.15)	(1.81)
Absence of land reallocations × land rental market development	0.21	0.11	1.88
	(0.31)	(0.40)	(4.68)
Possession of land certificates	-0.32***	-0.43***	-4.92***
	(0.12)	(0.15)	(1.79)
Possession of land certificates × land rental market development	0.15	0.25	2.44
	(0.28)	(0.35)	(4.08)
Perceived land tenure security			
No land reallocations expected	2.25***	2.72***	30.19***
	(0.50)	(0.61)	(7.03)
No land reallocations expected × land rental market development	-0.26	-0.24	-2.65
	(0.26)	(0.37)	(4.22)
Perceived effectiveness of land certificates	-0.73	-0.49	-5.29
	(0.77)	(0.94)	(10.77)
Perceived effectiveness of land certificates × land rental market development	0.35	0.37	4.11
	(0.24)	(0.32)	(3.55)

Land rental market			
Land rental market development	-0.25	-0.25	-3.23
	(0.34)	(0.48)	(5.33)
Natural capital			
Land area per capita	-0.04**	-0.05**	-0.55**
	(0.02)	(0.02)	(0.26)
Number of plots	0.01	0.01	0.15
	(0.01)	(0.01)	(0.10)
Physical capital			
Machinery	-0.14	-0.21*	-2.37*
	(0.09)	(0.12)	(1.35)
House	-0.15	-0.18	-1.97
	(0.10)	(0.12)	(1.38)
Human capital			
Average age of labourers	-0.05***	-0.06***	-0.62***
	(0.01)	(0.01)	(0.10)
Education level of labourers	-0.03	0.06	0.91
	(0.13)	(0.16)	(1.86)
Off-farm experience of labourers	0.60***	1.03***	11.77***
	(0.15)	(0.19)	(2.15)
Social capital			
Village official	-0.17*	-0.27**	-2.86*
	(0.10)	(0.13)	(1.48)
Demographic factors			
Number of labourers	0.35***	0.59***	6.65***
	(0.05)	(0.06)	(0.68)
Dependency ratio	-0.11	0.15	2.04
	(0.24)	(0.30)	(3.48)
Female labour ratio	-0.23	-0.26	-3.49
	(0.29)	(0.36)	(3.99)
Local conditions			
Large-scale farming	-0.37***	-0.44***	-4.64***

	(0.11)	(0.14)	(1.62)
Distance to town	0.02*	0.03**	0.33**
	(0.01)	(0.01)	(0.15)
Regional characteristics			
Jiangsu	0.30	0.10	1.04
	(0.21)	(0.25)	(2.92)
Liaoning	-0.15	-0.37	-4.47
	(0.24)	(0.30)	(3.44)
Chongqing	0.26	0.05	-0.16
	(0.27)	(0.32)	(3.74)
Generalized residuals			
Generalized residual from no land reallocation expected	-1.08***	-1.33***	-14.87***
	(0.27)	(0.33)	(3.83)
Generalized residual from perceived effectiveness of land certificates	0.32	0.18	1.61
	(0.43)	(0.53)	(6.07)
Constant	0.16	-1.02	-12.19
	(0.76)	(0.96)	(10.88)
Observations	1270	1270	1270
Log likelihood	-679.11	-1252.32	-2449.06
R^2	0.20	0.14	0.08
χ^2- statistics for joint significance of generalized residual (p-value)	15.95	16.56	15.78
	(0.003)	(0.0003)	(0.0004)
χ^2- statistics for over-identification (p-value)	1.05	1.10	1.30
	(0.5901)	(0.5747)	(0.5236)

[1] Standard errors clustered at village level are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[2] χ^2- statistics for joint significance of instrumental variables in the first stage (p-value): no land reallocations expected regression: 11.94 (0.0026), perceived effectiveness of land certificates regression: 19.01 (0.0001).

Table 4.3 Average Marginal Effects for Land Tenure Variables[1,2]

	Migration decision	Number of migrants	Migration duration
Actual land tenure security			
Absence of land reallocations (Land rental market development=0)	-0.09**	-0.34**	-3.59**
	(0.04)	(0.15)	(1.81)
Absence of land reallocations (land rental market development=1)	-0.03	-0.23	-1.71
	(0.09)	(0.39)	(4.55)
Possession of land certificates (Land rental market development=0)	-0.10***	-0.43***	-4.92***
	(0.04)	(0.15)	(1.79)
Possession of land certificates (Land rental market development=1)	-0.05	0.19	-2.48
	(0.07)	(0.31)	(3.61)
Perceived land tenure security			
No land reallocations expected (Land rental market development=0)	0.41***	2.72***	30.19***
	(0.03)	(0.61)	(7.03)
No land reallocations expected (Land rental market development=1)	0.40***	2.48***	27.54***
	(0.05)	(0.72)	(8.17)
Perceived effectiveness of land certificates (Land rental market development=0)	-0.22	-0.49	-5.29
	(0.22)	(0.94)	(10.77)
Perceived effectiveness of land certificates (Land rental market development=1)	-0.11	-0.12	-1.17
	(0.24)	(1.00)	(11.30)

[1] Standard errors clustered at village level are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[2] Average marginal effects for control variables are not reported for brevity.

4.5.2 Robustness check

To test the robustness of our main findings, we performed two additional analyses. First, we performed the "plug-in" approach to check the robustness of general results obtained from the 2SCF approach. In the first step, the Probit models were estimated for Eq. (3) to obtain predicted values of perceived land tenure security variables. In the second step, the Probit model or Tobit model for Eq. (1) was estimated by replacing the original endogenous variables in Eq. (1) with predicted values from the first step. The results are reported in Table 4.A.3. They are basically consistent, with one exception. The interaction between perception on land certificates and land rental market development has a significant positive impact on migration, while it is not significant using the 2SCF approach. A possible explanation is that the "plug-in" approach might yield biased estimates when the endogenous variable is discrete (Brasselle et al., 2002).

Second, we replaced possession of land certificates issued in the 1998 land allocation with the possession of either the 1998 land certificates or new certificates issued in the new-round land certification programme that was under way when we conducted our survey. The regression results are displayed in Table 4.A.4. The estimated coefficients for possession of at least one land certificate are also positive but are not statistically significant at the 10% testing level. The other main findings, however, remain unchanged.

4.6 Conclusion

In this paper, we investigated the impact of perceived and actual land tenure security on migration in rural China for different degrees of development of land rental markets. In theory there are several mediating channels between tenure security and migration. As a result, perceived and actual land tenure security can either positively or negatively affect migration. Testing this empirically, the two-step control function (2SCF) approach was applied to deal with the potential endogeneity of perceived land tenure security.

The main conclusion of our analysis is that both actual and perceived tenure security affect migration, but the impact of perceived tenure security as measured by land reallocation expectations is much stronger and is positive, whereas the separate impact of actual tenure security, i.e. its impact apart from affecting tenure security perceptions, is negative. This finding confirms that households perceiving a high risk of losing land when one or more members were to migrate may refrain from migration. Higher perceived tenure security may also stimulate land rentals and investments in farmland, but the subsequent effects on migration seem relatively minor. Actual tenure security, as measured by absence of land reallocations and possession of land certificates, negatively affects migration only in villages with less-developed land rental markets. This finding suggests that households tend to invest more in farmland when actual tenure security is high and where renting land is not an option, and as a consequence are less likely to be involved in migration.

Several policy implications may be generated from these conclusions. First, household perceptions of tenure security play a major role in migration decisions. Households that expect no land reallocations in the future are more likely to allocate labour to migration. Thus, convincing households that land reallocations will not occur when one or more members migrate can contribute to a more efficient allocation of labour, and thereby to poverty reduction and overall productivity growth. One way to do so is to improve the awareness and the understanding of households of the policy that prohibits land reallocations. As shown in Table 4.A.1, perceived tenure security is significantly higher when more households in a village agree with the policy that land cannot be reallocated in the village within 30 years.

Second, improving actual tenure security through issuing land certificates and implementing bans on land reallocation may in fact reduce migration – and thereby equity and efficiency – when the local land rental market is underdeveloped and tenure security perceptions remain unchanged. It is

therefore important to identify existing bottlenecks in the functioning of land rental markets in regions where they remain underdeveloped, and to develop policies to remove these bottlenecks.

Third, another interesting finding from our analysis is that the presence of large-scale farms in a village tends to reduce migration. Hence, the ongoing process of farm-scale expansion in Chinese agriculture does not lead to massive migration as is sometimes feared, but seems to contribute to the creation of more local off-farm opportunities. Whether these employment opportunities are inside or outside agriculture is an issue that needs further research.

Methodologically, this paper applied a two-step control function (2SCF) approach to household and village-level survey data to deal with the potential endogeneity of perceived land tenure security. Our results may still be affected to some extent by unobserved factors that differ between households or villages and that affect both the dependent and the main explanatory variables in our model. For future research, we therefore suggest that the robustness of our findings is checked by using panel data instead of cross-sectional survey data. Additionally, we tested only the overall effects of actual and perceived land tenure security in our empirical analysis. For follow-up research, we advise investigating in more detail the different channels through which actual and perceived land tenure security affect migration.

Appendix

Table 4.A.1 Regression results for perceived land tenure security, 1st stage of control function approach[1]

	No land reallocations expected	Perceived effectiveness of land certificates
Actual land tenure security		
Absence of land reallocations	0.42**	-0.05
	(0.17)	(0.13)
Possession of land certificates	0.27	0.08
	(0.18)	(0.15)
Land rental market		
Land rental market development	-0.07	0.11
	(0.21)	(0.16)
Natural capital		
Land area per capita	0.03	-0.01
	(0.03)	(0.02)
Number of plots	-0.03***	-0.00
	(0.01)	(0.01)
Physical capital		
Machinery	-0.12	0.20*
	(0.10)	(0.12)
House	0.21*	0.07
	(0.12)	(0.12)
Human capital		
Average age of labourers	-0.01	-0.01**
	(0.01)	(0.01)
Education level of labourers	-0.41**	0.17
	(0.17)	(0.15)
Off-farm experience of	0.16	-0.12

labourers		
	(0.16)	(0.13)
Social capital		
Village official	0.10	0.33***
	(0.11)	(0.11)
Demographic factors		
Number of labourers	-0.06	-0.05
	(0.05)	(0.05)
Dependency ratio	-0.20	-0.61**
	(0.32)	(0.24)
Female labour ratio	0.27	-0.02
	(0.26)	(0.29)
Local conditions		
Large-scale farming	0.39**	-0.16
	(0.17)	(0.11)
Distance to town	-0.02	0.01
	(0.02)	(0.01)
Regional characteristics		
Jiangsu	-0.05	0.55***
	(0.23)	(0.17)
Liaoning	0.56**	0.91***
	(0.27)	(0.21)
Chongqing	0.96***	1.04***
	(0.27)	(0.20)
Instrumental variables		
Mean household opinions	1.46***	0.95***
about policy	(0.44)	(0.23)
Village land area per capita	0.03	-0.03
	(0.04)	(0.03)
Constant	-0.10	0.64
	(0.54)	(0.56)
Observations	1270	1270

Log likelihood	-442.84	-523.44
R^2	0.25	0.16
χ^2-statistics for the joint significance of instrumental variables (p-value)	11.94 (0.0026)	19.01 (0.0001)

[1] Standard errors clustered at village level are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.A.2 Estimation ignoring the potential endogeneity of perceived land tenure security[1]

	Migration decision	Number of migrants	Migration duration
Actual land tenure security			
Absence of land reallocations	-0.04	0.01	0.29
	(0.12)	(0.16)	(1.84)
Absence of land reallocations × land rental market development	0.21	0.13	2.05
	(0.31)	(0.40)	(4.73)
Possession of land certificates	-0.17	-0.24	-2.71
	(0.13)	(0.16)	(1.91)
Possession of land certificates × land rental market development	0.08	0.15	1.29
	(0.28)	(0.37)	(4.23)
Perceived land tenure security			
No land reallocations expected	0.39***	0.47***	4.97**
	(0.14)	(0.18)	(2.04)
No land reallocations expected × land rental market development	-0.30	-0.33	-3.67
	(0.26)	(0.38)	(4.30)
Perceived effectiveness of	-0.12	-0.11	-1.64

land certificates	(0.12)	(0.15)	(1.76)
Perceived effectiveness of land certificates × land rental market development	0.34	0.35	3.88
	(0.24)	(0.32)	(3.59)
Land rental market			
Land rental market development	-0.23	-0.17	-2.25
	(0.34)	(0.49)	(5.48)
Natural capital			
Land area per capita	-0.03	-0.04*	-0.46*
	(0.02)	(0.02)	(0.26)
Number of plots	-0.00	0.00	0.02
	(0.01)	(0.01)	(0.09)
Physical capital			
Machinery	-0.22**	-0.30**	-3.33**
	(0.09)	(0.12)	(1.34)
House	-0.09	-0.10	-1.08
	(0.10)	(0.12)	(1.37)
Human capital			
Average age of labourers	-0.05***	-0.06***	-0.62***
	(0.01)	(0.01)	(0.09)
Education level of labourers	-0.19	-0.12	-1.10
	(0.13)	(0.16)	(1.80)
Off-farm experience of labourers	0.67***	1.12***	12.68***
	(0.14)	(0.19)	(2.18)
Social capital			
Village official	-0.17**	-0.24**	-2.45*
	(0.08)	(0.11)	(1.29)
Demographic factors			
Number of labourers	0.33***	0.57***	6.42***
	(0.04)	(0.06)	(0.67)

