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Haoran Yang

aus

Zhengding, China

Referent: Prof. Dr. Joachim von Braun

Korreferent: Prof. Dr. Thomas Heckelei

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Abstract

This study investigates the role of the land rental market in rural economic development with the province Chongqing, China, as case study region. The study focuses on the question participation in the land rental market can improve agricultural production efficiency and alleviate income inequality in rural areas. Finally, the factors that affect rental market participation of farm households are examined.

A stochastic frontier approach was employed to measure effect of the land rental market participation on agricultural productivity. Two competing hypotheses are tested: 1) Less efficient farm households rent out land to more efficient farm households and agricultural productivity is improved; 2) More efficient farm households rent out land and work off of farm, which results in lower agricultural productivity. The results showed that both of these hypotheses are possibly true, but more efficient farm households are more likely to rent land rather than rent it out, which implies the productivity enhancive effect of land rental market.

To investigate the impact of land rental market development on rural income distribution, firstly the income inequality was decomposed to measure the contribution of land rental income to total income inequality and the interactions between land rental income and other income sources. Then, relying on the inequality index calculated, a fixed effect model was used to investigate the impact of participation in the land rental market and land rental market imperfection on income inequality index. The results showed that contribution of land rental income to total income inequality is increasing over the observation period. And participation in land rental market may reduce income inequality, given an imperfect land rental market.

Deriving from a farm household model, farm households’ supply and demand decisions in land rental market were explored. The multinomial Logit model is used to examine factors that influence farm household participation probability in the land rental market. Furthermore, Tobit models are employed to measure the impact on the quantity of renting and renting out by farm households. Results from these two models show the importance of off-farm work wage and off-farm labor market imperfection in defining the rental behavior of farm households: it prevents farm households from renting land and encourage them to rent out. Simulation results show that rising off-farm work wages and participation rate in the off-farm labor market lead to a lower equilibrium land rent in a closed economy.

Zusammenfassung

Die vorliegende Arbeit untersucht die Rolle von Landpachtmärkten für die ländliche Entwicklung mithilfe in Chonqing (China). Gegenstand der Untersuchung ist, inwieweit die Teilnahme an Landpachtmärkten die landwirtschaftliche Produktionseffizienz verbessert und Einkommensungleichheiten in ländlichen Regionen reduziert. Zudem werden Einflussfaktoren für die Teilnahme an Landpachtmärkten untersucht.

Um den Effekt der Teilnahme an Landpachtmärkten auf landwirtschaftliche Produktivität abzuschätzen, wird ein, Stochastik Frontier“ – Verfahren angewendet. Zwei verschiedene Hypothesen werden getestet: 1) Weniger effiziente Farmhaushalte verpachten Land an effizientere Farmhaushalte, so dass die landwirtschaftliche Produktivität steigt; 2) Effizientere Farmhaushalte verpachten Land und arbeiten außerhalb des landwirtschaftlichen Sektros, was zu geringerer Produktivität führt. Die Ergebnisse zeigen, dass möglicherweise beide Hypothesen stimmen, jedoch haben effizientere Farmhaushalte eine höhere Wahrscheinlichkeit Land zu pachten als zu verpachten, so dass insgesamt eine Produktivitätssteigerung erwartet werden kann.

Zur Untersuchung des Einflusses der Entwicklung von Landpachtmärkten auf die ländliche Einkommensverteilung wurde eine Dekomposition der Einkommensungleichheit vorgenommen, um den Beitrag von Landpachtmärkten auf die gesamete Einkommensungleichheit und Interaktionen zwischen

Einkommen aus der Landverpachtung und anderen Quellen zu vergleichen. Basierend auf dem errchneten Ungleichheitsindex wird eine Regressionsanalyse durchgeführt, um den Einfluss der Teilnahme an Landpachtmärkten und der Unvollkommenheit dieser Märkte auf den Einkommensungleichheitsindex zu untersuchen. Die Ergehnisse zeigen, dass während des untersuchten Zeitraums Einkommen aus Landverpachtung zur Einkommensungleichheit beigetragen hat. Aufgrund der Unvollkommenheit des Marktes scheint die Teilnahme an Landpachtmärkten Einkommensungleichheiten zu verschärfen.

Von einem Farmhaushaltsmodell ausgehend werden die Angebots- und Nachfrageentscheidungen empirisch untersucht. Ein multinomiales Logitmodell wird genutzt, um die Faktoren zu finden, dei die Wahrscheinlichkeit beeinflussen, mit der ein Farmhaushalt entscheidet am Landverpachtungsmarkt teilzunehmen. Außerdem werden Tobitmodelle genutzt, um die Auswirkungen der Pacht und Verpachtung von Land zu analysieren. Die Resultate dieser beiden Modelle zeigen, dass Lohn für Arbeit außerhalb der Farm und Unvollkommenheiten von Arbeitsmärkten außerhalb der Farm das Pachtverhalten von Farmhaushalten beeinflussen. Steigende nicht-landwirtschaftliche Löhne und die Teilnahme an Arbeitsmärkten außerhalb der Landwirtschaft führen zu einem niedrigeren Gleichgewichtspreis für die Pachtung von Land.

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Chapter 1 Introduction and background

1.1 Research background

1.1.1 Land rental market development in China

Over the last thirty years, China has experienced an evolutionary economic and social transformation while moving toward a market-oriented economy. This process is accompanied by the land policy reform to improve land use efficiency. In the late 1970s and early 1980s, the household responsibility system (HRS) was established which would become the most fundamental change of land institution since the Opening Up. Under the HRS, farm households rent land from collectives and have the responsibility to deliver grain quota to the local government below market price. Even though land ownership was still held by village collectives, the usufruct of land and residual claim rights were granted to farm households[1]. Along with a series of reforms of output and input markets, the introduction of the HRS significantly promoted agricultural output growth (McMillan et al., 1989; Lin, 1992). However, despite these positive results, the HRS was often thought to be unacceptable due to its alleged incompatibility with the prevailing ideology at that time (Lin, 1987; Du, 2006). Therefore, the Central Committee

[1] Before 1978, agriculture was operated by collectives and peasants were employees of these farm collectives.

issued a series of policies to ensure the implementation of the HRS. Towards the end of 1983, the HRS covered 94.2% of farm households (Lin, 1987).

According to Document No.1 issued by the Central Committee of the Communist Party of China in 1982, under the HRS farm households obtained a certain area of collectively owned land based on family labor, the family dependent ratio and/or agricultural ability of family labor. But in practice, most villages distributed land plots equally among all families. This equality not only reflected in plot size, but also in the quality of land, which means each household would take equal acreage of poor and good cultivated land. This egalitarian distribution of land is the major reason for land fragmentation in China (Tan et al., 2006). A survey of 280 villages conducted by the former Rural Development Research Center (RDRC) under the State Council in 1986 indicated that the land per farm household ratio was 9.2 mu (or 0.61 ha, 1 hectare = 15 mu) which was divided into on average 9plots.

Surprisingly, it was not before 1986 when the HRS was legitimatized with the *Land Management Law* being amended to include the HRS as a legal land institution. Later, in 1988, the *Constitution of the People's Republic of China* was amended to permit that the use right of land can be transferred between farm households. Legalization of land rental has negligible impact on the development of the land rental market, despite China's major transformation from a planned economy to a market economy. In 1995, less than three percent of all land was rented out (Turner, et.al, 1998).

A wide range of literature investigates why the land rental market developed so slowly in this period. A scarcity in off-farm work (Kung, 2002; Tu et al., 2006), legal insecurity concerning land use (Yang, 1997; Lohmar et al., 2001), and grain quotas (Lohmar et al., 2000) are considered as the major obstacles to land rental market development. Without off-farm work, rural labor can only engage in agricultural production and with very low land labor ratio, we can expect that the supply side of the land rental market is short. The effect between land rental market development and the farm labor market could be mutual. Zhao (1999) pointed out that a slack land rental market discourages labor migration from rural to urban area. Moreover, rent-out land could be regarded as a signal that a farm household no longer needs land, which can cause the land be taken back or lead less land being assigned in next round of administrative reallocation to the farm household (Yang, 1997). This argument was initially claimed by Yang (1997). This threat to tenure security was curtailed with new policies which focused on promoting land rental instead of controlling every aspect of it.

In this context, the impact of grain quotas should not be underestimated, as grain quotas reduce the return on land, land rental transactions in the market equilibrium with quotas must be lower than in the market equilibrium without grain quotas. Empirical evidence has shown that land rental activity is higher in villages with low grain quotas (Lohmar et al., 2001).

The duration of the first round of land contracts between farm households and village collectives was 15 years, officially from 1983 to 1997. Farm households can extend their contract with collectives to another 30 years after expiration of the first round of land contracts. The administrative land reallocation has been decreasing since the second round of land contracts between farm households and village collectives (Tao et al., 2009).

In 2003, the *Rural Land Contract Law* was introduced to secure the contract right of farm households and reduce arbitrarily administrative land reallocation by village cadres. One chapter of this law focuses on land rental activity between farm households, in order to regulate land rental market and protect the rights of “landlord” and “tenant”. Another meaningful change was the cancellation of nation-wide grain quotas in 2006, which should have a positive impact on the development of the land rental market. Meanwhile, off-farm work opportunities are thriving. Hundreds of millions of agricultural laborers moved to newly developed non-agricultural industries. Benefitting from all these positive changes, the land rental market was promoted in recent years. The ratio of rented land area to total arable land increased from 5.2 per cent in 2007 to 16.2 per cent in 2011.

By now, farm households in China enjoy a relative secure land contract right. This security is only relative as there is no protection against state expropriation. By *Land Administration Law*, the central government and its local authorities have the exclusive right to change the land use type. Before any development on the agricultural land, land ownership has to change from collectively owned to state owned. The state, or government, will compensate the farm households whose land was expropriated based on the yield of this land. Then the government rents out this land through an auction, or by other ways and land rent is determined by what will be developed on the land. This process brings about enormous revenues constituting strong incentive to the local government to expropriate land from farm households for development use, especially for real estate. This is the major threat to the land contract right of farm households. Because location is one of the factors which determine the development value of land, land in underdeveloped regions (far away from any city or arterial road) is less likely to be affected by state expropriation (Deininger et al., 2004). Therefore, for farm households in these remote regions, land contract rights enjoy a much higher degree of security.

1.1.2 Rural economic development in Chongqing

Chongqing, in Southwest China, is a municipality which is directly controlled by the central government. Of its total population of 29.45 million in 2012, 43% lived in rural areas, compared to 64.4% in 2000. Contribution of agricultural gross domestic product (GDP) was declining from 15.9% in 2000 to 8.2% in 2012. Employment in the agricultural sector decreased also, from 55.4% in 2000 to 36.3% in 2012[2].

Table 1.1 Share of income from each component to net income of rural households in Chongqing (%)

	Migration income	local off-farm income	farming income	husbandry income	transfer income	other income
2003	22,00	22,29	31,31	15,18	6,18	3,03
2004	23,46	17,28	33,42	17,78	5,05	3,01
2005	25,37	18,20	33,93	14,63	5,28	2,59
2006	29,55	22,04	28,05	11,11	6,51	2,74
2007	29,37	20,16	26,64	13,53	7,59	2,70
2008	27,90	20,49	26,67	15,52	7,13	2,30
2009	27,32	21,73	26,07	13,40	8,47	3,00
2010	27,21	23,12	25,27	11,11	10,00	3,30
2011	25,33	25,75	22,03	13,02	10,77	3,10
2012	25,71	26,74	22,23	10,37	11,26	3,68

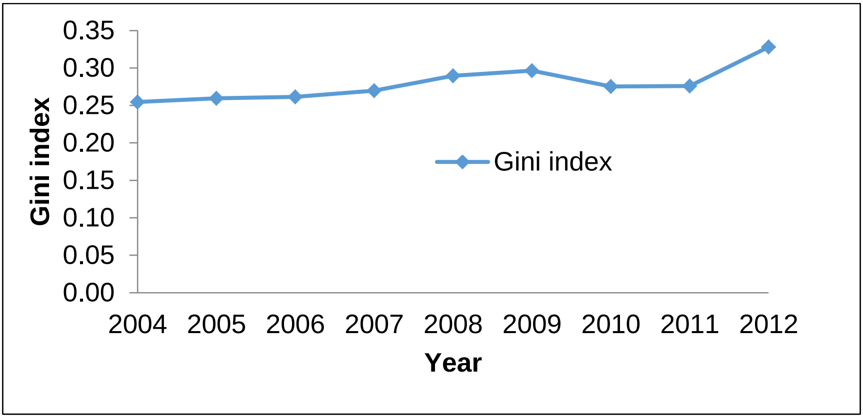
Data source: Calculated based on Chongqing Statistic Yearbook 2004-2013.

Structural changes to the economy diversified income sources of rural households. But agricultural income still accounts for a

[2]Data source: Chongqing Statistic Yearbook 2013.

significant share of a households' total income and is a reliable income source (see Table 1.1).

Figure 1.1 Gini index of rural Chongqing, 2004-2012



Data source: Chongqing Statistic Yearbook: 2005-2013.

Agricultural GDP increased at an annual rate of 3.4% from 1985 to 2012. Accompanying this considerable growth were increases in sown area (0.3%), irrigation area (0.5%), agricultural machinery (6.4%), electricity utilization in agriculture (9.6%), fertilizer (4.2%), agricultural film (8.3%), and pesticides (3.8%). But agricultural labor declined 2% annually in the same period. This may imply a low agricultural total factor productivity growth[3]. Income distribution got worse in rural Chongqing. The Gini index of rural income distribution in Chongqing rose from 0.25 in 2004 to 0.33

[3]Calculation based on the Chongqing Statistic Yearbook 2013.

in 2012[4], as it is shown in Figure 1.1.

1.2 Problem definition and research questions

As the developing land rental market has efficiency and equity implications for rural economic development, we would like to investigate the following research questions:

1. What factors affect farm household participation in the land rental market, especially in the context of increasing off-farm employment and rising off-farm work wages?