Dependency ratio	-0.10	0.12	1.67
	(0.22)	(0.28)	(3.17)
Female labour ratio	-0.11	-0.13	-1.99
	(0.28)	(0.35)	(3.93)
Local conditions			
Large-scale farming	-0.18	-0.22	-2.24
	(0.11)	(0.14)	(1.59)
Distance to town	0.01	0.02	0.24
	(0.01)	(0.01)	(0.16)
Regional characteristics			
Jiangsu	0.31*	0.18	1.98
	(0.18)	(0.23)	(2.63)
Liaoning	0.15	0.09	0.80
	(0.16)	(0.20)	(2.33)
Chongqing	0.55***	0.50**	5.08**
	(0.17)	(0.20)	(2.34)
Constant	0.74	-0.04	-0.78
	(0.52)	(0.67)	(7.48)
Observations	1270	1270	1270
Log likelihood	-687.59	-1261.60	-2458.41
R^2	0.19	0.14	0.07

[1] Standard errors clustered at village level are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.A.3 Estimation results based on "plug-in" approach[1, 2]

	Migration decision	Number of migrants	Migration duration
Actual land tenure security			
Absence of land reallocations	-0.31**	-0.38**	-4.13*
	(0.15)	(0.19)	(2.21)
Absence of land reallocations ×	-0.07	-0.21	-2.65

land rental market development	(0.46)	(0.60)	(6.73)
Possession of land certificates	-0.30**	-0.43***	-4.75**
	(0.13)	(0.16)	(1.88)
Possession of land certificates × land rental market development	0.17	0.29	2.71
	(0.28)	(0.35)	(3.96)
Perceived land tenure security			
Predicted no land reallocations expected	2.64***	3.47***	39.15***
	(0.75)	(0.97)	(11.13)
Predicted no land reallocations expected × land rental market development	-0.08	-0.26	2.23
	(1.07)	(1.41)	(15.65)
Predicted perceived effectiveness of land certificates	-1.59	-1.86	-22.61
	(1.35)	(1.71)	(19.49)
Predicted perceived effectiveness of land certificates × land rental market development	1.92**	2.55*	26.22*
	(0.93)	(1.35)	(15.22)
Land rental market			
Land rental market development	-1.50*	-1.82	-22.22
	(0.88)	(1.23)	(13.77)
Natural capital			
Land area per capita	-0.04**	-0.06**	-0.65**
	(0.02)	(0.02)	(0.28)
Number of plots	0.01	0.02*	0.19*
	(0.01)	(0.01)	(0.11)
Physical capital			
Machinery	-0.12	-0.17	-1.84
	(0.10)	(0.13)	(1.46)
House	-0.17*	-0.21*	-2.24
	(0.10)	(0.12)	(1.37)
Human capital			

Average age of labourers	-0.05***	-0.06***	-0.65***
	(0.01)	(0.01)	(0.11)
Education level of labourers	0.02	0.14	1.98
	(0.15)	(0.19)	(2.16)
Off-farm experience of labourers	0.56***	0.96***	10.91***
	(0.15)	(0.20)	(2.21)
Social capital			
Village official	-0.14	-0.22	-2.06
	(0.13)	(0.16)	(1.86)
Demographic factors			
Number of labourers	0.34***	0.59***	6.56***
	(0.05)	(0.06)	(0.71)
Dependency ratio	-0.21	0.01	0.16
	(0.27)	(0.34)	(3.89)
Female labour ratio	-0.28	-0.34	-4.52
	(0.29)	(0.36)	(3.99)
Local conditions			
Large-scale farming	-0.44***	-0.56***	-6.19***
	(0.14)	(0.16)	(1.91)
Distance to town	0.03**	0.04**	0.41**
	(0.01)	(0.01)	(0.16)
Regional characteristics			
Jiangsu	0.38	0.25	2.97
	(0.27)	(0.34)	(3.83)
Liaoning	-0.05	-0.22	-2.54
	(0.33)	(0.41)	(4.63)
Chongqing	0.31	0.14	1.08
	(0.36)	(0.44)	(5.00)
Constant	0.55	-0.41	-4.24
	(0.95)	(1.18)	(13.33)
Observations	1270	1270	1270
Log likelihood	-681.12	-1253.81	-2450.26

R^2	0.20	0.14	0.08

[1] Standard errors clustered at village level are in the parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[2] The χ^2-statistics for the significance of instrument variables in the first step: 11.94 (p=0.0026) for no land reallocations expected, and 19.01 (p=0.0001) for perceived effectiveness of land certificates.

Table 4.A.4 Estimation results using the possession of at least one land certificate[1, 2]

	Migration decision	Number of migrants	Migration duration
Actual land tenure security			
Absence of land reallocations	-0.32**	-0.35**	-3.68**
	(0.12)	(0.15)	(1.83)
Absence of land reallocations × land rental market development	0.22	0.14	2.05
	(0.30)	(0.39)	(4.60)
Possession of at least one land certificate	-0.21	-0.30	-3.29
	(0.15)	(0.19)	(2.20)
Possession of at least one land certificate × land rental market development	0.11	0.14	1.64
	(0.32)	(0.42)	(4.79)
Perceived land tenure security			
No land reallocations expected	2.09***	2.53***	27.92***
	(0.55)	(0.67)	(7.74)
No land reallocations expected × land rental market development	-0.25	-0.22	-2.52
	(0.26)	(0.37)	(4.13)
Perceived effectiveness of land certificates	-0.75	-0.51	-5.50
	(0.77)	(0.95)	(10.93)

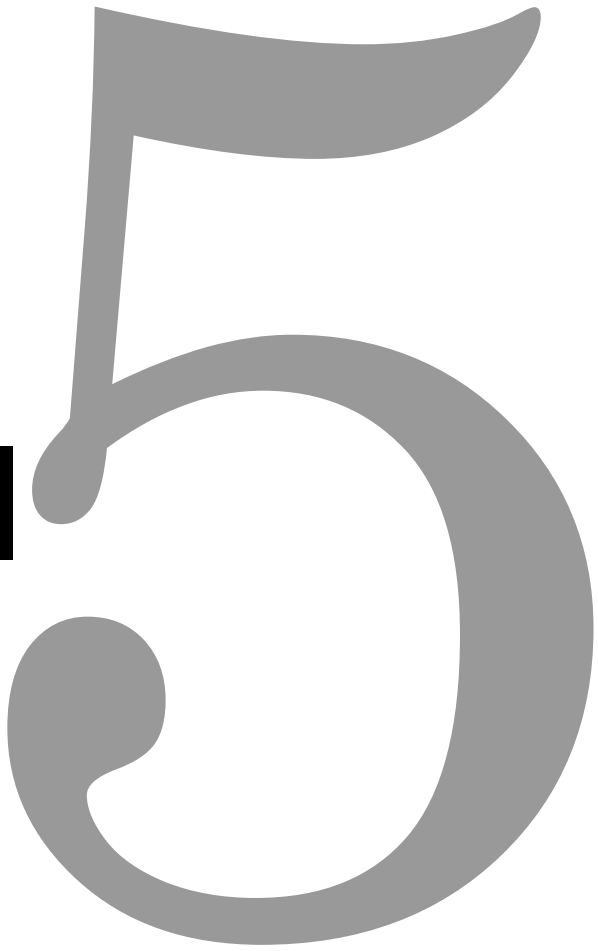
Perceived effectiveness of land certificates × land rental market development	0.34	0.35	3.91
	(0.24)	(0.32)	(3.56)
Land rental market			
Land rental market development	-0.22	-0.19	-2.59
	(0.36)	(0.51)	(5.69)
Natural capital			
Land area per capita	-0.03**	-0.05**	-0.53**
	(0.02)	(0.02)	(0.26)
Number of lots	0.01	0.01	0.13
	(0.01)	(0.01)	(0.10)
Physical capital			
Machinery	-0.14	-0.21*	-2.40*
	(0.09)	(0.12)	(1.36)
House	-0.15	-0.18	-1.95
	(0.10)	(0.12)	(1.38)
Human capital			
Average age of labourers	-0.05***	-0.06***	-0.62***
	(0.01)	(0.01)	(0.10)
Education level of labourers	-0.04	0.05	0.71
	(0.13)	(0.16)	(1.86)
Off-farm experience of labourers	0.61***	1.05***	11.92***
	(0.15)	(0.19)	(2.17)
Social capital			
Village official	-0.17	-0.27**	-2.82*
	(0.10)	(0.13)	(1.48)
Demographic factors			
Number of labourers	0.35***	0.59***	6.62***
	(0.05)	(0.06)	(0.68)
Dependency ratio	-0.12	0.14	1.99

	(0.24)	(0.30)	(3.50)
Female labour ratio	-0.21	-0.24	-3.21
	(0.29)	(0.36)	(3.98)
Local conditions			
Large-scale farming	-0.35***	-0.42***	-4.44***
	(0.11)	(0.14)	(1.67)
Distance to town	0.02*	0.03**	0.32**
	(0.01)	(0.01)	(0.16)
Regional characteristics			
Jiangsu	0.27	0.06	0.53
	(0.21)	(0.26)	(3.01)
Liaoning	-0.13	-0.35	-4.26
	(0.24)	(0.30)	(3.47)
Chongqing	0.26	0.05	-0.16
	(0.27)	(0.32)	(3.77)
Generalized residual from no land reallocation expected	-1.00***	-1.22***	-13.62***
	(0.30)	(0.37)	(4.24)
Generalized residual from perceived effectiveness of land certificates	0.33	0.20	1.80
	(0.44)	(0.54)	(6.16)
Constant	0.24	-0.92	-10.97
	(0.77)	(0.97)	(11.09)
Observations	1270	1270	1270
Log likelihood	-681.02	-1254.48	-2451.40
R^2	0.20	0.14	0.08
χ^2-statistics for the joint significance of generalized residuals (p-value)	11.20	11.24	10.54
	(0.0037)	(0.0037)	(0.0053)
χ^2-statistics for over-identification (p-value)	1.57	1.60	1.88
	(0.4553)	(0.4513)	(0.3901)

[1] Standard errors clustered at village level are in the parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[2] The χ^2-statistics for the significance of instrument variables in the first step: 12.38 (p=0.0021) for no land reallocations expected, and 19.48 (p=0.0001) for perceived effectiveness of land certificates.

CHAPTER 5



The impact of migration on farm performance: Evidence from China

Chapter 5 The impact of migration on farm performance: Evidence from China [1]

Abstract: Developing economies face challenges in improving the overall performance of farms. An essential obstacle could be a substantial shift in the agricultural labour force to off-farm sectors during the process of economic transition. This paper estimates the causal impact of migration on the economic and environmental performance of farms, measured using technical efficiency and fertilizer use efficiency. A stochastic frontier analysis, based on the survey data collected in four regions of China, is applied, finding an average technical efficiency of 0.92, while the average fertilizer use efficiency is only 0.22. The results of propensity score matching suggest that the migration of farmers has a negative impact on both technical efficiency and fertilizer use efficiency of their farms, and the impact is amplified for farmers who participated in migration more intensively. This would imply that the government policy on migration of rural households needs to consider this impact as well.

Key words: migration; stochastic frontier analysis, technical efficiency; fertilizer use efficiency; China

[1] This chapter is based on the working paper:
Ren, G., Zhu, X., Feng, S., 2019. The impact of migration on farm performance: Evidence from China.

5.1 Introduction

Improved farm performance benefits not only the welfare of agricultural households, a nation's food security, but perhaps also environmental quality when societies pursue sustainable agricultural growth. In contrast to developed economies, developing economies can face particular challenges in improving the performance of their farms. A notable one could be the substantial labour force shift from agriculture to off-farm sectors during the process of economic development. This process then causes difficulties for rural households in balancing resource allocations between on-farm and off-farm activities. For example, a household that has potential migrants should decide how much labour and money to invest in on-farm production and migration respectively. A natural question to ask is: does migration lower farm performance?

China makes a good case study due to its significant increase in the mobility of labour since the 1990s. The primary goal of this paper is to examine the impact of migration of rural households on farm performance. This performance could be measured by both economic and environmental behaviours. We use a cross-sectional dataset containing 809 households producing rice in 124 villages across four regions (Jiangsu, Jiangxi, Liaoning and Chongqing) in China. Specifically, we use stochastic frontier analysis (SFA) with Translog production function to estimate two specific measures for the economic and environmental performance of farms, i.e. *technical efficiency* and *fertilizer use efficiency*. The former indicates the economic performance measured by the ability of farms to minimize input use given the output level (e.g. Kumbhakar and Lovell, 2003; Zhu and Oude Lansink, 2010) and the latter indicates the environmental performance of the farms measured by the ratio of the minimum feasible fertilizer use to the actually applied fertilizer use, given the level of output and other inputs (e.g. Reinhard et al., 1999; Skevas et al., 2018).

Considering the wide-spread migration phenomenon of rural households to off-farm sectors in rural China, we examine the effect of migration on farms'

technical efficiency and fertilizer use efficiency using the propensity score matching (PSM) method. PSM allows us to construct comparable migration and non-migration groups. The effect of migration can be obtained by comparing the differences in technical efficiency and fertilizer use efficiency between migration and non-migration groups. To better understand the mechanism of estimated impact, we further identify whether more household members involved in migration lead to more efficiency loss.

Our major contributions to the literature are two-fold. First, this study is the first attempt to examine the impact of migration on fertilizer use efficiency. Increasing application of fertilizers is a key measure for improving agricultural productivity (Beaman et al., 2013; Duflo et al., 2011), but the excessive use of fertilizers has resulted in serious environmental problems (Wu et al., 2018). Migration might induce farmers to apply all their fertilizer when sowing rather than to apply it over time, depending on the needs of plant growth due to less labour being available for on-farm work (Ma et al., 2017). Fertilizer use efficiency could be a better measurement of environmental performance than the commonly used fertilizer use intensity (e.g. Li et al., 2013; Phimister and Roberts, 2006), as the latter ignores the levels of other inputs and output. For example, with the same level of total amount of fertilizer, a one-time application could result in a lower fertilizer use efficiency than applying it over time depending on the needs of plant growth. We empirically estimate the impact of migration on fertilizer use efficiency.

Second, we try to explore the labour reduction effect of migration on technical efficiency and fertilizer use efficiency. Migration affects technical efficiency and fertilizer use efficiency mainly through its labour reduction effect. That is, it is more difficult for households with more migrants to be resilient to the changes in the weather, the growth of the plant or incidence of natural disasters (Sauer et al., 2015). The one-time fertilization preferred by migration households will cause more fertilizer loss compared to spreading fertilizer over time. To illustrate the

existence of the labour-reduction effect, we investigate whether more household members involved in migration lead to more efficiency loss.

Our study is closely linked to the previous literature on determinants of technical efficiency and fertilizer use efficiency. However, this literature either does not consider the impact of migration (e.g. Guesmi and Serra,2016) or reaches different conclusions on the impact of migration on technical efficiency (e.g. Sauer et al., 2015, Wouterse, 2010 and Yang et al., 2016). Migration is found to have a negative impact on technical efficiency in Kosovo (Sauer et al., 2015), but a positive impact is found for cereal production in Burkina Faso (Wouterse, 2010). In China, Yang et al. (2016) find no significant impact of migration on technical efficiency. The mechanism of migration's effect on technical efficiency has not been studied. Moreover, the impact of migration on fertilizer use efficiency has not been studied yet. Therefore, our study makes a new contribution to the literature by investigating how household migration would influence both technical efficiency and fertilizer use efficiency of farms and by investigating the mechanism of the impact.

The rest of this paper proceeds as follows. Section 5.2 presents the theoretical framework on how migration could affect farms' technical and fertilizer use efficiency. Section 5.3 describes our empirical strategy and specifies the empirical model. Section 5.4 presents data and descriptive statistics. In Section 5.5, we discuss the empirical results. Section 5.6 provides a conclusion.

5.2 Theoretical framework: the impact of migration on farms' technical and fertilizer use efficiency

The relative availability of labour and finance is significantly different between migration and non-migration households (Wouterse, 2010). Migration entails reduced labour availability for agricultural production, while remittances sent by migrants provide households with liquidity and income security (Yang et al.,

2016; Wouterse and Taylor, 2008). Migration therefore affects farms' economic and environmental efficiency mainly through the decline in labour availability and the remittances from migrated household members (Wang et al., 2014; Gray, 2009; Rozelle et al., 1999). This will affect their farm production decisions in case labour, credit and insurance markets do not function perfectly (Taylor et al., 2003; Zhao, 2002; Taylor and Martin, 2001). In particular, it is expected to cause lower labour input, larger use of fertilizers, pesticides, seeds and other purchased inputs, and adoption of higher-yielding, but more risky technologies (Maharjan et al., 2013; Sauer et al., 2015; De Brauw and Rozelle, 2008; Barrett et al., 2001). But will it also affect the efficiency with which fertilizer and other inputs are used to produce a certain amount of output with a given technology?

5.2.1 The impact of migration on farms' economic performance

As migration implies a reduction of labour that is available for working on the farm, it will often be more difficult for households with migrants to mobilize sufficient labour rapidly corresponding to the changes in weather, the growth of plant or incidence of natural disasters (Mochebelele and Winter-Nelson, 2000). Migration households are therefore less resilient to unpredictable or urgent changes of conditions (Sauer et al., 2015). Thus the "labour reduction effect" of migration on technical efficiency could be negative.

5.2.2 The impact of migration on farms' environmental performance

Migration makes it difficult for households to adopt time-intensive techniques as a consequence of labour reduction when agricultural labour markets do not function perfectly. Households with migrants are more likely to apply large quantities of fertilizer when sowing or planting, instead of spreading fertilizer over time according to the requirements of the plant growth (Ma et al., 2017). The one-time fertilization preferred by migration households might yield more fertilizer loss and a lower fertilizer use efficiency compared to spreading over time, even for similar amounts applied. Additionally, compared to chemical fertilizer, application of manure could be more labour-intensive (Ebenstein et al., 2011; Shi et al. 2011). Migration households are therefore less motivated to apply

manure and might apply excessive chemical fertilizer to replace manure. Thus the "labour reduction effect" of migration on farms' fertilizer use efficiency could be negative.

5.3 Method

5.3.1 Estimating technical efficiency and fertilizer use efficiency

To estimate technical efficiency and fertilizer use efficiency, we first define the production function. We use the Translog production function because it provides a flexible functional form compared to the Cobb-Douglas production function. The Translog production function is presented as:

$$ln\,Y_i = \beta_0 + \sum_j \beta_j\, ln\,X_{ij} + \beta_f\, ln\,F_i + \frac{1}{2}\sum_j \sum_k \beta_{jk}\, ln\,X_{ij}\, ln\,X_{ik} + \frac{1}{2}\beta_{ff}\,(ln\,F_i)^2 + \sum_j \beta_{jf}\, ln\,X_{ij}\, ln\,F_i + \beta_c C_i + v_i - u_i, \quad (1)$$

where Y_i is the output of household i; X_{ij} (j=1,2, 3 and 4) represents four inputs, i.e., labour, machine, pesticide and land; F_i is fertilizer input, measured by the sum of three active ingredients, including nitrogen (N), phosphorus (P) and potassium (K); C_i represents control variables, including land quality, irrigation condition, a dummy variable of double-season rice, and regional dummies; v_i is the two-sided noise component; u_i captures the non-negative technical inefficiency component. Technical efficiency (TE) of farm i is calculated as:

$$TE_i = \exp(-u_i), \quad (2)$$

To calculate fertilizer use efficiency, we follow the method proposed by Reinhard et al. (1999). We use F_i^M to represent the minimum feasible fertilizer input given the production function and observed values of output and other inputs.

Fertilizer use efficiency (FE_i) is defined as the ratio of minimum fertilizer use (F_i^M) over observed fertilizer use (F_i). The fertilizer use efficiency could be expressed as:

$$FE_i = \frac{F_i^M}{F_i}, \tag{3}$$

The Translog production function of households that use fertilizer efficiently could be written as:

$$ln\, Y_i = \beta_0 + \sum_j \beta_j\, ln\, X_{ij} + \beta_f\, ln\, F_i^M + \frac{1}{2}\sum_j \sum_k \beta_{jk}\, ln\, X_{ij}\, ln\, X_{ik} + \frac{1}{2}\beta_{ff}\,(ln\, F_i^M)^2 + \sum_j \beta_{jf}\, ln\, X_{ij}\, ln\, F_i^M + \beta_c C_i + v_i, \tag{4}$$

Households that use fertilizer efficiently are technically efficient as well, so there is no technical inefficiency component (u_i) in Eq. (4) (Reinhard et al., 1999). Using Eq. (1) and Eq. (4), we get:

$$(\beta_f + \sum_j \beta_{jf} \ln X_{ij})\,(\ln F_i - \ln F_i^M) + \frac{1}{2}\beta_{ff}((\ln F_i)^2 - (\ln F_i^M)^2) - u_i = 0, \tag{5}$$

where, $\ln F_i^M - \ln F_i$ is equal to $\ln FE_i$ (see Eq. (3)). Eq. (5) can be rewritten as:

$$\frac{1}{2}\beta_{ff}(\ln F_i^M - \ln F_i)^2 + (\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i)\,(\ln F_i^M - \ln F_i) + u_i = 0, \tag{6}$$

Solving Eq. (6) yields:

$$lnFE_i = \ln F_i^M - \ln F_i = \frac{-(\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i) \pm ((\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i)^2 - 2\beta_{ff} u_i)^{0.5}}{\beta_{ff}}, \tag{7}$$

A technically efficient farm is necessary to use fertilizer efficiently, that is, when $u_i = 0$, $\ln FE_i = 0$. Thus "$+((\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i)^2 - 2\beta_{ff} u_i)^{0.5}$" is the only solution for calculating fertilizer efficiency. Therefore, fertilizer use efficiency could be expressed as:

$$FE_i = \exp\left(\frac{-(\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i) + \left((\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i)^2 - 2\beta_{ff} u_i\right)^{0.5}}{\beta_{ff}}\right), \quad (8)$$

where, "$\beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i$" is exactly the output elasticity of fertilizer (Ma et al., 2014). That is:

$$\tau_i = \beta_f + \sum_j \beta_{jf} \ln X_{ij} + \beta_{ff} \ln F_i, \quad (9)$$

where τ_i represents the output elasticity of fertilizer. We can rewrite the equation of fertilizer use efficiency as:

$$FE_i = \exp\left(\frac{-\tau_i + \left(\tau_i^2 - 2\beta_{ff} u_i\right)^{0.5}}{\beta_{ff}}\right), \quad (10)$$

So fertilizer use efficiency could be calculated with the output elasticity of fertilizer (τ_i), technical inefficiency component (u_i) and the coefficient of the squared term of fertilizer (β_{ff}). The stochastic frontier analysis (SFA) is used to estimate the production function to obtain β_{ff}, u_i, and the components of calculating τ_i according to Eq. (9). Technical and fertilizer use efficiency scores are then calculated according to Eq. (2) and Eq. (10).

Additionally, to better understand the results of production function, we calculate the output elasticities of the other inputs and scale elasticity. Similar to the output elasticity of fertilizer, we can obtain the output elasticity of each input j as:

$$\tau_{ij} = \beta_j + \sum_k \beta_{jk} \ln X_{ik} + \beta_{jf} \ln F_i + \beta_{jj} \ln X_{ij}, \quad (11)$$

where X_{ik} represents the other inputs except input j and fertilizer (F_i). The scale elasticity (L_i) could be expressed as:

$$L_i = \tau_i + \sum_j \tau_{ij}, \quad (12)$$

5.3.2 Impact of migration: propensity score matching

The second step in the empirical analysis is to estimate the effect of migration on technical efficiency and fertilizer use efficiency by applying the propensity score matching (PSM) approach. The outcome variables are technical efficiency – measuring the economic performance of farms – and fertilizer use efficiency – measuring the environmental performance. The treatment variable is migration (M_i), which equals one if the household has at least one member living outside the county for at least six months for employment purposes, and zero otherwise. For each household, in the treatment group (i.e., migration households, $M_i = 1$) or in the control group (i.e., non-migration households, $M_i = 0$), they have potential outcomes if non-treated, Z_i^0 and potential outcomes if treated, Z_i^1.

The effect of migration on outcome variables for migration and non-migration groups could be expressed as:

$$E(Z_i^1|M_i = 1) - E(Z_i^0|M_i = 1), \text{ for the migration group} \quad (13)$$

$$E(Z_i^1|M_i = 0) - E(Z_i^0|M_i = 0), \text{ for the non-migration group} \quad (14)$$

However, the observed outcome (Z_i) for treated and non-treated households is $E(Z_i^1|M_i = 1)$ and $E(Z_i^0|M_i = 0)$, respectively. The counterfactuals (i.e., $E(Z_i^0|M_i = 1)$ and $E(Z_i^1|M_i = 0)$) are unobserved with survey data. The PSM approach is therefore employed to construct the appropriate counterfactuals and estimate the causal effect of migration on technical efficiency and fertilizer use efficiency.

To find the counterfactuals, we first estimate the influencing factors of households' participation in migration by employing the Logit model:

$$M_i = \alpha_0 + \alpha_i W_i + \omega_0, \tag{15}$$

where W_i represents the influencing factors of migration. The probability of participating in migration conditional on W_i (i.e., propensity score, $P_i(W_i)$) of each household is predicted. That is, $P_i(W_i) = \Pr(M_i = 1|W_i)$. Based on the propensity score, the households in the treatment group could be matched with households in the control group. Therefore, the statistically comparable treatment and control groups can be constructed. For each treated household, the counterfactual outcomes are estimated based on propensity scores and the potential outcomes of matched control group households. The causal effect of migration (average treatment effect on treated, ATT), is expressed as:

$$ATT = E_{P_i(W_i)|M_i=1}\{E[Z_i^1|M_i = 1, P_i(W_i)] - E[Z_i^0|M_i = 0, P_i(W_i)]\}, \tag{16}$$

To ensure that PSM identifies the causal effect of migration on efficiencies, two key assumptions must be discussed (Khandker et al., 2009: 55-56). First, potential outcomes (Z_i) are independent of households' participation in migration (M_i), conditional on the set of observed characteristics (W_i). That is, $Z_i^1, Z_i^0 \perp M_i|W_i$. This is known as "conditional independence assumption". Second, there should be some overlaps between the treatment and control groups in the probability of participating in migration. This is the so-called "common support assumption". In empirical estimation, we use the most frequently used nearest neighbour (NN) matching for PSM. Specifically, we apply NN with five matching partners and restrict the matching within the common support.