2. Can participation in the land rental market improve agricultural production efficiency?

3. Can participation in the land rental market alleviate income inequality in rural areas?

4. After answering the first three research questions, we can then evaluate how land rental market development affects rural economic development, which mainly concentrates on off-farm labor market development, agricultural production efficiency, and income distribution.

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[4]Calculation based on the Chongqing Statistic Yearbook 2005-2013. Income data is net income per capita in rural Chongqing. Rural households were classified into five groups based on net income per capita. Only mean net income per capita data were reported in these yearbooks. However, these data could underestimate real income inequality in rural Chongqing.

5. We are, furthermore, interested in how the land tenure system has been evolving in China from the late 19th century until today. In spite of radical changes over the last century, we can still find some clues indicating the evolvement of land tenancy and implications for future changes of the land rental market in China.

1.3 Thesis structure

Chapter 2 examines the land rental market development from a historical perspective in order to provide deep insights on land institutional changes. Chapter 3 develops the analytical framework of this thesis. In Chapter 4, we use stochastic frontier analysis to analyze the effects of the land rental activities on agricultural production efficiency. The Bayesian procedure was used for the estimation. Chapter 5 investigates how income from land rental activities affects total income distribution in rural Chongqing. Correlations between income components and the land rental market environment are incorporated in this analysis. Chapter 6 studies factors that are relevant to the land rental market participation of farm households. Not only are we interested in the probability of participation; we are also trying to determine the supply and demand of land in the market. Finally in Chapter 7, we draw conclusions based on the extensive empirical research as presented in the previous chapters.

Chapter 2 Land rental market development in China: A historical review

2.1 Introduction

Since the late 19th century, land market and land institutional changes in China can be divided into three stages. The first stage (from the late Qing Dynasty to the foundation of the People's Republic of China in 1949) featured a "free land market" (Zhang, 1988a; Chao, 2006). In the first stage, land property rights, land ownership and use rights are privately owned. The land sale market coexisted with the land rental market where supply and demand law defined the market equilibrium. This free land market was deconstructed by the agricultural socialist transformation in China after 1949 when the second stage began[5]. In 1956, the government announced that this socialist transformation was completed. Afterwards, there was neither private land ownership nor a private land use right[6]. Arable land was owned by collectives, and agricultural production was conducted collectively. Thus, the farmers were employed by collectives to engage in agricultural production. The land market disappeared completely

[5] Agricultural socialist transformation means collectivization of land and agricultural production.

[6] One exception is Ziliudi ("private plot") in which land ownership was collectively owned and land use rights belong to farm households. During the period of planned economy in China, the proportion of Ziliudi increased from less than 5% to 15% as shown by Xiang and Su (2002).

during this stage. The second stage ended with the implementation of the HRS in the late 1970s and early 1980s. Under HRS, farm households were yielded land use rights while land ownership remained with the farmer collectives. Privatization of land use rights inevitably induced the emergence of the land rental market, even though the land transfer was illegal at the beginning of the HRS. And due to land ownership still being controlled by collectives and the *Land Management Law* which forbid land ownership transaction with individual units (firms, farm households, etc.), no land sale market could be established.

In the end it was the change of land property right distribution that lead to the change of the land market form. In the first stage, land ownership and land use rights were privately owned. Therefore, a free land sale market and land rental market could be established. In the second stage, private land ownership and use rights were eliminated, land was collectively owned. This collective ownership was managed by the government in the era of planned economy. A land market, therefore, would not appear. In the last stage, the land rental market can be established based on privately owned land use rights[7].

This chapter is organized as follows. Section 2 describes land institutions and land rental market development before 1949. Section 3 focuses on land institutions and the land rental market

[7]Land use rights can be transferred if the land use type is not changed.

in China after 1949; it also delves into the debate on land privatization and possible evolvement of land tenancy in the future. Section 4 tries to explore the relationship between the land rental market development and agricultural productivity and distribution. Section 5 summarizes and concludes this Chapter.

2.2 Land institutions and land rental market development before 1949

2.2.1 Development of the tenancy market

Private land ownership emerged in the Spring and Autumn Period (722-476 BC) and was legalized in 361 BC to 338 BC with Shang Yang's reforms during the Qin Dynasty (Chao, 2006, pp.32). Since then, private land ownership dominated most of China's history, except for the period of 485 to 780 A.D (Chao, 1983; Chao, 2006, pp.32). The establishment of private land ownership led to the emergence of the land sale market and land rental market. One of the earliest records for land rental transaction was developed during 179-104 BC (Chao and Chen, 2006, pp. 243). In the Qing Dynasty (1644-1911), private land ownership coexisted with state ownership and was the major form of land possession (Li, 1963).

Table 2.1 Share of tenant and rented land area in the Republic of China

	Share of tenant (%)[a]			Rented land (%)[b]
Province	1912	1917-1918	1931-1936	1936
Northwest				
Chahaer	30	16	35	10.20
Suiyuan	36	23	26	8.75
Ningxia	——	——	27	——
Qinghai	18	——	21	——
Gansu	16	18	22	——
Shaanxi	21	23	23	16.64
North				
Shanxi	19	16	17	——
Hebei	13	13	12	12.89
Shandong	13	14	12	12.63
Henan	20	27	22	27.27
East				
Jiangsu	31	31	33	42.33
Anhui	43	33	44	52.64
Zhejiang	41	36	47	51.31
Central				
Hubei	38	36	40	27.89
Hunan	48	70	48	47.80
Jiangxi	41	30	41	45.10
Southeast				
Fujian	41	34	42	39.33
Guangdong	52	37	52	76.95
Guangxi	35	——	40	21.20
Southwest				
Guizhou	33	——	43	——
Yunnan	29	——	38	——
Sichuan	51	——	56	——
Average	28	——	30	30.73

Data source: a: Perkins (1984), pp. 115; b: Outline of National Land Survey, edited by Land Committee of Republic of China, 1936, pp: 36.

The Qing government pursued *laissez-faire* policies in the agricultural sector (Myers and Wang, 2002; Perkins, 1984, pp. 220). Engagement and enforcement of land rental contracts mainly followed customary laws (Myers, 1988; Myers and Wang, 2002). But the government did interfere in the formulation of customary laws by establishing the*baojia* system [8] and disseminating Confucianism in communities (Myers and Wang, 2002). Furthermore, in the early Qing Dynasty, the government reduced land taxes, supported farm households in exploring new land and improved the irrigation system, grain storage and distribution systems (Myers, 1988; Myers and Wang, 2002; Perkins, 1984, pp. 221-225). All these contributed to the agricultural outputs market and tenancy development. While there is no hard evidence that makes it possible to determine the exact percentage of tenant farms, Chao (2006, pp. 262) estimates that more than half the land during Qing was farmed by tenants[9].

Until the early 20th century, there were some reliable nation-wide land rental data. A summary of the land rental market in the first half of 20th century was presented in Table 2.1. The share of

[8] *Baojia* is a collective neighborhood guarantee system in which 10 households constitute a *jia* and 10 *jias* make up a *bao* (*Encyclopædia Britannica Online,* s.v. “baojia,” accessed December 06, 2013, http://www.britannica.com/EBchecked/topic/441684/baojia.).

[9] This estimation is based on the *Fish scale book* (Land registration book) from the Qing Dynasty. Most of the contents of the preserved *Fish scale book* refer to the Yangtze valley and south China. Therefore, this estimation cannot be considered representative for China as a whole. Moreover, there were debates about the reliability of the *Fish scale book*, see Ho (1988, pp. 38-50), Chao (2010) for details.

tenants appears to be relatively constant, with a slight increase from 28% in 1912 to 30% in 1936. Geographically, however, the share of tenants and rented land show great heterogeneity. Regional differences in the land rental market participation may reflect a different degree in commercialization of agricultural products (Perkins, 1984, pp.123).

2.2.2 Tenancy contract and permanent tenancy

Fixed rent contracts, sharecropping, and wage contracts coexisted in the Qing Dynasty. Wu (1992, pp.102) examines land rental contract forms in 19 provinces from1736-1820. In total there were 1160 land rental contracts, only 7 (6%) of these were wage contracts, sharecropping accounted for 6.8% (79) of all contracts, while the remaining 1074 contracts were fixed rent contracts (708 of these contracts were paid with grain, the other 348 paid with cash). While researchers must be aware that these figures are not necessarily representative, they do, however, strongly indicate a dominance of fixed rent contracts during the Qing Dynasty.

Patterns in the land rental market of the Republic of China did not show many differences compared to the late Qing Dynasty. A nation-wide survey by the Land Commission in 1935-1936 demonstrates that fixed rent contracts, either grain rent or cash rent, were the dominant land rental contract form (see Appendix Table 2). On average, up to 84.63% of all land rental contracts were fixed rent contracts (24.62% paid by cash and 60.01% paid by grain), sharecropping accounted for 15.23% of total land rental contracts, the remaining 0.14% pertain to other forms of land rental contracts, for example wage contracts.

Land rental contracts form and contract duration varies across regions [10]. In northern China, where land quality was comparatively low and production risks were high, short term share contracts were the most popular kind of contracts (Perkins, 1984, pp. 131-138). In the Yangtze valley and southern China, however, long term fixed rent contracts were prevalent.

Return on agricultural investments heavily affected the length of land rental contracts (Perkins, 1984, pp. 133). In the Yangtze valley and southern China, where agricultural infrastructure like irrigation and the transportation system were well established and markets were prosperous, long-term rental contracts were made in order to make tenants preserve land fertility and promote long-term investments. In northern China, however, the agricultural

[10] Chao (1983) describes the coexistence of different contract forms from a general equilibrium point of view; tenant and landlord will chose a land rental contract which provides the maximum profit for both. Chao has also shown that share tenancy is not an equilibrium result but a partnership between tenant and landlord that perpetuates the share tenancy. Eswaran and Kotwal (1985) assume that landlords are more efficient in providing farm management skills and tenants are specialized in supply labor supervision. Both management skills and labor supervision are key to agricultural production and non-tradable. Landlords chose the land rental contract from which they can maximize their profit. Singh (1991) provides an extensive review of contract choices in the land rental market.

infrastructure and market were less well established, returns on investments in agriculture heavily correlated to production risks. Both landlords and tenants lacked incentives to enter long-term land rental contracts.

From the above analysis, the incentives pertaining to sharecropping and fixed rent contracts are obvious. In northern China, shared risks in agricultural production induced landlords and tenants to conclude share contracts. In Yangtze and southern China, long-term fixed rent contracts have been proven beneficial for both landlords and tenants as they provide incentives for tenants to improve land quality and increase agricultural production. Besides incentives and market factors, there were two more land institutions related to prevailing long-term fixed rent contracts in the Yangtze valley and southern China, which were permanent tenancy and landlord bursaries (*zu zhan*).

In the late imperial Qing, permanent tenancy thrived as a result of free market and population pressure. The question when permanent tenancy exactly began remains controversial. We know, however, that it was widespread during the Qing Dynasty (from 1616-1912), especially in the Yangtze valley and southern China (Chao, 2005)[11].

[11] Chao (2005, pp. 15-16) summarized debates about origins of permanent tenancy. Northern Song Dynasty (960-1127) and Southern Song Dynasty (1127-1279) was considered as the start of permanent tenancy respectively by Fu (1961, pp. 47) and Wu (1992, pp.87).

Permanent tenancy is a land use right which is permanently held by tenants. Myers and Wang (2002) called it "*two lords to a field*". One lord holds land ownership (landlord), another lord holds the land use right (tenant). Land owners cannot evict tenants because the land use right under permanent tenancy is autonomous from land ownership and land owners do not have the right to take land use rights away from tenants.

There are three origins of permanent tenancy (Chao, 2005, pp.16-29; Wu, 1992, pp. 88-89): 1. Land owners use permanent tenancy as a reward to tenants who helped them to reclaim uncultivated land, which means permanent tenancy is a property incentive to work hard (Myers, 1988). 2. Permanent tenancy emerges gradually due to mortgaged land use rights. 3. Permanent tenancy occurs as a result of increasing deposits paid by tenants to land owners. When the land owner is reluctant or unable to pay the deposit back, permanent land use rights may be granted to the tenant as compensation so that the tenant continues to pay land rent.

There is no official record to demonstrate the proportion of permanent tenancy in the Qing dynasty at national level, but there are some statistics pertaining to the local level. Based on the *Fish scale Book* (Land Register Books), Zhang (1988) estimated that arable land under permanent tenancy accounted for 95.5% of total arable land in Changzhou County (Yangtze delta) in 1676.

Another estimate of permanent tenancy based on the *Fish scale Book* was conducted by Chao (2003). Zhao estimated that arable land under permanent tenancy accounted for 48% of total arable land and 30% of farm households had permanent tenancy rights in Xiuning County, Anhui Province, around 1573-1620. Although it may not be a direct cause for permanent tenancy, fixed rent contracts serve as a precondition for permanent tenancy (Chao, 2006). Therefore, prevalence of fixed rent contracts may also indicate permanent tenancy is widespread.

In the Republic of China (1912-1949), a nation-wide survey showed that permanent tenancy made up 21.08% of all contracts. Up to 70.74% of contracts did not specify the duration of the rental (more details can be found in Appendix Table 3).

The emergence of permanent tenancy might be a sign of enhanced tenure security for tenants. But there was no solid data to demonstrate changes of permanent tenancy in the late Qing. Feuerwerker's empirical research (1983) indicates that the percentage of one-year land rental contracts increased slightly between 1924 and 1934, that the share of 3-10 years land rental contracts remained constant, while the percentage of 10-20 years land rental contracts and permanent tenancy decreased. This shift from long term to short term rental contracts might imply an increase of tenure insecurity for tenants.

Permanent tenancy, in general, was governed by customary laws (Chao, 2005, pp. 66-67). The late Qing government tried to legalize permanent tenancy in its civil code which was accomplished in 1911 to settle conflicts caused by permanent tenancy. Unfortunately, the Qing Dynasty's civil code never had a chance to be implemented because of the Xinhai Revolution in 1911 and the establishment of the Republic of China (1912-1949) in 1912. Finally, in 1930 the Land Law of the Republic of China was issued and regulated that permanent tenancy must be registered.

Landlord bursary emerged as a result of increasing numbers of tenants refusing to pay rent following the Taiping Rebellion (Wu, 1992, pp. 148-149) and the increasing phenomenon of landlord absenteeism in the late Qing Dynasty in the Yangtze valley and southern China (Feuerwerker, 1980; Chao, 2000). According to Feuerwerker (1980), landlord bursary is the place where "*individual landowners, primarily urban businessmen, entrusted their lands and tenants to the management of the bursary owner and received a proportionate share of the profits after taxes and other expenses were met*". Widespread fixed rent contracts in these regions should contribute to landlords moving out as fixed rent contracts free landlords from farm management. Easy access to the agricultural products market and the desire to setting up lineages in the countryside encourage urban businessmen to buy land in rural areas and become absentee landlords (Myers and Wang, 2002). According to Perkins' (1984, pp. 117) estimate, in the 1930s, approximately 75 per cent of rented out land was owned by absentee landlords.

2.3 Land institutions and land rental market development after 1949

During the planned economy period from 1949 to 1978, agricultural land in China is collectively owned and used. Allocation of land was regulated by governmental administration, no land market existed. In the land reform of 1950, complete land property rights were given to farmers, but collectivization in 1953 eliminated private land property rights. Information about the land rental market in this period (1950-1953) is scarce, so we treat it as part of collectivization in 1949-1978.

The reversion from collective farming to household farming after 1978 in China experienced three phases (Lipton, 2009). These three phases are common for most transition economies. The first phase is de-collectivization, which in the case of China, was achieved with the implementation of the HRS from 1979 to 1984. Due to the socialist ideology at that time, it was never easy to implement a market-orientated reform (Du, 2006; Lin, 1987). The HRS was initially evolved from grassroots and then got permission from the central authorities since its successfulness in promoting agricultural production (Du, 2006; Lin, 1987). The success of the HRS was not unique. Egalitarian decollectivization in Vietnam in 1988-90 and Azerbaijan in 1996 was also accompanied by improvements in efficiency and equity terms (Lipton, 2009).

The second phase is market liberalization which includes liberalizing agricultural output and input markets. Reforms in this phase are long and lasting, and still ongoing in China. Implementing the HRS ended the state monopoly for purchasing and marketing farm goods. Grain quota under HRS still distorted the grain market until 2006 when they are finally abolished. Since then, however, subsidies have been increasing in agriculture which includes subsidies on seed, land, machinery purchase, and other inputs (Huang et al, 2011). Surprisingly these subsidies barely affect farm household production decisions, which may due to subsidies received by farm household are rather small (in 2008 farm households received on average 442 Yuan or 43.24 Euro from the government (at price of 2008)) (Huang et al, 2011).

Another important liberalization affected the labor market. Before the HRS was implemented, labor migration from rural to urban areas was almost impossible (Cai et al, 2008). Reforms first allowed farmers to do business out of farm (work in town and village enterprise (TVE)), then labor was allowed to move inter-regionally. However, the household registration system (*hukou*), which divides the population of the People's Republic of China into rural and urban population, still imposes restrictions on internal labor migration in two ways (Chan and Zhang, 1999). Firstly, labor with rural status cannot benefit from the social security program and their children cannot be enrolled in elementary and secondary schools in the city they moved in. Secondly, most migrated workers find employment in the private sector as their rural status prevents them from working for urban state enterprises. Further reform in the labor market should focus on deconstructing discriminating elements of the *hukou* system.

Finally the reversion from collective farming to household farming should be accomplished by securing and expanding land property rights of farm households. The *Land Administration Law* was enacted in 1986. Distribution of land rights - collective ownership and individual use right - was legalized with this law. But land rental activity was explicitly prohibited. And the duration of land contracts between collective and farmers was not specified.

Restrictions on land rental activities were relaxed in 1988. It started with an amendment of the constitution of the People's Republic in April 1988 to allow the transfer of land use rights according to relevant laws. In December 1988, the article which prevents land rental was removed from the *Land Administration Law*. It was not until 1998, that the revised *Land Administration Law* stipulated that the duration of land contracts between collectives and farm households was 30 years. From that year, village collectives started to reallocate land among farm households and made new 30 year-land contracts with farmers.

A milestone in securing land use rights of farm households was the enactment of the *Rural Land Contract Law* in 2003. This law specifically regulates land contracts of farm households with collectives pertaining to the land rental market, resolution of disputes and liabilities. It provides that the duration of land rental contracts should not go beyond the deadline of land contracts between farmers and village collectives, so that the duration of land rental contracts cannot exceed 30 years.

The 17th Central Committee of the Communist Party of China in 2008 proposed that land contract between village collective and farm households should be permanent, which means that the 30 years land contract can be extended to permanent. This in turn provided the opportunity to conclude longer land rental contracts.

The above-mentioned laws and regulations have shown great improvements in securing land use rights of farm households. Even though administrative reallocation of land has not completely disappeared, the frequency of it has been vastly reduced since 1998 (Tao et al., 2009). Right now most of the administrative land reallocation aims at adjusting land held by farm households to demographic changes. And this reallocation is not just an enforced redistribution. Instead it depends on the availability of redistributable idle collective land. Into the 21st century, administrative reallocation is no longer a major threat to land security of farm households compare to government expropriation (Vendryes, 2010).

Amendments of *Land Administration Law* in the past years try to restrict the government's arbitrary appropriation of land but failed. One reason is that any construction land has to be state owned. Therefore if agricultural land is intended to be transferred for non-agricultural use, it has to be changed from collective ownership to state ownership. It means that governmental appropriation is a necessary step for land development. The *Land Administration Law* provides that land appropriation must serve "the public interest". But the scope of "public interest" remains vague, which gives local governments the opportunity to expropriate land in the name of the "public interest" (Ping-Li, 2003). The only change of the *Land Administration Law* with regards to taking of land was slight rise of compensation for expropriation. Since 1986, compensation to land expropriation couldn't exceed the average yield of three previous years by more than 20 times. In 2004, this law was amended, allowing for compensations up to 30 times of the average yield, though the compensation level is varying across regions.

All these three steps of reversion have implications for land rental market development. The HRS creates individual land use right. Legal reforms make these rights tradable, while market liberalization allows for profitable transaction of land use right. All these aspects contribute to the land rental market development in China. The proportion of rented land has increased from less than 3% in 1995 (Turner, et al, 1998) to 16.2% in 2011 (see Table 2.2).

Table 2.2 Land rental market development in China, 1995-2011

	Land rental area (thousand hectare)	Percentage of Total Contracted land area (%)
1995	-	3*
2007	4250	5.20
2008	7270	8.90
2009	10130	12.00
2010	12470	14.70
2011	13800	16.20

Data source: * Turner, et. Al, 1998; land rental data from 2007-2011 were published by Ministry of Agricultural of China.

More than 30 years after the implementation of the HRS, there seems to be no sign of land ownership privatization in China, and land privatization remains a controversial issue. There are mainly two arguments for people who oppose land privatization. The first is that land privatization would lead to an increase in landless peasants and impoverished farm households, which is an impediment to economic development (Li, 2004; Wen, 2009). We could not find evidence for this counterfactual argument to show if land privatization would generate these negative results, but we can look into experiences from other countries. Vietnam decollectivized its collective farming system and equally distributed land among farm households between 1988-1990, which is later than China's decollectivization, but goes further by granting farm households private land ownership (Ravallion and van de Walle, 2008). In 1998, Vietnam deregulated restrictions on the land rental and sales market. Indeed, such market-oriented reforms lea to an increase in landlessness, but not necessarily result in increasing poverty. It much rather depends on why landlessness increased, i.e. farm households give up land due to negative shocks or shifts in occupation from agricultural to non-agricultural sectors. Ravallion and van de Walle (2008) find an astute explanation for worries about land privatization and marketization. Especially for poor farmers, gain or loss from selling land and working off-farm depends on how the labor market equilibrium changes due to an increase of labor supply. However, as long as poor farmers can earn more from off-farm work than from cultivating their land, losing land due to land reforms may not raise the poverty rate. As in Vietnam, Ravallion and van de Walle (2008) found that landlessness closely correlated with non-family work opportunity, and there was no evidence indicating that an increase in landlessness causes poverty.

On the other hand, it does not mean that poor people would not be negatively affected by land privatization. Gain or loss from selling land depends on whether the land value is set correctly. Land valuation not only depends on the development of the land rental and sales market but also on the development of the off-farm labor market, other input and output markets and the rural credit market. In developing countries it is possible that incompleteness in these relevant markets is pervasive, as it would undervalue land and put the poor at risk of losing from selling their land. The second disagreement derived from the role of land as providing informal social security in rural China. Because rural areas in China are not covered by formal social security (pensions, unemployment insurances, etc.), the egalitarian distribution of land use rights and common land ownership ensures that every farm household in rural areas has land to live on and prevents them from losing it by selling it (Li, 2004; Wen, 2009). Not only is land is an income source for farm households, it also provides opportunity to use family labor and generate labor income. This implies that land privatization should not be implemented without prior reforms of the social security system in order to include people in rural areas. Furthermore, a prosperous off-farm labor market capable of absorbing farm labor would be essential.

Proponents of land privatization argued that, on the one hand, land privatization can promote incentives for farm households to invest long-term and hence can stimulate long-term agricultural growth, because land can be used as collateral in order to get loans for investments (Beslay, 1995; Yang, 2001).However, the role of land as collateral to improve investment in agriculture remains dubious and depends on the development of the rural credit market (Lipton, 2009). Empirical studies on Vietnam, Ethiopia and China have shown that it is indeed land tenure security which has a positive effect on long-term investments (Ngo, 2005, Deininger & Jin, 2006; Jacoby et al, 2002). This implies that the effect of full land ownership on investment could be rather weak (Lipton, 2009). As shown by Abdulai et al (2011) by using plot level data from Ghana that long-term investment on land with full property rights is significantly higher than on rented land. But this difference might be due to the impact of tenure duration, as full property rights on land means infinite duration which is significantly longer than fixed or shared rental contracts; and longer tenure duration tends to improve long-term investment on land (Abdulai et al, 2011). Clearly, Abdulai et al (2011) noticed the possible effects of tenure duration on investment, but in the results they tabulated, this effect is missing.

On the other hand, land privatization is expected to be an effective tool against government appropriation (Zhou, 2004). Land property arrangements in rural China could not provide an effective way for farmers against government acquisition due to the fact that under collective land ownership, as village cadres rather than farmers represent land owners. While village cadres are employed by the local government, they do not represent farmers' interests in the process of land expropriation. Change from collective ownership to individual ownership makes farmers represent their own interests on land and can thus be more effective against government appropriation. However, the government usually appropriates land in the name of the "public interest", and the scope of "public interest" is not clarified by law (Ping-Li, 2003). Therefore, the government might still have the power to invade individual land ownership. But individual land ownership would cause higher transaction cost in land appropriation than collective land ownership and at least complicate government appropriation.

Government appropriation under the HRS brings about another problem. Laws and regulations in China granted the government exclusive rights to transfer the use of land from agriculture to non-agricultural purposes (factory construction, real estate, infrastructures, etc.). This exclusive right generates numerous revenues for the local government, as the government appropriates land from farm households and compensates them only according to the average annual yield of land, and then rents out land based on how the land would be developed (Ping-Li, 2003). This arrangement of land property rights is a driving force for the rural urban income gap in China (James, 2007).

The debates above demonstrate that if land privatization is going to be implemented, it should be implemented with great caution. Especially reforms in other relevant markets should come about simultaneously.

While the usefulness of land privatization is questioned, there are further political impediments to be considered. de Janvry and Sadoulet (2011) argued that the government is reluctant to grant complete land property to farmers in order to secure their future control. Another possible reason why the central government keeps land collectively owned is that it reduces the governments' land expropriation costs for building infrastructure and increases public revenue by giving the government exclusive rights to change land use as was discussed previously[12].

In spite of these, the land rental market developed in recent years due to an abundance of off-farm work opportunities (Yao,1999) and a relatively secure land use rights position (Jacoby et al., 2002; Yao, 2004). In the US, a typical private property-based economy, the land rental market is the primary way of allocating land. Its annual ownership transfers are about 5% of total farmland and relatively lower compared to38% in the land rental market (Foster, 2006). This may imply that, whether land is privately owned or collectively, the land rental market always plays the major role in the allocation of land as long as land use rights are privately owned and secured. Moreover, this may imply

[12]Under the provision of the *Land Management Law*, any land use change from agriculture to nonagricultural use should change land ownership from collectively-owned to state-owned. And any individual unit that wants to use land for nonagricultural purposes should rent land from the government. Government-acquired arable land from collectives only compensates according to agricultural use, while it rents out land according to nonagricultural use. In 2007, this "land finance" accounted for 41.55% of local government revenue (Zhang and Li, 2010).

that the agricultural production itself may not yield sufficient demand for private ownership, while such a demand may come from outside of the agriculture sector (illegal appropriation of cultivated land and unjust compensation to farmers).

From a certain point of view, land tenancy in China at the current stage is similar to permanent tenancy which existed pre-1949. Land is owned by collective and farm households possess land-use rights. This ownership structure is analogue to permanent tenancy in which land ownership belongs to landlords and land-use rights were kept by tenants. Even though farm households do not have the right to sell land use rights as in permanent tenancy, they do have the right to rent out land use rights which constitute the foundation of the land rental market in today's China. In the circumstance where developing a private land ownership regime is unlikely, it could be preferable for current land institutions to evolve to state permanent tenancy as suggested by some scholars (e.g. An, 1988; Dong, 2010).

But there are barriers to overcome to make this evolvement possible. First, land is used as insurance for farmers who are weakly covered by the formal insurance market and the social security system. Keeping land use right exclusively in the hand of village members can make sure that rural people can remain self-sustainable. Thus, the social security system should be well-established in rural areas before land use rights can be sold.