5.3.3 Estimating propensity score: influencing factors of migration

As stated by the conditional independence assumption, the outcome variables must be independent of treatment conditional on the propensity score. Caliendo and Kopeinig (2008) suggest two criteria for selecting variables in estimating the

influencing factors of a treatment variable. First, only variables that influence both the treatment variables and the outcome variables should be included. Second, only variables unaffected by participation in migration should be included. Hence, variables fixed over time or measured before participation in migration are preferred.

Variables in Table 5.A.1 are used to estimate influencing factors of participation in migration. Land certificate and land reallocation are included to capture the impact of land tenure security. Households with experiences of land reallocation are less likely to migrate due to the potential risk of losing land during land reallocation (Giles and Mu, 2017). However, land reallocation might motivate migration as well. Because households with experiences of land reallocation might be less likely to invest in improving land quality and earning sufficient income from land, and therefore have a higher need to migrate (Deininger et al., 2014). Similarly, households with a land certificate are more likely to migrate since a land certificate provides legal protection against land expropriation and reallocations (Deininger et al., 2011). On the other hand, households with a land certificate are more likely to invest in improving land quality and earn sufficient income from land, and therefore less incentivized to migrate (De Janvry et al., 2015). The impacts of land certificate and land reallocation are therefore indeterminate.

Following Sauer et al. (2015), we include age and education level of both household head and household members. Younger or better-educated household head or household members could be more capable of engaging in non-agricultural jobs and are therefore more likely to migrate (Zhang et al., 2002). Other household characteristics including whether the household head is or was a village official, household size, number of adults, dependency ratio and female ratio of household are introduced as well. Households with village officials will have easier access to information about off-farm jobs, on the one hand, but on the other hand, they might prefer to combine local off-farm work with the work on the village committee (Guang and Zheng, 2005). For households with a larger

household size, the occupation of household members is more likely to be diversified and then more likely to have migrated household members. (Taylor et al., 2003). Households with a larger number of adults are more likely to have sufficient labour working on the farm and will then more likely have surplus labour for migration (Zhao, 1999). Dependency ratio might hinder migration as more labourers are occupied taking care of dependent people, but might also motivate labourers to migrate to meet the higher need of educational and medical costs (Shi et al., 2007). A higher female ratio could negatively affect the probability of migration because in rural China it is usually the female's task to do housework and take care of children (Feng and Heerink, 2008).

Additionally, contracted land area per capita and number of contracted plots are introduced to reflect the impact of natural capital. Larger contracted land area per capita increases the probability that households gain sufficient livelihood security from land, thereby decreasing households' incentives to migrate (Wang, 2019). The number of contracted plots, on the one hand, increases the travelling costs involved in farming and raises the need for income from migration, while on the other hand, it diversifies the land quality of households' land holdings, spreading the risk of natural disasters and therefore reducing the need for income from migration (Tan et al., 2010). Physical capital, represented by possession of houses and machinery, is expected to have an impact on migration. It might be easier for households with more houses to overcome the credit constraint of migration (McKenzie and Rapoport, 2007). However, households with more houses are wealthier and with lower needs for extra income from migration, and could thus be less likely to migrate (Mullan et al., 2011). The livelihood of households possessing production machinery are more likely to rely on farming activities instead of migration (Atamanov and Van den Berg, 2012; Deininger et al., 2014). Hence, possession of houses might have an indeterminate impact on migration, while possession of production machinery might have a negative impact on migration.

Distance to the centre of the nearest town is included to capture the access to market. Households living nearer to the town centre are more likely to get access to migration information and the transportation cost is lower for them as well (Ma et al., 2016; Kung et al., 2011). In contrast, households living nearer to a town might be more likely to find opportunities of local off-farm work in the same town (Bowlus and Sicular, 2003). Thus the impact of distance to a town on migration could be either positive or negative. Provincial dummies for Jiangsu, Liaoning and Chongqing are included to capture other factors that are systematically different between provinces but influence households' incentives to migrate.

5.4 Data and descriptive statistics

5.4.1 Research area

The data were collected in four regions of China: Jiangsu and Jiangxi provinces in 2015, and Liaoning province and Chongqing municipality in 2016 (see Figure 5.A.1). They are located in four major agro-ecological zones of China. The survey obtained information about agricultural production, occupation of household members and basic household characteristics. Using structured village leader and household questionnaires and face-to-face interviews, we collected data of 124 villages with 1,486 households in total. The detailed sample selection procedure is described in Ren et al. (2019). We use the subsample of the survey for households producing rice in this paper. After deleting households with missing information, the data on 809 rice-producing households is used for the empirical estimation.

5.4.2 Descriptive statistics of variables in the production function

The description of variables in the production function is shown in Table 5.1. The average total rice yield per household in the research area is 4111.28 kg. Fertilizer use, measured by adding up the active ingredients (nitrogen, phosphate and potassium), is 230.64 kg per household on average, with the minimum and

maximum levels of 3.68 kg/household and 3072.8 kg/household respectively. The average land input per household is 0.55 ha, ranging from 0.02 ha/household to 7.47 ha/household. Machinery input is measured in monetary terms, with an average level of 685.73 yuan/household. As the quantity of pesticide might not be comparable between households using different kinds of pesticide (e.g. herbicide or insecticide) or pesticide with different concentration levels (e.g. concentrated or diluted), pesticide input is measured in monetary terms as well. The average level of total pesticide application per household is 758.23 yuan. Labour input is measured in terms of labour days, the average level in our sample is 39.29 days. Soil quality and irrigation condition are 3.26 and 3.22 on average, with a scale from 1 (= low quality) to 5 (= high quality). The dummy variable of double-season rice is introduced to control the differences in the production between double-season rice and one-season rice. About 28% of households produce double-season rice in our sample.

Table 5.1 Descriptive statistics of variables in the production function

Variable	Unit	Mean	S.D.	Min.	Max.
Yield	Kg/household	4111.28	6993.148	135	56000
Fertilizer	Kg/household	230.64	394.1123	3.68	3072.8
Land	Ha/household	0.55	0.9	0.02	7.47
Machine	Yuan[1]/household	685.73	1478.8	0	16855
Labour	Labour days/household	39.29	128.31	0.33	3120
Pesticide	Yuan[1]/household	758.23	1511.4	0	22400
Soil quality	From 1 (= low quality) to 5 (= high quality)	3.26	0.92	1	5
Irrigation condition	From 1 (= low quality) to 5 (= high quality)	3.22	1.12	1	5
Double-season rice	=1 if a household produces double-season rice; =0 otherwise	0.28	0.45	0	1

Note: [1]. 1 yuan is about 6.69 US dollars according to the exchange rate in August 2016.

5.4.3 Descriptive statistics of variables for estimating propensity score

Table 5.2 shows the descriptive statistics of variables for estimating participation in migration, grouped by migration status. Regarding our treatment variable, we find that 43% of households in our sample have at least one member that has participated in migration. Many control variables show significant differences between treatment and control groups. In the non-migration group, land in about 45% households was reallocated at least once after the 1998 land contracting. In contrast, the share is significantly lower in the migration group, and only 36% experienced at least one land reallocation after the 1998 land contracting. Compared to non-migration households, migration households have relatively older household heads (58 vs 56), but with a much lower average age of adult members (46 vs 51) on average. What's more, the adult members of migration households tend to have a higher education level and are more likely to have off-farm experiences compared to non-migration households. Household size and number of adults show similar variation between the two groups. Compared with non-migration households, migration households have a relatively larger household size (4.89 vs 3.83) and more adult members (3.87 vs 2.98). Since migration households tend to have less contracted land, they possess less machinery for agricultural production. Moreover, migration households generally live further from the nearest town centre than non-migration households.

Table 5.2 Descriptive statistics and comparison of variables for estimating participation in migration

Variables	Control Migration=0	Treatment Migration=1	Difference[1]	Mean[2]	Std. Dev.[2]	Min[2]	Max[2]
Migration	--	--	--	0.43	0.50	0	1
Land certificate	0.65	0.68	-0.03	0.66	0.47	0	1
Land reallocation	0.45	0.36	0.09**	0.41	0.49	0	1
Household head age	56.15	57.79	-1.64**	56.85	9.45	23	83
Household head education level	2.66	2.59	0.07	2.63	0.99	1	6
Average age of adults	51.01	46.19	4.82***	48.95	8.71	29.33	74.33
Average education level of adults	0.54	0.61	-0.07***	0.57	0.33	0	1
Average off-farm employment experience of adults	0.54	0.66	-0.13***	0.59	0.31	0	1
Household size	3.83	4.89	-1.06***	4.29	1.74	1	15
Female ratio	0.49	0.48	0.01	0.49	0.12	0	1
Number of adults	2.98	3.87	-0.88***	3.36	1.16	1	9
Dependency ratio	0.22	0.24	-0.02	0.23	0.19	0	0.75
Village official	0.26	0.25	0.01	0.26	0.44	0	1
Land area per capita	2.28	1.22	1.06***	1.83	2.63	0	35
Number of land plots	8.36	8.22	0.13	8.32	7.22	0	45
Possession of houses	1.19	1.16	0.03	1.18	0.44	0	4
Possession of machinery	0.34	0.25	0.09**	0.30	0.46	0	1

Distance to town centre	5.11	5.67	-0.56*	5.36	4.19	0	26
Jiangsu	0.21	0.22	-0.01	0.21	0.41	0	1
Liaoning	0.09	0.07	0.03	0.08	0.27	0	1
Chongqing	0.24	0.32	-0.07**	0.27	0.45	0	1

Note: [1] Differences are tested by a two-sided unpaired t-test of means or proportion. [2] Values of mean, "std. dev.", min and max apply to the full sample.

*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

5.5 Results

5.5.1 Production function

Table 5.3 presents the results of the estimated production function. Land input and its squared term have significant positive effects on yield. In other words, sowing area increases yield at an increasing rate. The squared term of labour input has a significant positive impact, suggesting that labour is a nonlinear input in the production of rice. The coefficients of interaction terms between land and pesticide and between land and labour are both negative and significant, while the interaction term between pesticide and machinery has a positive impact on the yield. Land quality and irrigation condition both have positive impacts on rice production.

To obtain a direct insight of the impact of inputs, we further calculated the output elasticities with respect to each input at sample means (in Table 5.4). Consistent with previous studies, land is the most important input of the rice production in China. The corresponding elasticity of land is 0.95 at the sample mean. This is similar to Feng (2008)'s (i.e. land elasticity of 0.93) study of rice production in Jiangxi. Fertilizer also has a positive elasticity, but at a relatively low level, i.e. 0.029. This is lower than that of Feng (2008), in which output elasticity of fertilizer is 0.06. Machinery also has a positive elasticity of 0.047, while pesticide and labour have negative elasticities of -0.082 and -0.001, respectively. The sum of estimated output elasticities with respect to all inputs (i.e. the scale elasticity) is 0.95, indicating the decreasing return to scale of production technology. This is similar to the previous studies of China. For instance, Tan et al. (2010) indicates the sum of input-output elasticities are 0.93, 0.89 and 0.78 for early rice, one-season rice and late rice, respectively, in Jiangxi. Using the data of the same research area, Feng (2008) shows that the scale elasticity for rice production is 0.94.

Table 5.3 Estimated results of the production function

Variables	Coef.	z
ln(Fertilizer)	0.13	0.71
ln(Land)	1.31***	4.74
ln(Pesticide)	-0.11	-1.29
Zero pesticide[1]	-0.03	-0.25
ln(Machinery)	-0.04	-0.94
Zero machinery[1]	0.004	0.06
ln(Labour)	-0.14	-1.63
0.5(ln(Fertilizer))^2	-0.03	-1.28
0.5(ln(Land))^2	0.11*	1.84
0.5(ln(Pesticide))^2	0.0005	0.05
0.5(ln(Machinery))^2	0.002	0.33
0.5(ln(Labour))^2	0.01*	1.69
ln(Fertilizer)× ln(Land)	0.01	0.31
ln(Fertilizer)× ln(Pesticide)	0.01	1.01
ln(Fertilizer)× ln(Machinery)	0.001	0.2
ln(Fertilizer)× ln(Labour)	0.01	0.34
ln(Land)× ln(Pesticide)	-0.03**	-2.26
ln(Land)× ln(Machinery)	-0.01	-0.72
ln(Land)× ln(Labour)	-0.03*	-1.72
ln(Pesticide)× ln(Machinery)	0.004*	1.65
ln(Pesticide)× ln(Labour)	0.01	0.95
ln(Machine)× ln(Labour)	0.003	0.71
Soil quality	0.02**	2.04
Irrigation condition	0.01**	2.17
Double-season rice	-0.02	-0.6
Jiangsu	0.24***	7.21
Liaoning	0.20***	4.77
Chongqing	0.10***	3.62
Constant	9.14***	13.43
Sample size	809	

Log likelihood	329.32
Wald Chi2(28)	30569.42***

Note: [1]. Following the technique proposed by Battese (1997), the dummy variables for zero values of pesticide and machine were added to correct for zero values of inputs in an unbiased way.

*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level. We clustered standard errors at the village level.

Table 5.4 Output elasticities with respect to each input at sample means[1]

	Elasticity
Fertilizer	0.029
Land	0.95
Pesticide	-0.082
Machine	0.047
Labour	-0.001
Scale elasticity	0.95

Note: [1]. The output elasticity with respect to fertilizer is calculated according to Eq. (9). The output elasticities with respect to other inputs and scale elasticity could be calculated according to Eqs. (11) and (12).