Secondly, the implementation of permanent tenancy would lead to a substantial increase of the land use right price, even higher than land ownership (one reason could be that the demand for land use rights is high). This is what happened in the middle of the Qing dynasty when the land use right price was two times higher than land ownership (Chao, 2005, pp. 45-48). That implies buying land use rights could involve sufficiently large money transactions which make small and poor farm households unable to access. More importantly, farm households in China usually were rationed out from the formal credit market because they do not allow to using their house and land as collateral for loan. Therefore, it is necessary to improve accessibility to the credit market for farm households to make them benefit from selling land use rights on the market.

2.4 Land rental market development, productivity and distribution

It is difficult to analyze the historical relationship between the land rental market and agricultural production. Lack of data is the major obstacle. Perkins (1984) estimated grain yields from 1400 to 1957 in China and found an increasing trend in output per unit of land (yield data only available in the year of 1400, 1776, 1851, and 1957). But as we mentioned above, only after 1911 there were reliable data on shares of land tenancy. We may have observed a slight increase in shares of tenancy from 1912 to the period of 1931-1936 nation-wide in table 2.1, from 28% to 30%.

However, the increase in yields may not necessarily caused by increase in share of tenants.

One way out of this dilemma is to look into the correlation between the share of tenancy and land rent at provincial level (Feuerwerker, 1983). Feuerwerker (1983) has shown that there is a positive correlation between these two variables in the late Qing period (1800-1911). Land rent, either fixed or shared, positively correlates with productivity of land. Therefore, evidence from Feuerwerker (1983) may show a positive correlation between participation in the land rental market and land productivity.

Another hint for the relationship between land rental market development and agricultural production might be found in the change of duration of land rental contracts. Change to permanent tenancy may provide additional incentives to tenants to let them invest in land and promote long-term agricultural production (Myers and Wang, 2002). But permanent tenancy may also provide incentives to land owners to not invest in land and undermine long-term growth of agriculture. Thus, based on historical data there is not much to say about how permanent tenancy affects agricultural productivity.

Next, we will turn to the exploration of the relationship between the land rental market development and land distribution. Before we conduct the investigation, it is helpful to examine how land

and population in China changed historically in table 2.3. It shows that arable land has grown steadily, while the population has grown faster than arable land since 1776; consequently arable land per capita decreased on a long-term basis. Increasing population pressure on land can divide land economically and politically.

Table 2.3 Arable land and population in history of China

Year	Arable land area (Million mu)	Year	Population (Million)	Arable land per capita (mu)
1072	660	1109	121	5.45
1393	522	1391	60	8.70
1581	793	1592	200	3.96
1662	713	1662	83	8.59
1784	989	1776	268	3.69
1812	1025	1800	295	3.47
1887	1202	1848	426	2.82
1936	-	1936	-	2.70*
1952	1618.78	1952	574.82	1.88
1996	1950.5	1996	1223.83	1.59
2008	1825.7	2008	1328.02	0.92

Data source: Data from 1072-1887 comes from Chao and Chen (2006), pp.116. Data from 1952-2008 comes from China Statistical Yearbooks, compiled by National Bureau of Statistics of China. Beijing: China Statistical Press.

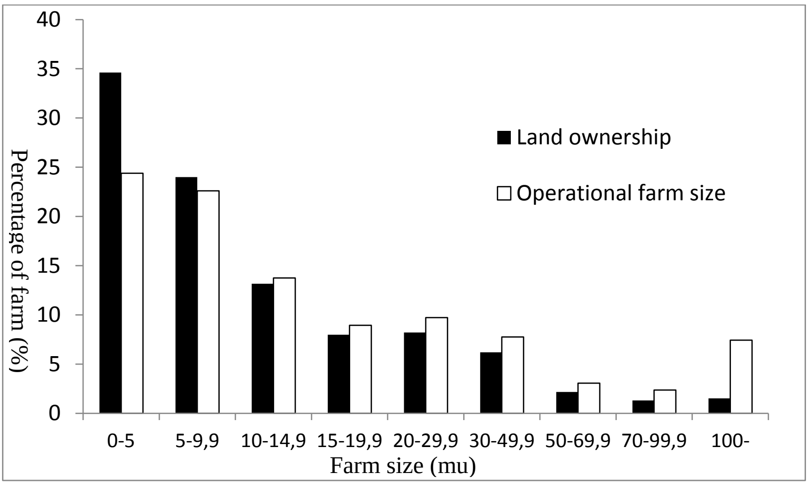
Another factor affecting land distribution in China is the inheritance system in which family wealth is equally distributed among sons of the family (Chao and Chen, 2006, pp. 146). Whether the inheritance system would divide land or not depends on the population growth rate in relation to land growth, and on fertility behavior of land-rich families and land-poor families. We have already shown that land per capita was decreasing after 1776. Lamson (1935) studied reproduction behavior of rich and poor families in China before 1933. Lamson found that in rich families more babies survived than in poor families (4.57 children for rich families and 2.29 for poor). And the sex ratio for children in the age of 5 to 14 was 123.2 boys on 100 girls in the 1930s (Chao, 2006, pp. 129). Even though rich families are more likely to own more land, they also tend to have more successors to divide land. This empirical evidence may suggest that the inheritance system in China of the 1930s was a force to divide land.

The above analysis shows that both population pressure and the inheritance system contributed to the diffusion of land. Evidence shows that the percentage of landless peasants was decreasing from 1746 to 1930s, and land possession of large land owners was decreasing in the same period (Chao, 2006, pp. 153-160). But we should note that most of the data used by Chao (2006) are not representative for the national level, given that the decreasing concentration of land could just be a regional phenomenon.

To investigate the relationship between the land rental market and land distribution, we use data from the Land Committee of the

Republic of China (LCRC). Based on the Outline of the National Land Survey compiled by the LCRC we have developed a graph in Figure 2.1 to show changes in farm size before and after land rental activities. We can see from this figure that after the land rental transaction, the proportion of farms under 10 mu decreased (farms under 5 mu reduced from 34.61% to 24.38% and farms between 5-9.9 mu reduced slightly from 23.99% to 22.60%), and the percentage of large farms (farm size above 10 mu) increased correspondingly (especially for farms whose size bigger than100 mu increased from 1.52% to 7.43%). These changes may imply a concentration of operational land through the land rental market.

Figure 2.1 Farm size change due to land rental market participation



Data source: based on Table 15 (pp. 16) and Table 21 (pp.32) from Outline of National Land Survey, edited by LCRC.

It seems that in the 1930s land was not transferred from large land owners to small or landless peasants. On the contrary, it was small land owners who rented out land to large farm operators. This phenomenon may lead us to rethinking two observations from our own experience. The first holds, as mentioned before, that land rented out by absentee landlord accounts for 75% of the total rented land (Perkins, 1984, pp. 117). If Perkins was right, then most of absentee landlords should be small land owners. But this may contradict Perkins' description of absentee landlords as wealthy and of high status (Perkins, 1984, pp. 118-122). Even if absentee landlords indeed own small land, we do not know that for sure.

A second observation is derived from the argument that the land rental market provides a way for the poor to access land (Sadoulet et al., 2001). This argument has been verified by many scholars pertaining to China and Vietnam (Deininger and Jin, 2005; Deininger and Jin, 2008). But if poor peasants are rationed out from the rural credit market, then the land rental market may not be friendly to the poor (Boucher et al., 2005). Shan (1995) found that in the Yangtze Valley during the Republic of China, loans of poor peasants was mainly used for smoothing consumption and paying back debts, the loans of richer peasants were mainly for production. This may explain the observation in Figure 2.1.

2.5 Conclusion

The land rental market during the late Qing Dynasty and the Republic of China experienced only few governmental interventions. Different regions developed different land rental patterns based on region-specific agricultural production risks, land fertility, agricultural infrastructures, market conditions, and customary laws. What are the implications of this freely developed land rental market on agricultural productivity?

In traditional agricultural societies, researchers often found inverse relationships between farm size and agricultural productivity (Fan and Chan-Kang, 2005; Lipton, 2009, Chapter 2). It is probably true in countries where agricultural labor is abundant and labor-intensive production technologies are widely used. The moral hazard problem in a principle-agent relationship may prevent large landlords from efficiently using hired labor in agricultural production. The land rental market in this situation can reduce farm size and save productivity from the inverse relationship. Feuerwerker (1980) shows that large land owners cultivate some of their land by using hired labor and rent out the rest. Furthermore, in the early 20th century, the farm size was closely correlated to family size.

From historical records, it is hard to tell how the land rental market development affects agricultural production in the long-term. In a traditional agrarian society, increase in yields mainly depends on increase in inputs, for example labor. If Perkins' estimate of yield growth from 1400 to 1957 was correct, it may be due to increase in labor supply in the same period, as we found that the population density was also increasing. The role of the land rental market in this process could be reallocating land among labor; thus relay on the "inverse relationship" yield can increase in the long-term.

Finally we found that a well-established land rental market may disadvantage the poor if rural credit market rations poor peasants out and if poor peasants borrow mainly for consumption and not for production.

Chapter 3 Analytical framework

3.1 Farm household model

Farm households in developing countries are living in an environment of prevailing market imperfections and restrictions. Thus, farm households have developed strategies to cope with market failures and to maximize the benefits from allocation of family resources (de Janvry and Sadoulet, 2006). The farm household model is the basic tool of analysis in this context (for instance, Carter and Yao, 2002; Sicular, 1986).

Using the farm household model in the event of market failures implies that farm household consumption and production decisions are non-separable (Singh, Squire, and Strauss, 1986). The problem of farm households is to maximize the utility from consumption and leisure by generating income from allocation of family endowments (labor and land generally):

$$max_{X,L_1,L_2,R_I,R_O,M} \; U(X, T - L_1 - L_2) \tag{3.1}$$

$s.t.$:

$$P_X X = \mathrm{w}L_2 + P_y F(L_1, \overline{D} + R_I - R_O, M; V) + r(R_O - R_I) - P_M M + I \tag{3.2}$$

$$L_1 + L_2 \leq T \tag{3.3}$$

$$R_O \leq \overline{D} \tag{3.4}$$

$$X, L_1, L_2, R_I, R_O, M \geq 0 \tag{3.5}$$

where $U(\cdot)$ is the utility function, X is the consumption goods vector and P_X is the corresponding price vector. In this model we assume that there is no agricultural labor market. Therefore, the labor used in agricultural production L_1, plus off-farm labor supply L_2 cannot exceed the total time endowment of farm households T .Farm households have access to the land rental market where they can either rent land(R_I), or rent out land(R_O) at market price(r). M denotes intermediate inputs in agricultural production purchased at price P_M . V is capital used in the production which is fixed in the short term. w is the off-farm work wage rate. $F(\cdot)$ is a constant return to scale production function.

Farm households allocate their land and labor in the agricultural production and off-farm work through the land rental market and the off-farm labor market to generate income that supports household consumption. In the context of this study it is of particular relevance to find out how these allocations affect the agricultural production efficiency and income distribution among farm households.

For we are not particularly interested in the consumption effect of the land rental market or the reverse, we can therefore ignore the utility function and concentrate on the objective of farm households to maximize income from agricultural and non-agricultural activities. There is another empirical argument which contributes to this rationale: for estimating consumer good demand functions and output supply and input demand functions. It is common to assume the two sets of error terms in these two system equations are uncorrelated in order to get consistent estimations for function coefficients (Strauss, 1986b). With these considerations in mind, problem (3.1)-(3.5) collapses to profit maximization (see also Carter and Yao, 2002):

$$max_{X,L_1,L_2,R_I,R_O,M}\pi = wL_2 + P_yF(L_1,\overline{D} + R_I - R_O, M; V) + r(R_O - R_I) - P_MM + I \quad (3.6)$$

$$\text{s.t.: } L_1 + L_2 \leq T \quad (3.7)$$

$$R_O \leq \overline{D} \quad (3.8)$$

$$L_1, L_2, R_I, R_O, M \geq 0 \quad (3.9)$$

Problem (3.6)-(3.9) is the model to start with. It governs farm household participation in the land rental market. This decision has an effect on agricultural production efficiency and on the income generating scheme of farm households and hence on income distribution among farm households. Before we go to the participation analysis of farm households in the land rental market, we will first concentrate on how participation affects agricultural production efficiency and income distribution.

3.2 Land rental market and agricultural production efficiency

In this section, we pay attention to the impact of the land rental market on agricultural technical efficiency in rural Chongqing. Two contradicting hypotheses were developed. The first (we denote this hypothesis as H1) stipulates that two ways to make farm households more efficient: 1) the land rental market can improve agricultural technical efficiency by transferring land from less technically efficient farm households to more technically efficient farm households, 2) farm households can raise their technical efficiency level by participating in land rental market. This hypothesis just follows the doctrine of new classical economics that transaction in a competitive market is a Pareto improvement.

But the land rental market in China cannot be regarded as competitive. Moreover, farm households may have different abilities to access off-farm work opportunities and receive different wages. This leads to the alternative hypothesis that more efficient farm households leave agriculture for well-paid off-farm work and rent land to less efficient farm households through the land rental market (we denote this hypothesis as H2).

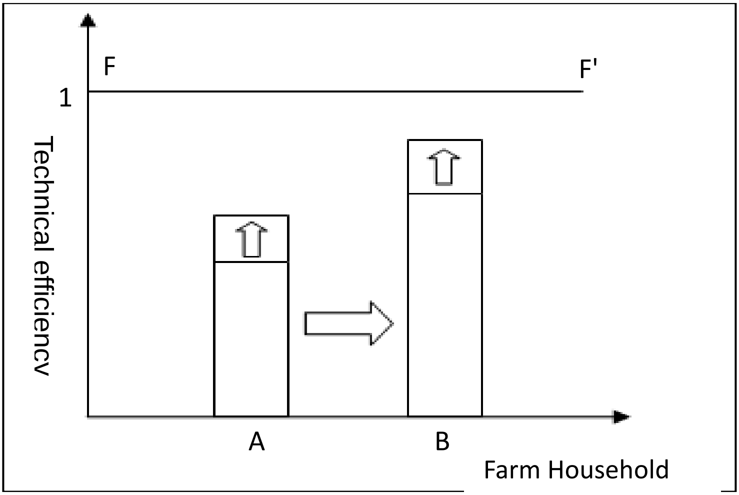
First, we focus on validating H1. In terms of the efficiency effect of the land rental market, there seems to be a broad consensus that access to the land rental market can improve agricultural production efficiency (Deininger and Jin, 2005; Jin and Deininger, 2009; Feng, 2008; Zhang et al., 2011). Feng (2008) and Zhang et al (2011) both employed stochastic frontier analysis to study the impact of land rental on technical efficiency but fail to incorporate regularity conditions in their estimation.