The kernel density distributions of the technical efficiency and environmental efficiency scores are shown in figures 5.1 and 5.2, respectively. As shown in Table 5.5, the technical efficiency score of our sample ranges from 0.77 to 0.97, with an average of 0.92. This is similar to the results of Tan et al. (2010), which were 0.91, 0.80 and 0.89 for early rice, one-season rice and late rice respectively for three villages in Jiangxi in 2000. The median technical efficiency is 0.92; the 25th and 75th percentiles are 0.9 and 0.93, respectively.

The fertilizer use efficiency score of our sample is 0.22 on average, ranging from 0.04 to 0.5. This suggests that only 22% of fertilizer applied to rice is utilized. The rest (nearly 80%) is excessive and lost to air, soil and aquatic ecosystems. It is lower than that of other countries, such as 0.49 for maize production of Zambia

(Abdulai and Abdulai, 2017) and around 0.45 for Dutch dairy farms (Reinhard et al., 1999). Our result is similar to Ma et al. (2014), which was 0.25 for rice production of the Taihu Basin in Jiangsu in 2008, and is lower than the score of 0.33 for grain production in five provinces in China in 2007 (Wu,2011). The median fertilizer use efficiency is 0.22; the 25th and 75th percentiles are 0.17 and 0.26, respectively.

Table 5.5 Technical efficiency and fertilizer use efficiency scores

	Technical efficiency	Fertilizer use efficiency
Mean[1]	0.92 (0.03)	0.22 (0.07)
Minimum	0.77	0.04
25th percentile	0.9	0.17
50th percentile	0.92	0.22
75th percentile	0.93	0.26
Maximum	0.97	0.5

Note: [1] The standard deviations are in parentheses.

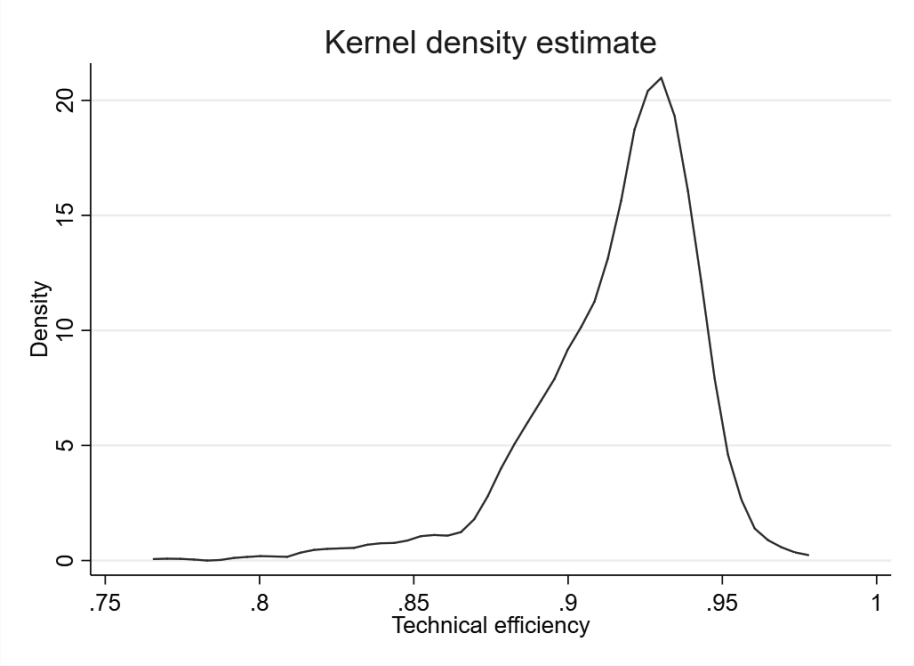


Figure 5.1 Kernel density distribution of technical efficiency

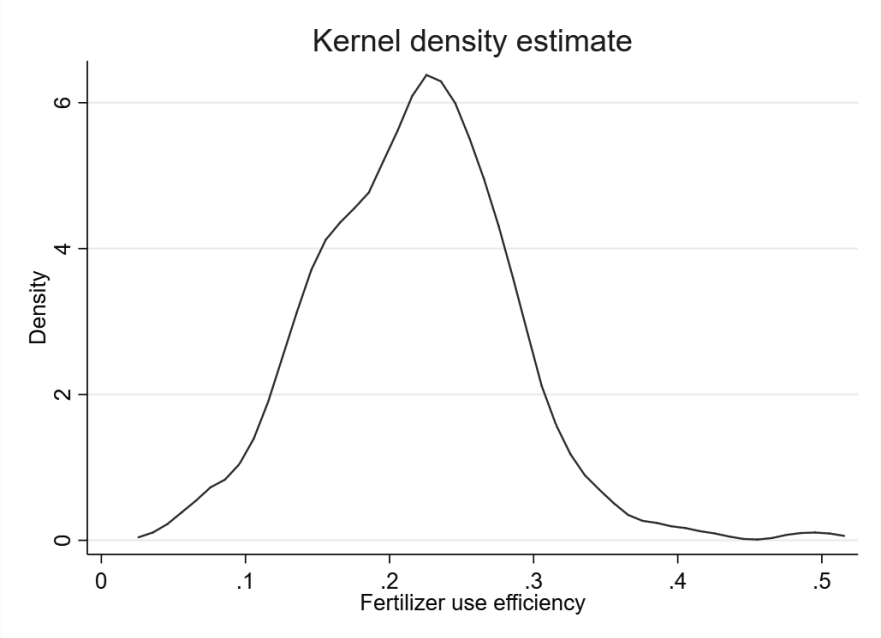


Figure 5.2 Kernel density distribution of fertilizer use efficiency

5.5.2 Influencing factors of migration

Table 5.6 shows the results of the Logit regression explaining influencing factors of participation in migration. Neither the issuing of land certificates nor experience of land reallocations has a significant effect on migration. The age of household head has a positive impact on migration, while the average age of adults in the family has a negative impact. Average off-farm employment experience of adults is found to have a positive impact on migration. It is consistent with our expectation that it is easier for households with off-farm experiences to migrate than those without off-farm experiences. Household size has a negative effect on migration, whereas number of adults has a positive effect on migration. Households with a larger number of adults tend to have more labourers available for migration and thus are more likely to have migrants.

Land area per capita has a negative impact on migration. In other words, more income from land lowers households' incentives to migrate. Additionally, possession of houses has a negative impact on migration. Households possessing

more houses are less likely to rely on the income sourced from migration and therefore less likely to migrate.

Table 5.6 Influencing factors of migration

Variables	Coef.	Z
Land certificate	-0.24	-0.93
Land reallocation	-0.28	-1.05
Household head age	0.04***	3.46
Household head education level	-0.02	-0.19
Average age of adults	-0.09***	-5.00
Average education level of adults	0.01	0.03
Average off-farm employment experience of adults	0.87***	2.60
Household size	-0.32**	-2.43
Female ratio	0.21	0.32
Number of adults	0.90***	5.03
Dependency ratio	0.56	0.99
Village official	-0.15	-0.71
Land area per capita	-0.16**	-2.02
Number of land plots	-0.005	-0.32
Possession of houses	-0.50**	-2.15
Possession of machinery	-0.32	-1.59
Distance to town centre	0.04	1.31
Jiangsu	0.13	0.46
Liaoning	0.42	0.87
Chongqing	0.49	1.52
Constant	-0.009	-0.01
Observations[1]	746	
Log likelihood	-403.53	

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level. We cluster standard errors at the village level.

[1]. Deleting observations with missing information of migration and its influencing factors, the data of 746 households are used for propensity score matching.

5.5.3 The impact of migration on technical efficiency and fertilizer use efficiency

To match treatment and control groups, we first estimate the Logit model of migration participation to estimate the propensity score. Figure 5.A.2 and Table 5.A.3 show that 314 treated households and 427 households in the control group are within common support (on support), while five treated households are beyond common support (off support). Table 5.A.2 presents the descriptive statistics after matching. The t-test suggests there are no significant differences in the sample means of independent variables between treated and control groups after matching. Table 5.7 shows the technical efficiency and fertilizer use efficiency, distinguishing between treatment and control groups. The treatment variable is households' participation in migration last year (2014 for Jiangsu and Jiangxi households; 2015 for Liaoning and Chongqing households). The results reveal that migration leads to a lower technical efficiency and fertilizer use efficiency. Households participating in migration have a technical efficiency of 0.9141 on average, which is significantly lower than that of non-migration households (0.9170 on average), which is about 0.0029, or 0.3% lower. It is consistent with Yang et al. (2015), who illustrated that migration has a negative impact on technical efficiency, using household survey data from five provinces (including Jiangxi) of China. Households with migrants have a lower level of fertilizer use efficiency as well, which is 0.2113 on average, compared to the non-migration group (0.2207). Migration decreases fertilizer use efficiency by 4.5%, which is to some extent consistent with Wu (2011)'s finding that households with farming as their major business tend to be more efficient in fertilizer application. Compared to technical efficiency, migration has a larger impact on fertilizer use efficiency.

Consistent with the theoretical framework in Section 5.2, the results suggest that migration negatively affects farm performance through the changes in production behaviour due to labour reduction.

Table 5.7 The effect of migration on technical efficiency and fertilizer use efficiency

	Treated	Control	Difference[1]	*Std. Err.*
Treatment: migration				
Technical efficiency	0.9141	0.9170	-0.0029*	0.0025
Fertilizer use efficiency	0.2113	0.2207	-0.0093**	0.0061
Observations	314	427		

Note: 1. A t-test is used to identify the differences in outcomes between treatment households and their matching partners.

*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level; † Significant at the 15% level.

To directly illustrate the existence of a labour reduction effect, we divided the treatment households into two groups, comprising a less intensive migration group and a more intensive migration group (see Table 5.8). As farm labour is generally over-abundant in developing countries, technical efficiency and fertilizer use efficiency are less likely to be affected by a slight movement of labour (Wang et al., 2014; Lewis, 1954). In the migration group, the median value and average value of the migrant ratio is close to 0.5. We therefore use 0.5 as the threshold. A less intensive migration group is therefore defined as one where less than half of the family labourers migrated, while a more intensive migration group is one where more than half of the family labourers migrated. As shown in the 3rd and 4th rows of Table 5.9, we find no evidence of significant differences in technical efficiency and fertilizer use efficiency between the control group and the less intensive treatment group. In other words, because of labour surplus, technical efficiency and fertilizer use efficiency are less likely to be influenced

when less than half of the family labourers have migrated. By contrast, the more intensive migration group produces greater differences in technical efficiency and fertilizer use efficiency (see the7th and 8th rows of Table 5.9). To be specific, the migration intensity magnifies the negative effect of migration on technical efficiency and fertilizer use efficiency. The technical efficiency of the more intensive migration group is 0.9128 compared to 0.9195 of the control group. The difference is about 0.7%, although it is only significant at 15% testing level (with a *p*-value of 0.1064). The fertilizer use efficiency of the more intensive migration group is 0.2076, which is 0.0183 (or 8%) lower than the control group (0.2259). The efficiency reduction effect of migration is enhanced when more labourers participated in migration. The results, therefore, confirm the existence of a "labour reduction effect".

Table 5.8 The causal effect of migration intensity on technical efficiency and fertilizer use efficiency

	Treated	Control	Difference[1]	*Std. Err.*
Treatment: low intensive migration, <=0.5 migrants				
Technical efficiency	0.9144	0.9169	-0.0025	0.0027
Fertilizer use efficiency	0.2112	0.2173	-0.0061	0.0063
Observations	250	427		
Treatment: high intensive migration, >0.5 migrants				
Technical efficiency	0.9128	0.9195	-0.0067†	0.0045
Fertilizer use efficiency	0.2076	0.2259	-0.0183*	0.0114
Observations	62	427		

Note: 1. A t-test is used to identify the differences in outcomes between treatment households and their matching partners.

* Significant at the 10% level; † Significant at the 15% level.

5.5.4 Robustness check

To check the robustness of the production function, we present the results using the Cobb-Douglas production function in Table 5.A.4 and the calculated efficiency scores in Table 5.A.5. The results of the production function are generally consistent with our primary results. The estimated technical efficiency is the same as the estimation from the Translog production function, with the mean level of 0.92. The estimated mean of fertilizer use efficiency is 0.14, which is lower than that estimated from the Translog production function. This may be because the Cobb-Douglas production function underestimates the output elasticity of fertilizer.

The robustness of PSM is further checked by using another matching method. We use the radius matching to check the robustness of the nearest neighbour matching. As shown in Table 5.A.6, the results are quite consistent with Table 5.7 and 5.8. Migration has a negative impact on technical efficiency, fertilizer use efficiency and output. After we divide the treatment group into less intensive and more intensive treatment groups, the negative effects of migration are more significant for the less intensive treatment group, but are larger for the more intensive migration group.