In their collaborations, Deininger and Jin tackle this relationship from a different angle. They use “agricultural ability” as an indicator of agricultural production efficiency, which is analogue to the “residual” in the growth model (Solow, 1957). Then they show that, both analytically and empirically, that there is a transfer of land from farm households with lower agricultural ability to those with higher agricultural ability via the land rental market. And they also show that the land rental market is more efficient in generating this efficiency improving transfer than administrative reallocation.

Under the H1, the effect of access to the land rental market on agricultural production efficiency is twofold. On the one hand, land can be transferred from less efficient farm households to more efficient farm households. Deininger and Jin(2005) focus on this “horizontal effect” which is represented by the horizontal arrow in figure 3.1. FF' is the production frontier which is denoted by 1. The height of histograms represents the production efficiency level of farm households A and B. The horizontal arrow shows that land is transferred from the less efficient farm household A to the more efficient farm household B.

On the other hand, farm households can improve their own production efficiency by participating in the land rental market, which is the focus of Feng (2008) and Zhang et al (2011). This “vertical effect” is shown in Figure 3.1 by the vertical arrows which indicate improvement of production efficiency.

Figure 3.1 Production efficiency change and land rental market



While the horizontal effect implies improvement in land use efficiency, the vertical effect means improvement in farm management skills. Both of these effects are important but none of the above studies covers these two effects together. In this study we use stochastic frontier analysis to investigate the horizontal effect and the vertical effect in synthesis.

Building upon the results of production function analysis, we can develop a method to measure land rental market imperfection and off-farm labor market imperfection by using differences between the marginal product of land and agricultural labor and their corresponding market prices. With these measures we can assess the effect of market imperfection on farm households' participation in the land rental market and on income distribution.

The elaboration above provides a strategy for testing test H1. Testing H2 is relatively simple. We classify farm households equally into three groups according to their technical efficiency level: less efficient farm households (LFHs), medium efficient farm households (EFHs), and more efficient farm households (MFHs). Then we examine whether any of the more efficient farm households rent out land and how many of them. Moreover, it will be analyzed how many less efficient farm households rent land.

3.3 Land rental market and income distribution

Studies in this realm mainly focus on the equalization effect of access to the land rental market, according to which the land rental market is a favorable tool for the "land poor" to find access to land (Sadoulet, et al., 2001). It suggests that the land rental market equalizes land distribution in terms of operational farm size. The rationale behind this assumption is derived from observing the competitive land rental market and decreasing marginal return to land.

In an agrarian society where land is scarce relative to labor, the distribution of land determines the distribution of wealth. But as farm households diversified their income sources, the role of land in the distribution of wealth becomes less important[13]. This is what Brandt and Sands (1992) and Benjiamin and Brandt (1997) observed by using data in Northern China in the 1930s. One important conclusion of their studies states that income distribution is more equal than land distribution when family labor has the opportunity to access non-agricultural work.

As a matter of fact, the contribution of wages to per capita income of farm households in rural China has increased from 22.3% in 2000 to 30.1% in 2009[14].This implies that using land distribution to approximate wealth distribution could generate misleading results as has been examined by Deininger & Jin (2005, 2009) and Wang (2006), as the equity effect of the land rental market means equal access to land via the land rental market. Given that the contribution of agricultural income to overall income decreased, it is more appropriate to study the effect of the land rental market development on income distribution, not just land distribution.

This is clear in model (3.6)-(3.9) in which farm households can diversify their income sources by allocating land and labor when access to factor markets is possible. With endowment constraints and a lacking agricultural labor market, renting decisions cannot

[13]Here we are only concerned with land used in agricultural production. We ignore the value of land for commercial development and other non-agricultural uses for now.
[14]19. Data source: Summary of Rural Fixed Observation Point Survey in China: 2000-2009.

be separated from the allocation of family labor. This non-separability reproduces a correlation between income generated from land rental activities and other income sources.

Therefore, by studying the land rental market and income distribution, we firstly look at the relation between land rental income and other income sources. Then we analyze the effects of land rental income on overall income distribution. We classify farm household income into five components: land rental income, other agricultural income, income from labor migration, local off-farm income, and other income sources (including rental income other than land rent, interest payments and investment income, pensions, husbandry income, government transfer, and all the other forms of income). In practice, the generalized entropy index is employed to measure and decompose the income inequality index.

Other than correlations between different income sources, market imperfection also affects how income generated from rented land is distributed among farm households as suggested by Benjamin and Brandt (1997). Therefore, we also do a supplemented regression analysis to provide insight into the effects of the imperfect land rental market and the off-farm labor market on income distribution.

3.4 Land rental market participation

So far, the discussion has been particularly focused on the consequences of participating decisions of farm households in land rental market. It means that farm households have already solved their profit maximization problem in (3.6)-(3.9). Now we seek to investigate how these participating decisions were made by farm households.

Studies in this field consist of two branches of literature. One branch uses the concept of “desired land area” to study which factors affect land rental activities (Bliss and Stern, 1982; Skoufias, 1995). “Desired land area” is defined as a function of labor, bullocks, and other non-land factors of agricultural production. Farm households adjust farm size to “desired land area” through the land rental market by renting or renting out land. The difference between “desired land area” and land endowment of farm households determines the net rent area which is positive for the tenant and negative for the landlord. Farm households whose “desired land area” is identical to the land endowment will not participate in the land rental market. Land rental transaction costs were introduced to the model to account for substantial non-participants. The role of transaction costs in this model is to prevent some farm households from adjusting their farm size to the desired size.

Another relevant approach based on the profit maximization perspective (Carter and Yao, 2002; Deininger and Jin, 2005, Kimura et al., 2007; Jin and Deininger, 2009; Kimura et al., 2011). In the basic model farm households try to maximize their profit by means of agricultural production and off-farm work. Thus, the model involves allocation of land and labor of farm households, rendering the concept of “desired land area” incompatible. From profit maximization we can derive the optimal land supply and demand in the land rental market, together with optimal off-farm labor supply. Again, transaction costs are introduced to widen the range of non-participants.

But what these two models have in common is that they both lead to estimate a reduced form. Therefore, in the empirical practice these two methods are quite similar. For model (3.6)-(3.9), with slight modification, the Lagrangian for this problem is

$$\mathcal{L} = P_y F\left(L_1, \bar{D} - R_O + R_I, M; V \right) - (r + C) R_I + (r - C) R_O + w(T - L_1) + \lambda\left(\bar{D} - R_O \right)$$

where λ is the Kuhn-Tucker multiplier. C is the unit transaction cost and is measured by land rental market imperfection. Unit transaction cost is assumed to be identical for renting and renting out. $r + C$ and $r - C$ are real pay and gain for tenants and landlords respectively.

The following analysis heavily borrows from Deininger and Jin (2005). We specify the first order conditions of profit maximization in terms of farm household type, namely rented farm households, rented out farm households, and farm households that do not participate in the land rental market. They all have the same first order condition of labor allocation,

$$F_L = w/P_y \tag{3.10}$$

For farm households which rent land, the optimal condition for renting land is

$$\partial\mathcal{L}/\partial R_I = P_y F_D - (r + C) = 0 \tag{3.11}$$

For farm households which rent out land, the optimal condition for renting out land is

$$\partial\mathcal{L}/\partial R_O = -P_y F_D + (r - C) - \lambda = 0 \tag{3.12}$$

$$\lambda\left(\bar{D} - R_O\right) = 0, \lambda \neq \left(\bar{D} - R_O\right)$$

And for farm households that do not participate in the land rental market, its marginal productivity of land falls in the interval of $\left[r - C - \lambda, r + C\right]$, or

$$(r - C - \lambda)/P_y \leq F_D \leq (r + C)/P_y \tag{3.13}$$

$r - C - \lambda$ and $r + C$ formulate two critical points to classify farm households. From these first order conditions it is clear that for farm households which participate in the land rental market (rented farm households and rented out farm households), its marginal productivity of land is determined by the state of the art of agricultural production, land rent, and transaction costs. This suggests that agricultural production decisions of land rental market participants are independent from initial land and labor endowment of farm households. For the farm households who do not participate in the land rental market, the land labor ratio depends on household land and labor endowment. This is the regime separable model suggested by Carter and Yao (2002). Note that the underlying assumption is that transaction costs are not affected by farm household factor endowment.

The role of transaction costs is clear. It can enlarge or narrow the range of the interval in which non-participant farm households fall in. If transaction costs are too high, no farm household will participate in the land rental market. Lower transaction costs will stimulate land rental market participation.

Equations (3.10) and (3.11) jointly determined the optimal operational land size for rented farm households. From these simultaneous equations we can solve the optimal rented land $R_I^* = R_I^*\left(P_y, r, C, w, \bar{D}, M, T, V\right)$ as a function of agricultural output prices, land rent, transaction cost, off farm wage, farm household land endowment, intermediate inputs, and capital. System of equations (3.10) and (3.12) produce the supply function for rented out farm households and optimal rented out land is given by $R_O^* = R_O^*\left(P_y, r, C, w, \bar{D}, M, T, V\right)$. $R_O^* =$

$R_O^*\left(P_y, r, C, w, \overline{D}, M, T, V\right)$

In practice, we use the first order Taylor series expansion to linearize $R_I^* = R_I^*\left(P_y, r, C, w, \overline{D}, M, T, V\right)$ and $R_O^* = R_O^*\left(P_y, r, C, w, \overline{D}, M, T, V\right)$ for estimation. We also include demographic variables in empirical analysis (see Chapter 6 for more details).

3.5 Further Discussion

The above analysis is static in that we not only ignore how the land rental market emerged, but also neglect how the land rental market evolves in the process of rural economic development. In the following discussion, we will widen the frame of reference to account for these two crucial issues.

3.5.1 Emerge and development of land rental market

Although land sale is prohibited, the land rental market is not the only way to reallocate land in rural China. The other one is administrative land reallocation.

Administrative reallocation of land has its merits. At least in terms of land distribution, administrative reallocation of land reaches a very high level of land equality. But this merit becomes less important when the full value of land cannot be enjoyed by farmers. The value of land is mostly derived from development, i.e. from building factories, real estate, or other commercial entities (for now we just neglect the ecological and environmental value of land for the sake of simplification). But only a very small share of land development value goes to farmers, most of them are directly controlled by the government (see section 2.3 for detail). Hence, granting use rights on a piece of land to farmers is not very useful for reducing the income gap between rural and urban areas (Dollar, 2007). Even within the rural society, the equity effect of administrative reallocation of land becomes less significant as more and more families derive their income from the non-agricultural sector; thus reducing the resistance to change from administrative reallocation to the land rental market in terms of distribution of land.

Administrative reallocation of land also worked as an informal social security system in rural China where the public social security system is not well covered (Zhang and Sun, 2009). Under administrative reallocation of land, every person in rural area gets a piece of land, so they have something they can depend on for their livelihood. Renting out land does not mean that the use right of land is lost, the use right is just rented to other farmers. From an economic perspective, farm households rent out their land in order to maximize their utility, and farmers can make a short-term land rental contract to avoid a potential long-term welfare loss. Therefore, participation in the land rental market would not undermine the social security role of land in rural China.

The transition from administrative reallocation of land to the land rental market as a way to transfer land may bring about productivity gains. Zhang et al (2011) show that land reallocation from the both land rental market and administrative reallocation increases the technical efficiency of the agricultural production, nonetheless the land rental market performs better.

The above analysis can be summarized as follows: resistance to the land rental market development decreases as determining factors of income inequality shift from land distribution to other sources. The land rental market is not necessarily harmful to the social security role of land in rural China, and switching to the land rental market brings about productivity gains. These three factors facilitate the land rental market development in China. Furthermore, the role of the government cannot be ignored in the process of land rental market development.

Apparently laws and regulations implemented in recent years in order to secure land use rights of farm households contribute to the development of the land rental market. But more importantly, we should note that change from administrative reallocation of land to the land rental market also changed who will bear transaction costs in land reallocation. In administrative reallocation, transaction costs are taken by village cadres to negotiate and make contracts with farmers. In the land rental market, it is the farmer who bears transaction costs. Before abolishing agricultural quota, village leaders seek to take these transaction costs in order to fulfill quota missions. Consequently, the incentive to reallocate land administratively decreases and gives way to the land rental market.

3.5.2 The Land Rental Market in the Process of Rural Economic Development

In order to examine how the land rental market affects economic development, it is important to be aware of a potential endogenous problem.

Marxism entails an endogenous theory of institutions: material production force (productivity) determines the relations of production (institutions), and the relations of production affect the production force (Bardhan, 1989). For an econometrician this clearly constitutes simultaneity or reversal causation between production force and relations of production.

When collective farming became incompatible with the eagerness to improve agricultural productivity in late 1970s, collective farming was adjusted by means of the HRS (Du, 2006). This adjustment, together with the price reform and other market reforms, generated incentives for farmers to increase their agricultural production between 1978 and 1987 (McMillan et al., 1989; Lin, 1992). Eventually, the HRS, however, lost its clout and technological change accounted for most of the long-term growth in total factor productivity in the agricultural sector (Huang and Rozelle, 1996). Nonetheless, HRS might still facilitate technology adaptation and pave the way for long-term agricultural growth.

The “inverse relationship” between farm size and productivity (Fan and Chan-Kang, 2005; Lipton, 2009) may justify the implementation of administrative reallocation, which is roughly matching land to labor. This is not wrong when off-farm work opportunities are scarce and the land rental market is almost absent. China’s prosperous non-agricultural sector, however, has largely absorbed rural labor from the agricultural sector for years. Labor migration from the agricultural sector to the non-agricultural sector causes additional problems, most notably being the abandoning of farms (Tan, 2001; Tang et al., 2002). Concerned about the waste of valuable land resources, the government enacted the *Rural Land Contract Law* in 2003 in order to regulate and promote the land rental market development. Then, under the HRS, the land rental market gradually substituted administrative reallocation in order to promote agricultural production growth.

Now it is clear that the land tenure system is endogenous in the process of rural economic development or agricultural productivity changes. Thus, to measure the impact of land rental market participation on agricultural productivity in this study, it is necessary to incorporate this potentially endogenous problem in the analysis.

Chapter 4 Land rental market and agricultural production efficiency

4.1 Introduction

Chongqing is undergoing profound social and economic structural changes. The agricultural sector is shrinking, but still a significant proportion of labor is engaged in agricultural production. Accompanying these changes is the persistent income divergence between rural and urban Chongqing.

Two seminal papers which focus on structural change and inequality have been provided by Kuznets (1955) and Lewis (1954). Both of these studies suggested an inverse U-shaped curve of economic growth and income inequality. Although many empirical researchers reject such a relationship (Deininger and Squire, 1998; Herzer and Vollmer, 2012), structural change as a major source of inequality cannot be ignored (Aizenmen, 2012).

In such a transition economy, developing a well-functioning land and labor market is crucial for most people living in a rural area because land and labor are their most precious endowments which can generate income. A functioning land rental market was considered as an effective instrument to transform the rural economy from an unproductive to a productive and efficient one

(Rozelle, et al, 2002; Kimura, *et al*., 2007). This belief comes from the doctrine of neoclassical economics that any exchange of land will improve the efficiency of use by competitive bidding to gain contracts (Rothenberger and Truffer, 2003). Hence, in the equilibrium of a competitive land rental market, technical efficiency can be realized since prices will provide the correct incentives and signals to producers to equal marginal rates of technical substitution. A perfect land rental market improves technical efficiency; however, in developing countries such a market does not exist because of informational asymmetry, informal contract, and unclearly defined land rights.

Farm households in the area of field research featured as mall farm size, relatively active land rental participation and large scale labor migration. Nevertheless, the land rental market in China was characterized by large numbers of incomplete contracts (oral contract) and gift transfers (zero rent) (Ye, et al., 2006). After having introduced data sources in section 4.2, we analyze the land rental market conditions in rural Chongqing in detail in section 4.3. As we will see later, market imperfection in this region is obvious. Then we look at how the land rental market imperfections affect agricultural production efficiency from a new institutional economics perspective. We also provide further evidence to show the relationship between the land rental market and agricultural production efficiency.

In section 4.4, we develop Bayesian procedures for stochastic production frontier analysis. After having obtained the technical efficiency level of farm households, the two hypotheses (H1 and H2) are tested in 4.5. In section 4.6 we discuss the implications of this analysis.

4.2 Data description

Data used in this study is a combination of two sources. To describe the land rental market environment in rural Chongqing, we use our own survey data in three villages (Tianba village, Changshui village, and Xiehe village) of Chongqing in 2011 (Data-1). Data used for analysis of the impact of the land rental market on technical efficiency came from a survey conducted by a fixed observation point of the Research Center for Rural Economy (RCRE) of China in the same three villages (Data-2). Data-1 comprises data of 135 households, mainly focuses on their land endowment and land rental market participation. Data-2 constitutes a of 94 farm households from 2003-2006, and 2008-2010. We use a one output and four inputs production function. Output is the aggregate value of grain crop, cash crop, and livestock, measured in Yuan. Inputs are aggregated labor (days), capital (measured in Yuan), land (sown area), and intermediate input of crop production activities of farm household as we have mentioned before. All the monetary valued variables were deflated to the price of 2003.The sample data were deflated by the sample mean of each variable so that the mean of data used in the estimation had a sample mean of 1. A summary of the data used in the stochastic frontier analysis can be found in Appendix table-4.

4.3 Land Rental Market and Agricultural Production Efficiency: Descriptive Analysis

In spite of the importance of the land rental market in China, not too much attention was paid to the structure of the market itself, which is characterized by contract completeness, trading partners, and land rent. As explained below, all these factors crucially related to the technical efficiency impact of the land rental market through transaction costs.

Transaction costs were modeled as an additional “production” cost in the neoclassical model (Deininger and Jin, 2005; Jin and Deininger, 2009). As explained by Furubotn and Richter (2005, pp. 64-71), such an approach neglects the details of the market structure and assumes a perfectly rational decision-maker, thus contradicting the basic assumption of NIE (new institutional economics): bounded rationality, opportunism, and risk aversion (Chiles and McMackin, 1996). More importantly, the attempts of decision-making units to minimize transaction costs and the implications of the resulting market transaction outcomes have not been studied.

In this section, we employ the tools of NIE to analyze the structure of the land rental market in rural Chongqing. To do this, we assume the farm households are characterized by bounded rationality, opportunism, and risk aversion. The referring data comes from three villages (Changshui, Tianba, and Xiehe) in Chongqing in 2011. The relevant information pertaining to the land rental market in this area was listed in Table 4.1.

Table 4.1 Summary of the rental market in three villages

Village	Tianba Nobs		Changshui Nobs		Xiehe Nobs	
Households	45		48		42	
Tenant	12		26		3(3)	
Landlord	16		8		34(1)	
Contract						
Oral	10		29		4(4)	
Paper	18		5		33(0)	
Trading partner						
Acquaintance	21		34		4(4)	
Non-acquaintance	7		0		33(0)	
Rent						
Zero	18		25		4(4)	
Payment	10		9		33(0)	
Farm size	Mean	SD	Mean	SD	Mean	SD
Before rental	4.94	1.73	5.38	2.25	3.23	1.86
After rental	4.75	3.90	8.07	6.04	1.77	1.87
Rent area	1.41	2.98	3.30	5.39	0.08	0.46
Rent-out area	1.32	2.06	0.54	1.28	1.56	1.39

*The numbers in parentheses in the last column count transactions between farms in all transactions in Xiehe. The numbers listed under Tianba and Changshui are transactions between farm households.Data source: author's own survey.

In the sample, almost half (48.9%) of the farm households participated in the land rental market[15]. One of the characteristics of the land rental market in rural Chongqing was that nearly two thirds (65.2%) of the rental contracts were made in oral form. Another feature was that most of the land rental transactions (83.3%) were conducted between acquaintances and 71.2% of the land transactions were free transfer[16]. These results are joint products of high transaction costs in transferring land and efforts by participants to reduce transaction costs.

A land transaction starts with searching for a suitable partner and this process is not cost-free. Searching and information costs correlate positively with the asymmetry of information. While most rental transactions in this study are small-scale transactions, these costs are not trivial for participants of the land rental market. Dealing with acquaintances is a way to reduce search and information costs, since mutual trust between landlords and tenants can reduce transaction cost (Holden and Ghebru, 2005). Therefore, on the one hand, trading partners are more likely to be acquaintances in order to reduce transaction cost. On the other hand, renting out land to relatives and friends before leaving has been proven efficient to prospective labor migrants. Under these circumstances, land rental transactions are not conducted

[15] Here we are only interested in land rental transactions between farm households. Most land rental transactions in Xiehe villages were between farm households and non-agricultural units, like school, factories and village utilities. Transactions like this were not included in our analysis.
[16] "Acquaintances" means that transaction partners of a land rental had prior social ties based on kinship or friendship.

through competitive bidding, which means that the tenant may not be the one who can provide the highest rent (in several cases, the rent is zero). In this case the land rental transaction is not orientated towards technical efficiency but, much rather, towards reducing transaction costs. Therefore, by trading with acquaintances, market transaction efficiency may be improved, but it is not clear whether in agricultural production technical efficiency can be improved.

Previous concerns about land contract forms mainly focused on fixed rental contracts and sharecropping (Shaban, 1987; Ray, 1998), while the degree of completeness of rental contracts receives little attention in the research of rural land rental markets. As suggested by Furubotn and Richter (2005), a contract is incomplete due to bounded rationality of participants as it is impossible to elaborate every detail of a contract as well as uncertainties regarding the future. Establishing a detailed land rental contract is time-consuming and increases transaction costs. In many cases, a detailed and formal contract can facilitate enforcement and supervision. However, at community level, when enforcement and supervision of contracts can be based on reputation or social capital, trading partners are tempted to make informal contracts (Edwards and Ogilvie, 2012). This informal relationship could be stable, because the participants of a land transfer do not just engage in one time trade. In the long run, they are interdependent regarding many aspects of social life, their strategic actions should be perceived as pertaining to a dynamic equilibrium result (for example in the rural financial market in China Zhu et al. (1997)). In this dynamic game, they will maintain cooperation in order to maximize long-term benefits. Therefore, oral contracts might be motivated by minimizing long-term transaction costs.

Landlords have an additional motivation to make an oral contract, especially when the landlord or family members of the landlord engage in labor migration. For the uncertainty which off-farm jobs entail and the lack of unemployment insurances for migrating agricultural laborers, migrated laborers may be forced to return to their village in case of unemployment. Considering this unemployment risk, landlords prefer to make an informal and flexible contract with a tenant in order to be able to reclaim the land easily, which may limit the landlord's ability to negotiate a high rent. Hence, the landlord may refrain from searching for a competitive tenant. In table 4.2, we classified farm households into 12 categories based on their occupational choices and land rental market participation [17]. Farm households with labor migration participate actively in both sides of the land rental

[17] In table 2, "Farmer" denotes farm households which are only engaged in agricultural production , "Part-time farmer without labor migration" refers to a family that has agricultural laborers and laborers which were employed within the county, but no out-of county labor migration, "Part-time farmer with labor migration" refers to farm households which not only operated agricultural production but also have out-of county labor migration; moreover, they may have family labor working off-farm within the county, "Non-Farmer without migration" and "Non-farmer with migration" is defined in the same manner as part-time farmer only without agricultural labor.

market. 12 out of 19 rented farm households are subject to labor migration, which also holds for approximately the same proportion of rented out farm households (61.82%)[18]. Most likely both landlord and tenant are well informed about the risks involved in labor migration.

Table 4.2 Land rental market participation and occupation of farm households

	Rent in	Do not participate	Rent out	Sum
Farmer	2 (1.89)	9 (8.49)	4 (3.77)	15 (14.15)
Part-time farmer without migration	5 (4.72)	6 (5.66)	5 (4.72)	16 (15.09)
Part-time farmer with migration	12 (11.32)	17 (16.04)	11 (10.38)	40 (37.74)
Non-farmer without migration	0 (0.00)	0 (0.00)	12 (11.32)	12 (11.32)
Non-farmer with migration	0 (0.00)	0 (0.00)	23 (21.70)	23 (21.70)
Sum	19 (17.92)	32 (30.19)	55 (51.89)	106 (100.00)

Note: this table lists farm household occupational choices and participation in the land rental market in 2010. Figures in parentheses denote the number of households in each category. Figures in parentheses denote the percentage of each category. Data source: RCRE.

The opportunism of landlords increases the chance of renegotiation after land transactions which may decrease the expectation of returns from investment. Claiming revenues from agricultural production is particularly time-consuming. Thus, assets specificity and uncertainty about the future may prevent

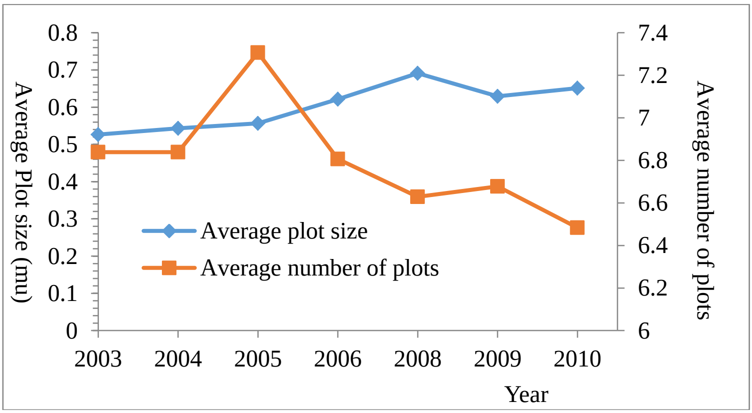
[18] The percentage is calculated by using the total number of labor migrants (11+23), divided by total number of rented out farm households (55).

tenants from investing in rented land, and cannot benefit from the technical efficiency enhancing effect of land rental. All of these factors will reduce the tenant's willingness to pay and, therefore, lower the price for rental in equilibrium. Furthermore, informational asymmetry increases the tenant's risk when dealing with an unfamiliar landlord and constraints him or her to trade with acquaintances.

Participants of the land rental market in these three villages attempt to minimize transaction costs in an environment of informational asymmetry, and try to mitigate risks from off-farm work uncertainty. All this leads to a land rental market characterized by oral contract, acquaintance trading, and zero rent. And these reactions may undermine the efficiency-enhancing effect of the land rental market.

Apart from the possible impact of the market environment, there are other channels through which the land rental market may affect agricultural production efficiency. Firstly, the land rental market may affect agricultural production through the impact on land fragmentation. Empirical studies show that land fragmentation in China leads to agricultural productivity losses (Fleisher and Liu, 1992; Nguyen et al, 1996; Tan et al, 2006, 2008).The land rental market provides farm households with the opportunity to reduce land fragmentation by renting and improve agricultural production efficiency. We depict changes of average land plot size and average number of plots cultivated by farm households in the three villages from 2003 to 2006, and 2008-2010 in Figure 4.1. The average land plot size in these villages increased from 0.53 *mu* in 2003 to 0.65 *mu* in 2010, and the number of plots per household decreased from 6.84 plots in 2003 to 6.48 plots in 2010. Even though these changes are rather marginal, they are nonetheless pertaining to the impact of the land rental market, considering that during this time period there was no administrative reallocation of land in these villages.