The robustness of the labour reduction effect is checked by investigating the impact of migration on yield per hectare and fertilizer applied per hectare, that is, output and fertilizer use intensity as presented in Table 5.A.7. Households with migrants also have a lower level of output, i.e. 7266 kg/ha on average. This is 340.85 kg/ha (or about 4.5%) lower than that of households without migrants (7606 kg/ha). However, there is no difference in fertilizer use intensity between migration households and non-migration households. Hence, with a similar intensity of fertilizer application, migration households have relatively higher output levels than non-migration households. This can be explained by the "labour reduction effect". Because migration households are less flexible in terms of labour, they are more likely to apply fertilizer when sowing or planting instead of spreading it out over time. One-time fertilization will cause more fertilizer loss

compared to non-migration households, which are more likely to spread fertilizer out over time according to the growth of plants. Therefore, compared to non-migration households, migration households have a lower level of output when the amount of fertilizer applied per land area is similar. This also suggests that the impact of migration on production is the result of the labour reduction effect.

5.6 Conclusions

We applied the stochastic frontier analysis (SFA) and propensity score matching (PSM) method to the survey data collected in the four regions of Jiangsu, Jiangxi, Liaoning and Chongqing. We estimated the technical efficiency and fertilizer use efficiency of rice-producing households and examined the impact of migration on technical efficiency and fertilizer use efficiency. We also elaborated the mechanism of how migration affects farms' economic and environmental performance.

The average technical efficiency of sample households is 0.92, which implies that an improvement of 8% of output could be achieved in rice production given the present input level. The average of fertilizer use efficiency is 0.22, which indicates that only 22% of applied fertilizer is utilized and a reduction in fertilizer application is possible given the current technology and output levels. Nearly 80% of applied fertilizer is lost to air, soil and aquatic ecosystems. We recommend drawing up policies for improving fertilizer use efficiency.

The results of PSM suggest a negative impact of migration on both the economic and environmental performance of farms, the impact on environmental performance is larger than on economic performance and the impact is amplified for households that have participated in migration more intensively. Although migration provides another source of income for rural households, it also generates some economic loss for on-farm production but also especially environmental loss. We also identified the labour reduction effect of migration on

technical efficiency and fertilizer use efficiency. To avoid the efficiency loss caused by migration, policies encouraging rural households to specialize in either migration or on farm work might be recommended.

Two limitations should be noted. First, pesticide use efficiency is not included as a measurement of environmental performance because we do not have specific data on the type, contents and concentration levels of pesticide. Future studies might estimate pesticide use efficiency with more accurate data on pesticide. Second, we examined the "labour reduction effect" of migration by differentiating the treatment group into more intensive and less intensive groups. It might be of interest for future studies with a larger sample size to divide the treatment group into more categories.

Appendix

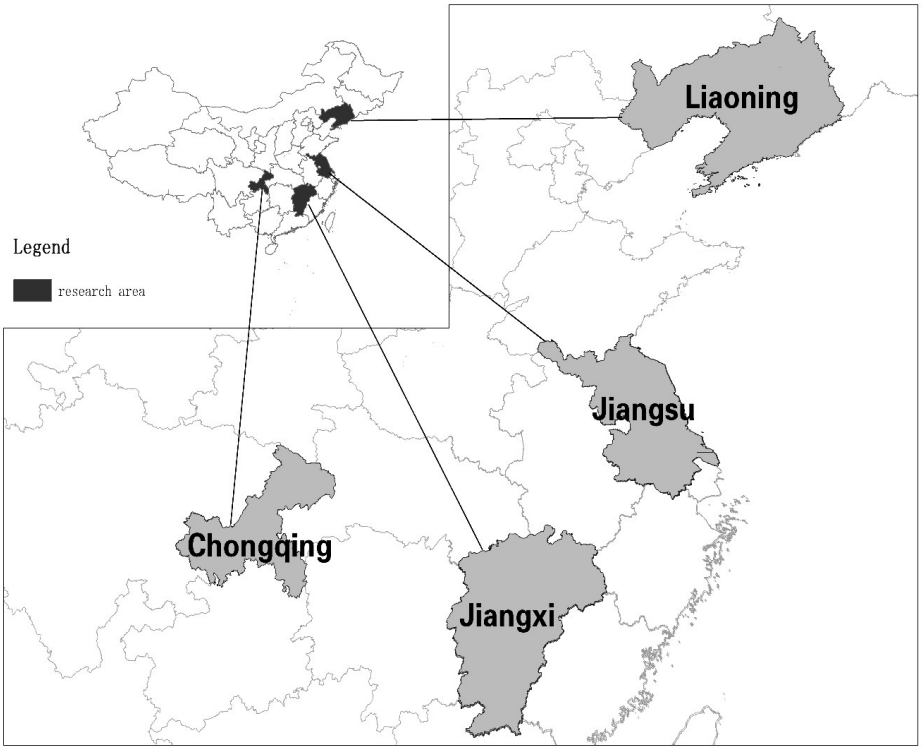


Figure 5.A.1 Study area location

Data source: National Catalogue Service for Geographic Information (2017).

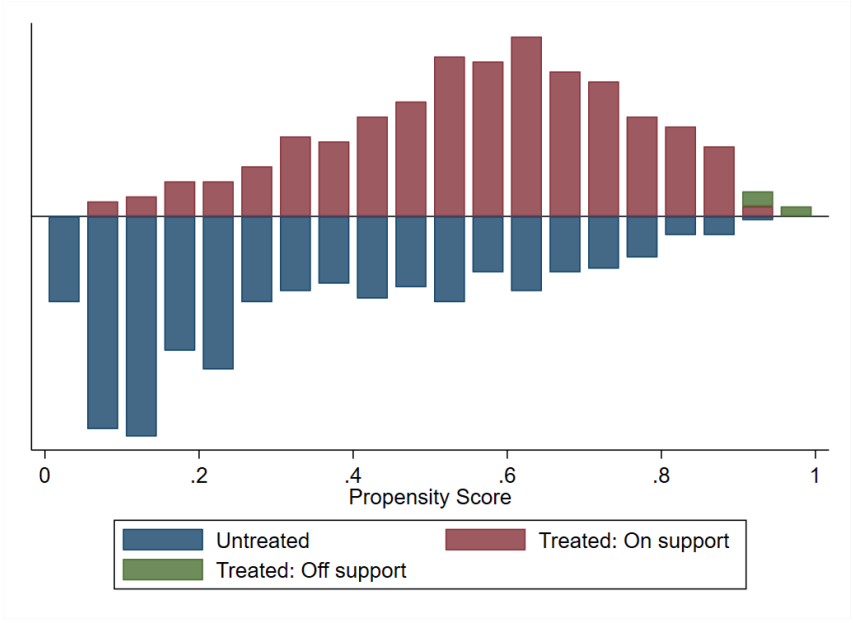


Figure 5.A.2 Distribution of pair-wise propensity score (treatment: migration)

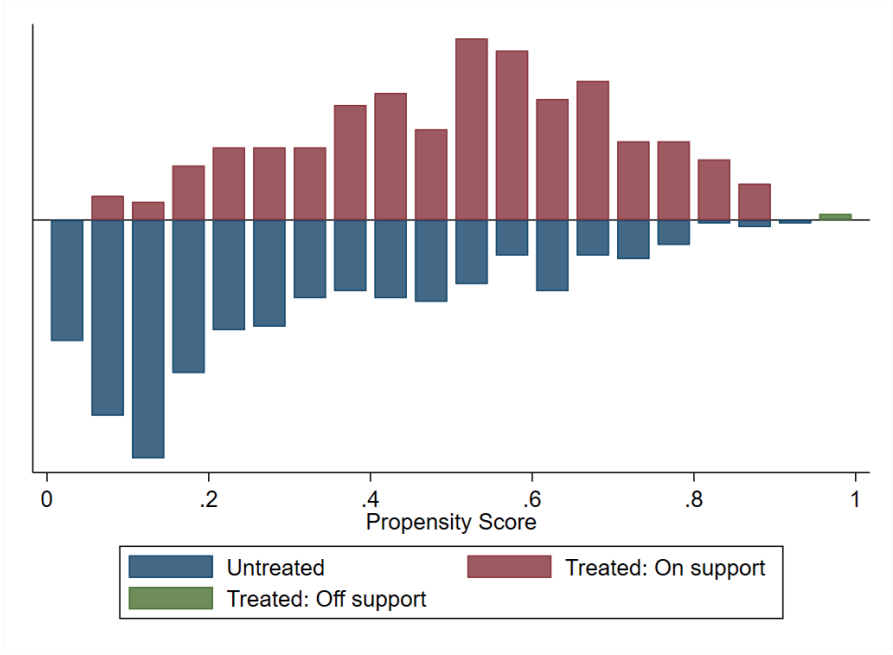


Figure 5.A.3 Distribution of pair-wise propensity score (treatment: less intensive migration)

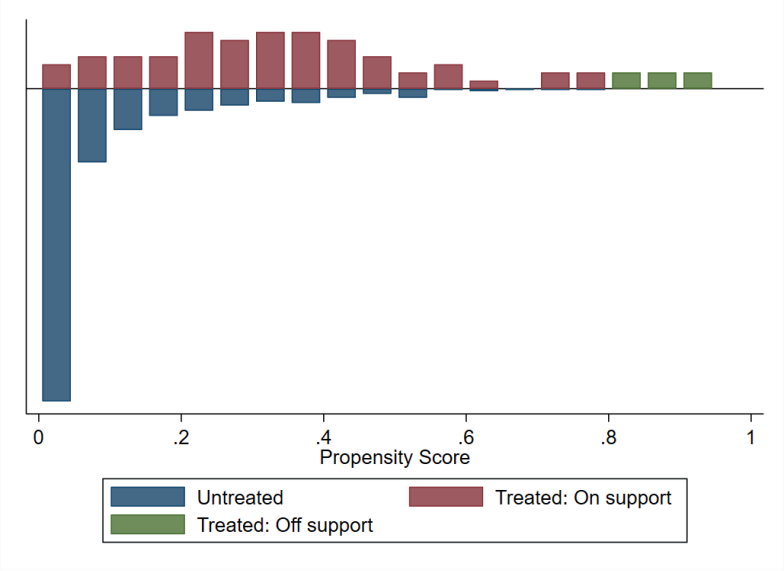


Figure 5.A.4 Distribution of pair-wise propensity score (treatment: more intensive migration)

Table 5.A.1 Definition of variables in estimating propensity score

Variables	Definition
Migration	=1 if the household has at least one member living outside the county for at least six months for employment purposes; =0 otherwise
Land certificate	=1 if the village issues land certificates to households in the 1998 land contracting; =0 otherwise
Land reallocation	=1 if the village reallocated land at least once after the 1998 land contracting; =0 otherwise
Household head age	Age of household head
Household head education	Education level of household head

level	
Average age of adults	Average age of adults (aged 16 years old and above, and excluding those who are still students)
Average education level of adults	Ratio of adults having taken junior high school or higher to all adults in the household
Average off-farm employment experience of adults	Ratio of adults with off-farm experience in the year before last to all adults in the household
Household size	Number of household members
Female ratio	Ratio of female adults
Number of adults	Number of household members aged 16 years old and above
Dependency ratio	The number of family members aged over 65 or below 16 divided by family size
Village official	Household head is or was a village official
Land area per capita	Area of contracted land per capita (mu)
Number of land plots	Number of contracted land plots
Possession of houses	The number of houses the household owns in the year before last
Possession of machinery	=1 if the household possesses machinery the year before last; =0 otherwise
Distance to town centre	Distance to township centre (km)
Jiangsu	=1 if the household is from Jiangsu; =0 otherwise
Liaoning	=1 if the household is from Liaoning; =0 otherwise
Chongqing	=1 if the household if from Chongqing; =0 otherwise

Table 5.A.2 Descriptive statistics of treated and control groups after matching

Variables	Mean		t [1]
	Treated	Control	
Land certificate	0.68	0.70	-0.38
Land reallocation	0.36	0.40	-1.03
Household head	57.65	57.87	-0.3

age			
Household head education level	2.59	2.58	0.2
Average age of adults	46.28	46.13	0.27
Average education level of adults	0.61	0.62	-0.65
Average off-farm employment experience of adults	0.66	0.66	0.09
Household size	4.87	4.96	-0.73
Female ratio	0.48	0.47	0.73
Number of adults	3.83	3.89	-0.68
Dependency ratio	0.24	0.25	-0.54
Village official	0.25	0.25	0.09
Land area per capita	1.23	1.22	0.1
Number of land plots	8.19	7.88	0.55
Possession of houses	1.16	1.22	-1.55
Possession of machinery	0.26	0.26	-0.13
Distance to town centre	5.67	5.42	0.71
Jiangsu	0.22	0.25	-0.92
Liaoning	0.07	0.08	-0.58
Chongqing	0.32	0.30	0.41

Note: [1]. A t-test is used to determine if the sample means are significantly different between treated and control groups. The results of the t-test show

that none of the means are significantly different between treated and control groups.

Table 5.A.3 Number of treated and untreated households on/off support

	Off support[1]	On support
Treatment: migration		
Untreated	0	427
Treated	5	314
Treatment: less intensive migration, <=0.5		
Untreated	0	427
Treated	1	250
Treatment: more intensive migration, >0.5		
Untreated	0	427
Treated	6	62

Note: [1]. A treated household is on support if its propensity score is within the scope of propensity scores of all non-treated households; otherwise, it is off-support.