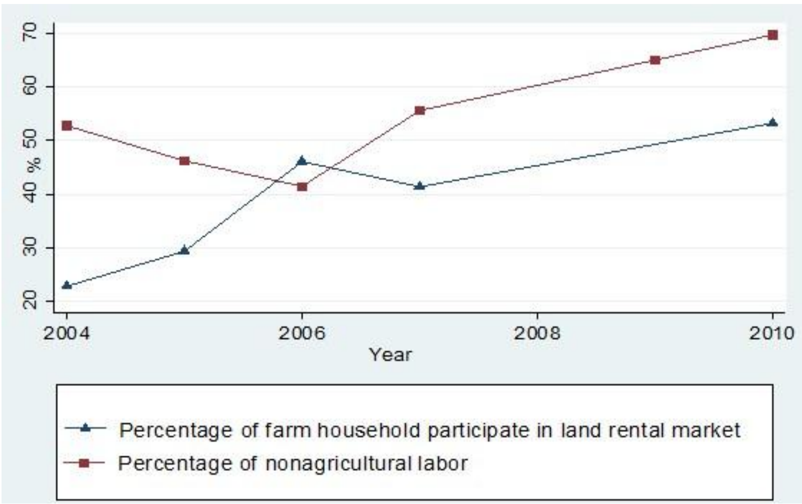
Figure 4.1 Change of Average Plot Size and Number of Plots per Household



Data source: RCRE

Secondly, the land rental market has the potential to save the loss of productivity due to agricultural labor migration. The new economics of labor migration highlight the complexity of the effect of migration of agricultural labor on agricultural productivity (Stark, 1991). On the one hand, loss of labor due to migration may have a negative impact on productivity given production technology; on the other hand, remittances from migration can relax capital constraints on agricultural production and therefore increase investments which can compensate for the negative effect of losing farm labor. The overall impact of migration on agricultural productivity is ambiguous and depends on which of the two above-mentioned trends is dominant.

Figure 4.2 Development of the land rental market and labor migration in three villages from 2004 to 2010



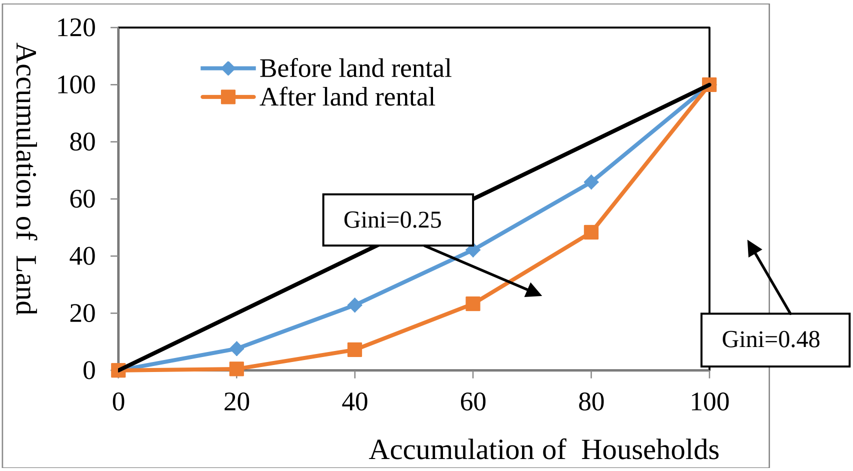
Data source: RCRE

An empirical study on northern China has shown that the impact of migration on maize production was negative by using Stark's framework (Rozelle, et al, 1999). Therefore, the land rental market has a productivity enhancing effect by allowing tenants to exploit the land which was only marginally exploited by landlords whose labor migrated out (Jin and Deininger, 2009). As illustrated in figure 4.2, a positive correlation between the land rental market participation and agricultural labor migration may imply a productivity enhancing effect on the land rental market in the field research area.

Agricultural production may also benefit from economies of scale through the land rental market. Land transaction between migrated households and non-migrated households should indicate a concentration of operational farm size. In figure 4.3we depict operational land distribution before and after land rental in 2011 by means of the Lorenz curve and the Gini coefficient. Farm size before rental is denoted by land contracted from village collectives, and farm size after rental is denoted by the actual operational area. We can see in Figure 4.3 that land holding is concentrated through land rental transactions as the Gini coefficient increased from 0.25 to 0.48.

Therefore, in rural Chongqing we observed both negative and positive effects of the land rental market on agricultural production efficiency. On the one hand, an incomplete land rental market environment may reduce the incentive of tenants to invest and maximize work load and may prevent land match with the potentially most productive farm households; both of these factors tend to lower production efficiency. On the other, land rental transaction could save the loss of productivity due to labor migration and land fragmentation. Through the land rental market it is also possible to establish economies of scale. The overall impact of these factors is the focus of the following empirical research.

Figure 4.3 Lorenz Curves of land distribution before and after land transaction



Data source: author's own survey.

4.4 Research Methodology

In this study we focus on the technical efficiency of agricultural production. As a component of economic efficiency (the other is allocative efficiency), technical efficiency is defined as the ability to produce as much output as possible from a given bundle of inputs and technology (Farrell, 1957). Technical efficiency is defined in relative terms, relative to the theoretical maximum output from given input mix and technology. This is the output-oriented technical efficiency measurement, in contrast to the input-oriented technical efficiency measurement. Allocative efficiency refers to the ability to maximize profits or minimize costs in production. Without a doubt, the management level of a farm affects the technical efficiency and allocative efficiency. But to achieve allocative efficiency it is important to have a well-functioning and competitive input and output market, so price information can be transferred to farmers freely (imperfect market structure, informational asymmetry and transaction costs are potential obstacles). It implies that not only management skills but also market conditions which are beyond the control of farm household impact allocative efficiency. To measure allocative inefficiency formally we need to estimate a production function plus a demand system or a cost function and derived demand system (Greene, 2008, pp. 96). Limited information on all relevant input and output markets restrict our ability to investigate the relationship between allocative efficiency and the land rental market participation. But we can explore the relationship between technical efficiency and land rental market participation by focusing on the production function, and we will do it in a stochastic production frontier framework.

Stochastic frontier analysis was initially developed by Aigner, Lovell and Schmidt (1977) as well Meeusen and van den Broeck (1977) independently. The application of the Bayesian analysis in stochastic frontier analysis was introduced by van den Broeck et al (1994) for its advantage in taking account of parameter uncertainties.

In this study, we employ a generalized true random effect model (GTRE) for stochastic frontier analysis (Tsionas and Kumbahakar, 2012). This model has the form

$$y_{it} = F(x_{it}; \beta) + \alpha_i + v_{it} - u_{it} - z_i \quad (4.1)$$

where y_{it} is the output of farm households $i (i = 1, \ldots, I)$ at year $t (t = 1, \ldots, T)$. x_{it} denotes the input matrix. β is the parameter vector of the production function. α_i represents a farm specific effect which is time-persistent, v_{it} denotes the stochastic error of production, u_{it} is time-varying technical efficiency and z_i is time-persistent technical inefficiency. Colombi *et al* (2011) and Tsionas and Kumbahakar (2012) provide examples and intuitions to formulate such a general form of a stochastic frontier model. It is reasonable to assume that management may change over time, even though some managing skills are time invariants. Because of the inefficiency related to management, it is also reasonable to assume that technical inefficiency has a time-varying part and a persistent part.

Economic theory suggests that the production function $F(x_{it}; \beta)$

should be a monotonic and concave function on inputs, x_{it} (Chambers, 1998). Furthermore, as we have mentioned before, the production function should have constant returns to scale. Sauer et al. (2006) and O'Donnell and Coelli (2005) demonstrated the importance of imposing these regularity conditions in estimating the stochastic frontier model in the Frequentist as well in the Bayesian context respectively. The requirement of these regularity conditions on functional coefficients depends on which empirical form of production function we choose.

Here, we employ the translog production function to approximate the true production function in (4.1). The translog production function has the form,

$$F(x_{it};\beta) = \beta_0 + \sum_{j=1}^{n} \beta_j \, lnx_{it,j} + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \beta_{jk} \, lnx_{it,j} lnx_{it,k}$$

$j,k = 1, \ldots, n$ denote inputs. And also left hand side of (4.1) changes correspondingly to lny_{it} . The translog version of production function (4.1) is therefore

$$lny_{it} = \beta_0 + \textstyle\sum_{j=1}^{n} \beta_j \, lnx_{it,j} + \frac{1}{2}\sum_{j=1}^{n}\sum_{k=1}^{n} \beta_{jk} \, lnx_{it,j} lnx_{it,k} + \alpha_i + v_{it} - u_{it} - z_i \qquad (4.2)$$

Taking the exponent to both sides of the function (4.2) we have

$$y_{it} = exp\big(F(x_{it};\beta)\big) exp(\alpha_i) exp(v_{it}) exp(-u_{it} - z_i)$$

in which $exp\big(F(x_{it};\beta)\big)exp(\alpha_i)exp(v_{it})$ indicates the theoretical maximum output (y_{it}^{*}) produced from the given input mix and technology. $y_{it}/y_{it}^{*} = exp(-u_{it} - z_i)$ measures the proportion of actual output y_{it} as the theoretical maximum output, which means that $exp(-u_{it} - z_i)$ is the index of the technical efficiency level of farm households. We denote $exp(-u_{it} - z_i)$ as the technical efficiency score of farm households. If a farm household is technically efficient, its technical efficiency score is 1, which implies that $exp(-u_{it} - z_i) = 1$ or $-u_{it} - z_i = 0$, i.e. production of farm household lies on the stochastic production frontier. As the technical efficiency of farm households decreases, the technical efficiency score approaches to 0. Note that $exp(-u_{it} - z_i)$ approximates 0 as $-u_{it} - z_i$ goes to negative infinite, which means that $exp(-u_{it} - z_i) \in (0, 1]$.

Constant return to scale (homogeneity) in inputs implies that $\sum_{j=1}^{n} \beta_j = 1$, and $\sum_{j=1}^{n} \beta_{jk} = 0$.

$F(x_{it}; \beta)$is monotonic (marginal output of input is positive) in x_{it} implies,

$$\frac{\partial y_{it}}{\partial x_{it,j}} = \frac{\partial \ln y_{it}}{\partial \ln x_{it,j}} \frac{y_{it}}{x_{it,j}} = \left(\beta_j + \sum_{k=1}^{n} \beta_{jk} \ln x_{it,k} \right) \frac{y_{it}}{x_{it,j}} \geq 0 \Leftrightarrow \beta_j + \sum_{k=1}^{n} \beta_{jk} \ln x_{it,k} \geq 0 \qquad (4.3)$$

$F(x_{it}; \beta)$ is concave (marginal output of input is non-increasing function of input) in x_{it} if and only if the Hessian matrix H of $F(x_{it}; \beta)$ is negative semi-definite. The hessian matrix is given by:

$$H = \begin{bmatrix} F_{11} & \dots & F_{1n} \\ \vdots & \ddots & \vdots \\ F_{n1} & \dots & F_{nn} \end{bmatrix}$$

where

$$F_{jk} = \frac{y_{it}}{x_{it,j}x_{it,k}}\left(\beta_{jk} + \left(\beta_j + \sum_{k=1}^{n} \beta_{jk} ln\, x_{it,k}\right)\left(\beta_k + \sum_{j=1}^{n} \beta_{jk} ln\, x_{it,j}\right)\right) - \frac{y_{it}}{{x_{it,j}}^2}\left(\beta_j + \sum_{k=1}^{n} \beta_{jk} ln\, x_{it,k}\right)\frac{\partial x_{it,j}}{\partial x_{it,k}}$$

for $j, k = 1, \dots, n$. $\partial x_{it,j} / \partial x_{it,k} = 1$ for $j = k$, or 0 otherwise. H is negative semi-definite if and only if the sign of the first leading principal minor is not positive, i.e. $|F_{11}| \leq 0$, and the signs of the further leading principal minors alternate, i.e.

$$sign\left|H_j\right| = sign(-1)^j \text{ or } \left|H_j\right| = 0, \text{ for } j = 2, \dots, n \qquad (4.4)$$

Other than homogeneity, monotonicity and concavity not only depend on the estimated parameters, but also depend on the sample data used for estimating the production function. Except for several specific functional forms (e.g. Cobb-Douglas production function, CES (constant elasticity of substitution) production function), we cannot know whether the estimated parameters will or will not satisfy regularity conditions a priori. The homogeneity conditions can be imposed simply by using one input to normalize the translog production function first. Because no information about the error term is needed in the curvature conditions, we can test it by performing an ordinary least square (OLS) estimation on the normalized model. Here we use intermediate input as a normalizer. The results are presented in table 4.3[19].

Table 4.3 OLS estimation of stochastic frontier model

Output	Coef.	Std.Err.	T	P>|t|	[95% Conf.	Interval]
β_1(logc*)	0,0753	0.0157	4,8	0.000	0.0445	0.1061
β_2(logld*)	0.4316	0.0279	15.42	0.000	0.3767	0.4866
β_3(loglb*)	0.1514	0.0267	5,67	0.000	0.0990	0.2038
β_{11}(logcc)	-0.0242	0.0094	-1.29	0.197	-0.0306	0.0063
β_{12}(logcld)	-0,0077	0.0251	-0.31	0.759	-0.0569	0.0416
β_{13}(logclb)	0.1293	0.0181	7,15	0.000	0.0938	0.1648
β_{22}(logldd)	-0,1898	0.0261	-3.64	0.000	-0.1462	-0.0439
β_{23}(logldb)	0,0492	0.0345	1,42	0.155	-0.0186	0.1170
β_{33}(loglbb)	-0.0458	0.0198	-1.16	0.245	-0.0618	0.0158
β_t(time)	-0.0008	0.0173	-0.05	0.962	-0.0347	0.0331
β_{tt}(time2)	0.0039	0.0023	1,74	0.083	-0.0005	0.0085

Note: *c represents *capital*, ld denotes *land*, lb is *labor*.