Table 5.A.4 Stochastic frontier analysis using the Cobb-Douglas production function[1]

Variables	Coef.	Z
ln(Fertilizer)	0.04**	2.19
ln(Land)	0.96***	39.91
ln(Pesticide)	0.004	0.35
Zero pesticide	-0.06	-1
ln(Machinery)	0.01*	1.95
Zero machinery	0.05	1.41
ln(Labour)	-0.01	-0.75
Land quality	0.02*	1.83
Irrigation condition	0.01**	2.24
Double-season rice	-0.02	-0.86

Jiangsu	0.23***	7.56
Liaoning	0.22***	4.81
Chongqing	0.11***	3.74
Constant	8.49***	58.1
Observation	809	
Log likelihood	312.29	
Wald Chi^2 (18)	22635.10	

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level. We clustered standard errors at the village level.

[1]. A likelihood ratio test is conducted to test the null hypothesis, "the reduced model (the Cobb-Douglas production function) fits the data as well as the full model (Translog production function)". The χ^2 statistic is 34.05 (p-value is 0.0033). Therefore, we present the results from the Translog production function as the main results.

Table 5.A.5 Technical efficiency using the Cobb-Douglas production function

	Technical efficiency	Fertilizer use efficiency
Mean[1]	0.92 (0.03)	0.14 (0.08)
Minimum	0.76	0.001
25th percentile	0.9	0.08
50th percentile	0.92	0.14
75th percentile	0.93	0.18
Maximum	0.97	0.5

Note: [1]. The standard deviations are in parentheses.

Table 5.A.6 The causal effect of migration and its intensity on technical efficiency, fertilizer use efficiency and output using radius matching

	Treated	Control	Difference	*Std. Err.*	T-statistic[1]
Treatment: migration					
Technical efficiency	0.9141	0.9182	-0.0041	0.0017	-2.37***
Fertilizer use	0.2113	0.2211	-0.0098	0.0041	-2.39***

efficiency					
Observations	314	427			
Treatment: less intensive migration, <= 0.5 migrants					
Technical efficiency	0.9144	0.9182	-0.0038	0.0019	-2**
Fertilizer use efficiency	0.2122	0.2211	-0.0089	0.0045	-1.97**
Observations	250	427			
Treatment: more intensive migration, > 0.5 migrants					
Technical efficiency	0.9128	0.9182	-0.0054	0.0036	-1.5†
Fertilizer use efficiency	0.2076	0.2211	-0.0135	0.0084	-1.6†
Observations	62	427			

Note: [1]. A t-test is used to identify the differences in outcomes between treatment households and their matching partners.

*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level; † Significant at the 15% level.

Table 5.A.7 The effect of migration on output and fertilizer use intensity (kg/ha)

	Treated	Control	Difference[1]	S. E.
Treatment: migration				
Output	7266	7606	-340.85***	144.46
Fertilizer use intensity	408	413	-5.43	18.78
Observations	314	427		

Note: 1. A t-test is used to identify the differences in outcomes between treatment households and their matching partners.

*** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

CHAPTER 6

6

Conclusion

Chapter 6 Conclusion

6.1 Introduction

Although China has moved from being an underdeveloped country to becoming the world's leading emerging economy since 1978, rural poverty and inequality are still the major concerns of the country's development (Piketty et al., 2019). China's land reform in 1978 unleashed rapid growth in farm output and household income (Almond et al., 2019). However, the actual arrangements of land tenure varied from place to place. The level of actual land tenure security could be different across villages. Households' perceptions on land tenure security (hereafter referred to as perceived land tenure security) could be different even between households facing similar actual tenure security.

Large flows of migration have further contributed to the reduction of rural poverty since the 1990s (Zhu and Luo, 2010). However, when facing a high risk of losing land, potential migrants might choose to stay at home. The degree of land tenure security could be a hurdle for migration. Both actual and perceived land tenure security are likely to play a role. Moreover, concerns over food security and sustainability of agriculture call attention to the performance of agriculture production.

The joint analysis of land tenure security, migration and farm performance is lacking. It is difficult for a partial analysis of land tenure security, migration and farm performance to provide full insights for the benefit of policy making. Policies suggested by a partial analysis are less likely to be as effective as those based on a joint analysis, as the former cannot give a full description of the relationships between land tenure security, migration and farm performance. A better understanding of the linkages between land tenure security, migration and farm performance are of great importance for the land tenure reforms, policies relevant for migration, and agricultural green development.

This study has attempted to conduct a joint analysis of land tenure security, migration and farm performance. To be specific, four research questions are addressed. First, what are the driving factors of the persistence of land reallocations? Particular attention has been paid to the impact of village democracy and households' knowledge of policy. Second, how do land reallocation and certification affect households' perception of land tenure security? Third, how do actual and perceived land tenure security affect migration? What is the role of the land rental market in the impact? Finally, what is the impact of migration on technical efficiency and fertilizer use efficiency?

This final Chapter summarizes the answers to the four research questions, generates the overall conclusion by looking at the Chapters together and puts them into policy perspectives. Moreover, the contribution to scientific debates, limitations of this study, and recommendations for further research are discussed.

6.2 Answers to research questions

6.2.1 Impact of village democracy and households' knowledge of policy on persistence of land reallocations

In Chapter 2, we investigated the driving factors of land reallocations. Land reallocations were conducted periodically to account for the demographic changes within the family after the introduction of the Household Responsibility System (HRS) in 1978-84. Following the second-round land contracting in 1998 (hereafter referred to as the 1998 land contracting round), land reallocations were generally restricted. The 2002 Rural Land Contract Law (RLCL) mandated that land reallocations were only allowed under special conditions, such as natural disasters or land expropriation, and that formal approval was needed from two-thirds of the villagers or villager representatives as well as authorization by higher-level governments (hereafter referred to as the constrained rules of land reallocations). Individual villages are therefore empowered to determine their own arrangements of land reallocations.

The major factors include village democracy and households' knowledge of policy, as land reallocations are conducted at village level and villagers' approval is the legal condition for land reallocations. We find that both village democracy and households' knowledge of policy encourage land reallocations. Villages with democratically elected village leaders are more likely to reallocate land after the 1998 land contracting round. Democratically elected village leaders tend to be more accountable to villagers and are therefore more likely to reallocate land when there is a high demand for it.

Villages with more households that have heard of the RLCL are more likely to conduct land reallocations after the 1998 land contracting round. RLCL restricts the conditions for land reallocations and encourages land transfers through land rental markets. However, RLCL also specifies the special cases under which land could be reallocated. This finding suggests that households' knowledge of policy mainly affects land reallocations through improving their awareness of the possibility of reallocating land.

6.2.2 Impact of land reallocations and certification on households' perceptions of land tenure security

Factors affecting rural household tenure security perceptions were examined in Chapter 3. Households' perception of land tenure security (so-called "perceived land tenure security") is measured by their expectations concerning land reallocations in the next five years. We mainly focus on the impact of actual implementation of legal arrangements (so-called "actual land tenure security"). Actual land tenure security improves perceived land tenure security in two major ways: (i) implementation of bans on land reallocations; and (ii) issuing of land certificates. Two land certificates have been introduced, that is, one issued after the 1998 land contracting round (hereafter referred to as "old certificates") and one issued during the new-round land certification programme started in 2009 (hereafter referred to as "new certificates").

The past occurrence of land reallocations is found to exert a significant positive impact on household expectations regarding land reallocations within the next five years. This implies that households with experiences of land reallocations tend to feel more tenure insecurity as compared to households without such experiences.

Possession of new certificates has a significantly positive impact on perceived land tenure security, whereas possession of old certificates does not have a significant impact on perceived land tenure security. Compared to old certificates, the new certificates contain detailed specifications of plot size and locations, and are backed up by a land registration system and an information platform on land management contracts and certificates. This could be a potential explanation for the more significant impact of the new land certificates.

By adding interaction terms in the model, we further examined whether the impact of land certificates depends on land reallocations. Both old and new certificates have significant positive impact on perceived land tenure security in villages that reallocated land periodically. The estimated effect is more significant and larger for the new certificates than for the old ones. The impact becomes insignificant in villages that did not reallocate farmland after the second-round land contracting. Thus land certificates affect perceived tenure security especially in villages with a (recent) history of land reallocations.

6.2.3 Impact of actual and perceived land tenure security on migration

In Chapter 4, we examined the impact of actual and perceived land tenure security on migration, taking into account the degree of land rental market development. We found that both actual and perceived tenure security affect migration. For perceived land tenure security, land reallocation expectations have a positive impact on migration. Households that expect no land reallocations in the near future are more likely to migrate. The estimated effects are significant for all three migration variables (i.e., migration decision, number of migrants and migration duration) and are independent of the availability of

land rental markets in their villages. Household perceptions regarding the importance of land certificates do not significantly affect the three migration variables.

With regard to actual tenure security, both the absence of land reallocations and the possession of land certificates have a significant negative impact on each of the three migration indicators in villages with less-developed land rental markets. The impact of actual tenure security is insignificant in villages where land rental markets are more developed.

6.2.4 The impact of migration on farms' technical efficiency and fertilizer use efficiency

In Chapter 5, we estimated the impact of migration on technical efficiency and fertilizer use efficiency for rice farms. We found that the average of technical efficiency among interviewed rice production households is as high as 0.92, while the average of fertilizer use efficiency is only 0.22.

The results suggest a negative impact of migration on both economic and environmental performance of farms, and the impact is amplified for households that participated in migration more intensively. Thus our results reveal that migration has a negative impact on both economic and environmental performance of farms especially when more household members participated in migration. Migration exerts a stronger impact on environmental performance than economic performance. Although migration provides another source of income for rural households, it is economically and environmentally inefficient for households with migrants to continue working on-farm.

6.3 General conclusions and policy implications

6.3.1 General conclusions

We can draw three main conclusions when looking at the Chapters together. First, our study suggests that village democracy and households' knowledge of policy have a positive impact on migration through encouraging land reallocations, but this impact is only significant in villages where land rental market is less developed. In Chapter 2, we found that village democracy and households' knowledge of RLCL encourage land reallocations. Chapter 4 indicated that an absence of land reallocations hinders migration in villages with less-developed land rental markets. Village democracy and households' knowledge of policy are therefore likely to positively affect migration, and this positive impact is only significant in villages with less-developed land rental markets. Thus village democracy and households' knowledge of policy are not likely to exert an impact on migration when the land rental market is more developed. Moreover, in villages where land rental markets are less-developed, village democracy and households' knowledge of policy negatively affect farm performance, given the evidence that migration leads to a reduction of technical efficiency and fertilizer use efficiency.

Second, actual land tenure security has a positive impact on migration through perceived land tenure security, but a negative impact on migration through other channels in villages where the land rental market is less-developed. Chapter 3 showed that households with a high level of actual land tenure security are less likely to expect a land reallocation in the near future. In other words, actual land tenure security leads to a secure land tenure perceived by households. Chapter 4 suggests that perceived land tenure security encourages migration, while the separate impact of actual land tenure security (i.e., except its impact through perceived land tenure security) is negative. The two findings together suggest that actual land tenure security has a positive impact on migration through perceived land tenure security, and a negative impact on migration through other channels in villages where the land rental market is less-developed.

Third, through influencing households' migration decisions, actual land tenure security has a positive impact on farm performance, while perceived land tenure security has a negative impact on farm performance, given the level of actual land tenure security. The impact of actual land tenure security is only significant in villages with less-developed land rental markets, while the impact of perceived land tenure security is independent of the availability of land rental markets in the villages. Chapter 4 indicated a negative impact of actual land tenure on migration in villages with less-developed land rental markets, in contrast to a positive impact of perceived land tenure security on migration. Chapter 5 suggested that migration has a negative impact on farm performance. Combining these two findings, we can achieve actual and perceived land tenure security's impact on farm performance through migration.

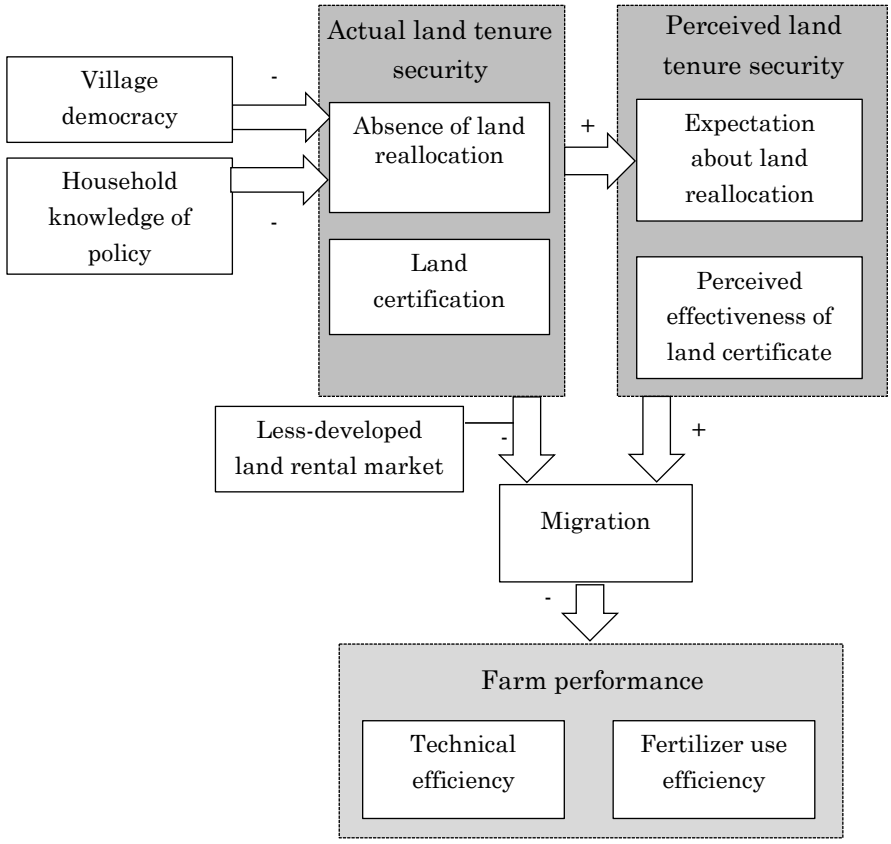


Figure 6.1 An overview of main results based on Chapters 2-5

6.3.2 Policy implications

The general conclusions of this study have several important implications for policy making.

First, village democracy and households' knowledge of RLCL contribute to the massive migration flows in villages where the land rental market is less developed. Poverty alleviation is one of the top priorities of Chinese rural policies and migration is an important approach for diversifying and raising incomes of rural households. In practice, villages that are economically underdeveloped are usually confronted with a less-developed land rental market as well. Therefore, in these villages, spreading information about existing land laws and improving households' understanding of national laws and regulations could facilitate migration and contribute to poverty alleviation. Similarly, improving village democracy could also activate households' participation in migration when the land rental market is less developed in their villages.

Second, land tenure security is important for ensuring a sustainable livelihood security from land. A higher level of actual land tenure security could improve production efficiencies through reduced migration when the land rental market is absent; a higher level of perceived land tenure security could lead to an efficiency loss of farm production as it has a positive impact on migration. Therefore, in areas where the land rental market is underdeveloped, banning land reallocations and issuing land certificates could contribute to a higher level of production efficiency of farms. Moreover, it is not a wise option for households with a higher level of perceived land tenure security to keep working on farms. To avoid the potential efficiency loss, measures should be taken to encourage households who perceive their land tenure to be secure and who have migrated to rent out their land.

Third, development of the land rental market and migration facilitate the division of labour. The negative impact of village democracy and households'

knowledge of RLCL on farm performance, and the negative impact of actual land tenure security on migration, are only significant when the local land rental market is underdeveloped. In other words, these negative effects become insignificant when the land rental market is more developed. It is therefore important to identify existing bottlenecks in the functioning land rental market, and allow families with higher agricultural productivity to gain access to additional land, and get sufficient livelihood security from land. On the other hand, other families, who participate in migration and off-farm employment, can rent out their land, find employment in the manufacturing or service sectors in surrounding cities, and diversify their sources of livelihood security.

6.4 Contribution to scientific debates

The study contributes to scientific debates on land tenure security, migration and farm performance. The joint analysis of land tenure security, migration and farm performance contributes to existing literature by providing a full picture of the potential linkages between land tenure, migration and farm performance. Specifically, each research question makes a unique contribution to available literature.

6.4.1 What matters for the persistence of land reallocations?

Most studies consider land reallocations to be a result of competition between "economic efficiency" (e.g. maximization of households' investment incentives; minimization of administration costs) and "ensuring equitable land distribution" (Kung and Bai, 2011; Rozelle and Li, 1998). As individual villages were empowered to decide on their own arrangement of land reallocations, village democracy could play an important role in their decisions of land reallocations. Moreover, as the majority principle became a crucial requirement after 1998, households' knowledge of policy might influence villages' decisions on land reallocations as well. Our first contribution in Chapter 2 was to develop a more

comprehensive theoretical framework, taking into account village democracy and households' knowledge of policy.

Several studies have identified factors affecting land reallocations before the 1998 land contracting round (e.g. Brandt et al., 2004; Yao, 2004; Kung, 2000; Rozelle and Li, 1998). Much less attention has been paid to the socio-economic factors affecting the persistence of land reallocations in Chinese villages after the 1998 land contracting round. The second contribution of Chapter 2 was to conduct an empirical analysis on the factors explaining the persistence of land reallocations following the 1998 land contracting round. The empirical results show that both village democracy and households' knowledge of policy increase the incidence of land reallocations.

6.4.2 How does actual land tenure security affect households' perceptions?

Most empirical studies on tenure security and agricultural productivity use indicators of actual and/or perceived tenure security in their analysis (see overview in Arnot et al., 2011: Table 2). Little attention, however, has been paid so far in the literature to the impact of actual land tenure security on household perceptions of tenure security. An exception is the study by Deininger et al. (2011) on the impact of a land certification programme in Ethiopia which found that land certification significantly reduced household fear of land loss by some 10 percentage points. In a study on China, Kung (2000) found that the frequency of land reallocations within villages had a significant positive effect on farmers' perceptions that they are likely to lose their land during the tenure period. No studies have so far examined whether China's new rural land certification programme contributes to increased tenure security perceptions of rural households. Households' recent experiences with land reallocations may affect such perceptions as land certificates can serve as an instrument to oppose future reallocations.

The objective of Chapter 3 was to examine the impact of actual land tenure security, measured by possession of land certificates and recent experiences with

land reallocations, on perceived land tenure security of rural households in China. The major contribution of this Chapter was therefore to estimate the impact of the new certificates that have been issued since 2009 and to estimate the combined effects of land certificates and land reallocation experiences. The empirical results suggest that perceived tenure security is positively affected by the possession of land certificates in villages that conducted land reallocations but not in villages that did not do so. The estimated impact is larger for land certificates issued in the new round of land certification than for land certificates that were issued earlier.

6.4.3 What is the impact of actual and perceived land tenure on migration?

Empirical studies of tenure security and migration in China either focus on household perceptions of tenure security (so-called 'perceived tenure security') (e.g. Mullan et al., 2011) or on existing land tenure arrangements (so-called 'actual tenure security') (e.g. Deininger et al., 2014). Studies in the latter group commonly use indicators of actual tenure security as proxies of tenure security perceptions that drive rural household migration decisions. To our knowledge, there has been no research so far that has analysed the impact of both actual land tenure security and tenure security perceptions on household migration decisions.

In Chapter 4, we aimed to contribute to the available literature in this field by estimating the effects of both actual and perceived tenure security on migration of household members. We found that both actual and perceived tenure security affect migration, but that the impact of perceived tenure security is much stronger, and positive, whereas the separate impact of actual tenure security, i.e. its impact excluding affecting tenure security perceptions, is negative. Households perceiving a low risk of losing land when one or more members migrate are more inclined to migrate, independent of the availability of land rental markets in their villages. Actual tenure security, as measured by possession of land certificates and absence of land reallocations, has a separate

negative effect (the impact excluding affecting tenure security perceptions) on migration only in villages with less-developed land rental markets.

6.4.4 Does migration affect farm performance?

There are several shortcomings of previous empirical studies of the impact of migration on economic and environmental performance of farms. First, the linkage between migration and environmental performance is lacking. Second, the mechanism of migration's effect on economic and environmental performance are overlooked. The economic and environmental performance are measured through technical efficiency and fertilizer use efficiency, respectively.

The major contributions of Chapter 5 were two-fold. First, we linked migration with fertilizer use efficiency, defined as the ratio of minimum feasible fertilizer use to observed fertilizer use, conditional on output level and other inputs. We found that migration results in a reduction in both technical efficiency and fertilizer use efficiency. Second, we investigated the existence of the labour reduction effect. To meet this objective, we differentiated the migration group into less-intensive and more-intensive groups and estimated the impact of less-intensive and more-intensive migration on technical efficiency and fertilizer use efficiency. Our results suggest that the efficiency reduction effects of migration are amplified for households who participated in migration more intensively.

6.5 Limitations and suggestions for future studies

We outline several limitations of this thesis and propose suggestions for future studies. First, for both actual and perceived land tenure security, we focus on those derived from land reallocations and land certificates. In Chapters 3 and 4, actual land tenure security is measured through the absence of land reallocations and the possession of land certificates. Similarly, perceived land tenure security is measured through households' expectations about land reallocations and perceived effectiveness of land certificates (in Chapter 4). Other aspects of tenure

security, including risk of expropriation, type of tenure, bundles or categories of rights and so on (Arnot et al., 2011; Brasselle et al., 2002), are omitted in our analysis. For follow-up studies, we suggest using the other measurements of land tenure security.

Second, the empirical studies of this thesis are based on cross-sectional survey data. A major limitation of using cross-sectional data is that some unmeasured household and/or village characteristics may affect both our dependent variable and some of the explanatory variables, and may thereby cause biased results. Additionally, some variables are not able to be measured adequately with cross-sectional data. For instance, in Chapter 2, demographic changes and land investments prior to land reallocations were ignored because they cannot be obtained from the cross-sectional data. For future research, we therefore recommend checking the robustness of our findings by using panel data instead of cross-sectional survey data.

Third, the potential intermediate effects of the relationships examined in Chapter 4 (shown in the ovals of Figures 4.1 and 4.2) were not included in the empirical analysis. According to the theoretical framework of Chapter 4, perceived land tenure security could affect migration through the positive risk-reducing effect, negative investment effect and positive land renting-out effect. Apart from the effect through perceived land tenure security, actual land tenure security has a negative land quality effect and an indeterminate land renting effect on migration. We only tested the overall effects of actual and perceived land tenure security in our empirical analysis. It might be of interest for future studies to investigate in more detail the different channels through which actual and perceived land tenure security affect migration.

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Summary

Given the importance of land tenure security, migration and farm performance, and their interrelationships, this thesis provides a joint analysis of land tenure security, migration and farm performance in China. This study starts with identifying influencing factors of persistence of land reallocations, which is the major sources of land tenure insecurity in rural China. A particular emphasis is placed on the impacts of village democracy and households' knowledge of policy. This study then continues to study the impact of land reallocations and land certification on households' perceptions of land tenure security. Afterwards, this study turns to explore the impact of actual and perceived land tenure security on migration of rural households. This is followed by an analysis of the economic and environmental consequences of the migration of rural households. The empirical analyses of these issues are based on a household and village survey in four regions of China, containing 124 villages and 1486 households.

The thesis consists of six chapters. In chapter 1, the four research questions are motivated, the theoretical frameworks are established, and research methodologies are introduced. In chapter 2, we examine the impact of village democracy and households' knowledge of policy on persistence of land reallocations. We develop a comprehensive theoretical framework, indicating that village self-governance rules affect the implementation of national laws and regulations and that election of village leaders and villagers' knowledge of relevant policies are the major driving forces in the use of village self-governance rules for land reallocations. The results suggest that both village democracy and households' knowledge of policy have positive impacts on the persistence of land reallocations.

Chapter 3 focuses on the impact of land reallocation and certification on households' perceptions of land tenure security. Special attention has been paid to the impact of a new round land certification after 2009, as compared to the older certificates, and the combined effects of land certificates and land

reallocations. We find that households perceived land tenure security is positively affected by the possession of land certificates in villages that reallocated land but not in villages that did not do so. The estimated impact is larger for land certificates issued in the new round than for land certificates issued earlier.

In chapter 4, we study the impact of actual and perceived land tenure security on migration of rural households, taking into account the degree of development of land rental markets. We argue that actual and perceived tenure security can have positive as well as negative effects on migration and that the presence of land rental markets may modify these effects. Applying the two-step control function approach, we find that both actual and perceived tenure security affect migration, but the impact of actual tenure security is negative, whereas the impact of perceived tenure security as measured by land reallocation expectations is positive and much stronger than actual land tenure security. Specifically, households perceiving a low risk of losing land when one or more members migrate are more inclined to migrate, independent of the availability of land rental markets in their villages. Actual tenure security, as measured by possession of land certificates and absence of land reallocations, has a separate negative effect on migration only in villages with less-developed land rental markets.

In chapter 5, we use technical efficiency and fertilizer use efficiency to measure the economic and environmental performance of farms and study the impact of migration on the economic and environmental efficiency. Using stochastic frontier analysis and Translog production function, we estimated the technical efficiency and fertiliser use efficiency of farms. Using propensity score matching, we found negative impacts of migration on both economic and environmental performance of farms, and the impacts are amplified for households who participated in migration more intensively.

At last, chapter 6 concludes by providing the answers to the four research questions, the general discussions and policy implications of the whole thesis,

contribution to scientific debates and the limitation of this study and suggestions for future studies.

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Guangcheng Ren
February, 2020

Guangcheng Ren
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Advanced Econometrics AEP 60306	WUR	2016	6
Theory and Models in Environmental Economics ENR 30306	WUR	2016	6
Writing research proposal	WUR	2016	6
Impact Assessment of Policies and Programmes DEC 32806	WUR	2019	6
B) General research related competences			
WASS Introduction Course	WASS	2015	1
The Essentials of Scientific Writing and Presenting	WGS	2016	1.2
Advanced Speaking Skills	Wageningen in*'* to language	2015	1.5
Summer school: Theory and Practice of Efficiency & Productivity Measurement: Static and Dynamic Analysis	WASS	2017	3
'Farmland tenure security, land renting and rural-urban migration in China'	EAAE PhD workshop, Barcelona, Spain	2017	1
'The economic and environmental performance of farms: the impact of migration'	BIOECON 2019 Congress, Wageningen, the Netherlands	2019	1
'Rural-urban migration in China: the role of land tenure security and land rental market'	CAER-IFPRI Annual Conference, Guangzhou, China	2018	1
Economics of Farm Households	WASS	2019	1
C) Career related competences/personal development			
Teaching assistant for "Theories and Models in Economics"	YSS	2018	1
Visiting scholar at University of Florida		2019	1
Total			**36.7**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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