Greene (1980) has shown that the OLS estimator provides a consistent and best linear unbiased estimate of β in the stochastic frontier model. Even though the intercept parameter α is not consistently estimated by OLS, we can get a correct regularity conditions assessment because $\alpha$was not included in regularity conditions. Therefore OLS results are sufficient for us to evaluate the regularity conditions of the underlying production function. First we assess monotonic and concave conditions at

[19]We conduct this estimation in the way of the fixed effect model, i.e. we firstly eliminate α_i by demeaning the variables using the within transformation, then we perform the OLS estimation on the transformed data. Therefore, only slope parameters were included in Table 4.3.

the data mean. Because we have deflated the sample data to make each variable have a sample mean of one, the derivative (4.3) reduce to β_j when evaluated at data mean. $\beta_j \geq 0$ indicates the fulfillment of monotonicity conditions. The OLS estimations of β_j in Table 4.3 are all positive, which implies that monotonicity constraints are satisfied at data mean. At the sample mean, F_{jk} collapses to $\beta_{jk} + \beta_j \beta_k - \beta_j \, \partial x_{it,j} / \partial x_{it,k}$. The corresponding leading principal minors are $|H_1| = -0.4351$, $|H_2| = 0.0627$, $|H_3| = 0.0036$, and $|H_4| = 0.0000$. Because $|H_3|$ is positive, the OLS estimator violates concave conditions at sample mean. Therefore, some structures must be placed on the production frontier estimation.

We employ the Bayesian procedure in stochastic frontier analysis because it is straightforward to impose monotonic and concave conditions in estimation by simply using prior information (O'Donnell et al, 1999). Moreover, it has good finite-sample properties with small I and T compared to the maximum likelihood estimation (Tsionas and Kumbahakar, 2012). The details of the Bayesian MCMC inference in the GTRE model were presented in Appendix I.

Our aim is to see the effect of the land rental activities on technical efficiency. Firstly, we focus on testing H1 which can be pursued by addressing two questions: 1. Can land rental markets transfer land from LFHs to MFHs? 2. Can participation in land rental markets improve the technical efficiency of production for farm households? We can answer the first question by comparing the willingness to pay for an additional unit of land (i.e. the value of the marginal product of land) between LFHs and MFHs. If the willingness to pay at MFHs is higher than at LFHs, a competitive land rental market can transfer land from LFHs to MFHs because MFHs can provide higher rents. Even though transaction costs were involved, MFHs are more likely to overcome the restriction of transaction costs to rent a piece of land. But if transaction costs are too high, any efficiency enhancing transaction could be blocked. As a reaction to significant transaction costs, farmers may want to negotiate land rental with their acquaintances even though the potential tenant cannot provide the highest bidding for land. Therefore, even if MFHs will pay more for an additional unit of land, it not necessarily means that MFHs can actually rent land when transaction costs are sufficiently high, but it still shows the potential of a competitive land rental market.

To answer the second question, we estimate the impact of the participation in the land rental market on the technical efficiency score of farm households as we are trying to explain the mean of $\exp(-u_{it} - z_i)$ by a bundle of explanatory variables in which the participation in the land rental market is the key explaining variable.

Here we use the ratio of absolute value of net-rented land to land endowment of farm households as an indicator of participation in the land rental market of farm households (P_{it}). Suppose the net-rented land for farm households$i$ at time t is R_{it}, R_{it} is positive for renting land and negative for renting out land. Land endowment of farm households is given by $\overline{D}_i$. Then

$$P_{it} = \frac{|R_{it}|}{\overline{D}_i}$$

The marginal effect of P_{it} on $\exp(-u_{it} - z_i)$ is given by the coefficient of P_{it} in regression. Denote $E\big(\exp(-u_{it} - z_i)\big)$ by $E(TE_{it})$, the efficiency function can be elaborated as

$$E(TE_{it}) = \alpha_{0i} + \alpha_1 H_{it} + \alpha_2 P_{it} + \alpha_3 AGE_{it} + \alpha_4 G_{it} + \alpha_5 F_{it} + \alpha_6 FS_{it} + \omega_{it} \quad (4.5)$$

where H_{it} is the Herfindahl index which measures cultivate diversity, F_{it} is the number of plots cultivated by farm households which was used to measure land fragmentation, AGE_{it} denotesthe age of household heads. $G_{it} = FM_{it}/(FM_{it} + AP_{it})$, where FM_{it} denotes expenditure on the use of farm machines and AP_{it} denotes expenditure on use of animal power.FS_{it} is farm size of farm household. As we use a point estimation of TE_{it} (the expectation) as dependent variable, and we do not have prior information about the parameters in (4.5), in addition we do not need to impose monotonic and curvature conditions in (4.5), so we just use the traditional Frequentist method to estimate (4.5). It should be noted that we estimate (4.2) and (4.5) separately. This two-step procedure which has its genuine drawbacks (Wang and

Schmidt, 2002) permits us to maintain the assumption that technical inefficiency consist of a persistent part and a time varying part[20].

In chapter 3 we discussed the endogenous relationship between land rental market development and agricultural production efficiency change. In function 4.5 this endogenous relationship constitutes the inverse causality between $E(TE_{it})$ and P_{it}. In this study we use $P_{i,t-1}$, degree of participation in the land rental market in the last period, as an instrumental variable for P_{it}. The current state of the technical efficiency level of farm households will not affect land rental market participation in the last period, and as we will show in Table 6.2, farm household participation in the current period is closely related to participation in the last period. These make $P_{i,t-1}$ a qualified instrumental variable for P_{it}.

4.5 Empirical Results

4.5.1 Stochastic frontier analysis

In the estimation we generate 70,000 draws by using the Metropolis-within-Gibbs algorithm as discussed in Appendix I.

[20]In the Bayesian context, based on the assumption of ω_{it}, we are able to derive the likelihood function of $\mathrm{E(TE_{it})}$ as a function of explanatory variables in 4.5. Combining with the prior of $\mathrm{TE_{it}}$, we can derive the posterior of $\mathrm{TE_{it}}$. However, we did not do this in our analysis because we have to make an assumption about the distribution of $1/\gamma + 1/\eta_t$ instead of TE_{it}, which means we have to give up the assumption about the distinction between time varying technical inefficiency and persistent technical inefficiency.

The first 20,000 draws were discarded as "burn-in" to eliminate the effects of initial values. In table 4.4 we list the mean of the marginal posterior distributions of the parameters in the translog production frontier function, together with the 90% highest probability density (HPD) interval. Convergence diagnosis (CD) of the Metropolis-within-Gibbs algorithm was implemented by using the procedure of Geweke (1992).

Table 4.4 Posterior estimation of slope parameters

Stochastic frontier production function			
Parameters	Posterior mean	90% HPD*	Geweke's CD
β_0	0.3650	(0.1736,0.5578)	0.6314
β_1(logc)	0.1772	(0.1229,0.2323)	0.4879
β_2(logld)	0.3963	(0.3272,0.4647)	-0.2049
β_3(loglb)	0.1947	(0.1416,0.2575)	0.6072
β_{11}(logcc)	-0.0063	(-0.0251,0.0127)	0.6747
β_{12}(logcld)	-0.0029	(-0.0452,0.0372)	-1.5399
β_{13}(logclb)	-0.0055	(-0.0328,0.0173)	0.6519
β_{22}(logldd)	-0.0128	(-0.0571,0.0271)	-0.0198
β_{23}(logldb)	0.0768	(0.0525,0.1005)	0.1986
β_{33}(loglbb)	0.0046	(-0.0116,0.02047)	-0.6797
β_t(time)	-0.3005	(-0.3067,-0.2944)	0.2255
β_{tt}(time2)	0.2132	(0.1965,0.2294)	-0.9042
Posterior predictive p-value 0,2484			

*HPD stands for highest probability density interval.

We present the posterior mean of five farm households whose technical efficiency score is ranking from low to high and its composition in table 4.5 to exemplify the structure of technical inefficiency. These farm households include the most technically efficient farm household and the least technically efficient farm household and three farm households who equally divide total farm households into four groups according to their technical efficiency score. We demonstrate the total technical efficiency score and its compositions in each farm household. Total technical efficiency equals the persistent technical efficiency multiplied with the time-varying technical efficiency.

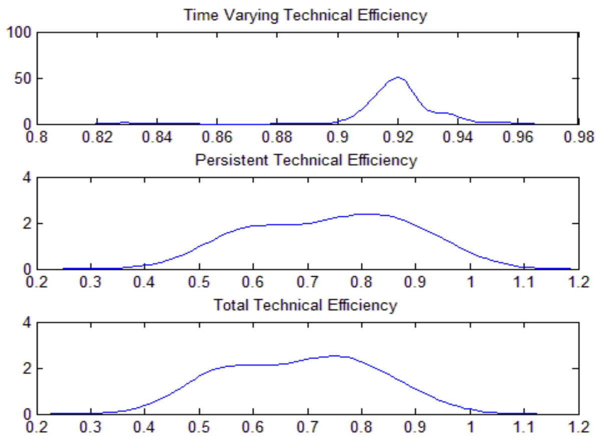
Table 4.5 Technical efficiency score*

Farm household	Persistent technical efficiency	Time varying technical efficiency	Total technical efficiency
1	0.456	0.91	0.417
	(0.326,0.669)	(0.778,0.993)	(0.253,0.664)
2	0.567	0.907	0.541
	(0.433,0.847)	(0.776,0.993)	(0.336,0.841)
3	0.681	0.912	0.621
	(0.498,0.927)	(0.777,0.994)	(0.387,0.921)
4	0.832	0.93	0.774
	(0.634,0.987)	(0.812,0.995)	(0.514,0.982)
5	0.979	0.956	0.936
	(0.937,0.999)	(0.883,0.997)	(0.827,0.996)

*Numbers in parentheses are 90% highest probability density interval.

In table 4.5 we can see that the major source of technical inefficiency was attributed to persistent technical inefficiency. Time-varying technical efficiency shows is approximating to 1 and no big difference between farm households. It is the divergence of persistent technical inefficiency which leads to vast differences in the efficiency score[21]. In this context, Figure 4.4 demonstrates the kernel estimation of the posterior mean of technical efficiency and its components of farm households in the sample. Clearly, the distribution of technical efficiency of farm households mainly depends on the kernel density of the posterior mean of persistent technical efficiency.

Figure 4.4 Kernel estimation of persistent, transient and total technical efficiency



Our interest is not in technical inefficiency per se but in the relationship between technical inefficiency and land rental market

[21] The figures in the row of "Time varying technical efficiency" were the mean of this variable over time.

participation. We have already constructed a functional relationship for these two variables in equation (4.5). As we have a time-varying and time-invariant technical inefficiency element, we are going to discuss how land rental market participation can affect these technical inefficiencies.

Persistent technical inefficiency is varying among individuals but not across time, so individual characteristics which are not changing over time may correlate closely with persistent technical inefficiency; even though farm household participation in the land rental market remains relatively constant from the last period to the present (the probability is around 0.7 as it is shown in Table 6.2). As time passes by, the probability of farm households to change their rental behavior is increasing. It may imply that in the panel data model in which time is long, the correlation between persistent technical efficiency and land rental market participation may be weak. But we should also note that as the time dimension in panel data is increasing, the assumption of persistent technical inefficiency becomes inappropriate.

The above discussion suggests that land rental market participation might correlate more tightly with the time varying technical inefficiency. Variation of the time-varying technical inefficiency among individuals is small, and variation of individual’s time-varying technical inefficiency across time is also relatively small compared to the variation of persistent technical inefficiency among individuals. Therefore, we may expect that the impact of land rental market participation on technical inefficiency (vertical effect) should be small, at least in the short term.

4.5.2 The efficiency function

As previously introduced, our research objectives are aiming at examining the “vertical” and “horizontal” effects of land rental market participation. First, we look into the vertical effect by estimating (4.5). We use the fixed effect model for our estimation (the Hausman test shows that the fixed effect model is preferable). The results are listed in table 4.6.

The results show that the impact of land rental on the total technical efficiency is positive, but insignificant. This may suggest that participating in the land rental market has the potential to improve technical production efficiency, but the gain is marginal, indicating that a land rental market environment which is characterized by widespread informal contracts (oral contract), acquaintances transactions, and gift transfer of land (no explicit monetary rent) cannot provide enough incentives for farmers to improve their management skills. The impact of land fragmentation is insignificant, too. Therefore, reduced land fragmentation through land rental market may not bring about a technical efficiency gain. But the implications of farm size are significant, indicating that increased farm size can improve farm households’ technical efficiency. Though participation in the land rental market may not lead to an increase in technical efficiency, expansion of farm size through land rental, however, does. Diversifying farm cultivation has a significant and positive effect on technical efficiency of farm households as indicated by the coefficient of the Herfindal index. Household head age and agricultural machinery use in production have no significant effect on technical efficiency in this sample.

Table 4.6Estimation of slope parameters in the efficiency function

	TE_{it}	
Variables	Coeffficients	Standard error
Constant	0.0575	0.0441
Herfindal index	0.8232***	0.0829
Extent of participation in land rental market (%)	0.2490	0.2817
Household head age	-0.0005	0.0005
Machinery	-0.0234	0.0204
Number of plots	0.0028	0.0052
Farm size (mu)	0.1183***	0.0144
R^2	0.4793	

Note: *Statistically significant at the 10%-level. **Statistically significant at the 5%-level. ***Statistically significant at the 1%-level.

One important conclusion for the following analysis of the "horizontal" level is that the correlation between land rental market participation and the individual technical inefficiency level can be ignored. We will further discuss the significance of this conclusion in the following analysis.

4.5.3 Investigation of “horizontal” effect

We calculated the value of the marginal product of land, i.e. the shadow price of land. We group farm households into three categories according their technical efficiency score: less efficient farm households (LFHs), moderately efficient farm households (EFHs), and more efficient farm households (MFHs) (The farm households are divided equally into three groups). Then we use analysis of variance (ANOVA) to test if the shadow price of land is higher for MFHs than for the other two groups. The results of ANOVA were presented in Table 4.7. A very small *p value* indicates that differences between the three groups are highly significant, which implies that the shadow price of land of more efficient farm households is higher than moderate and less efficient farm households. Therefore, in a competitive land rental market, land will be transferred to more efficient farm households, and land use efficiency will be improved. But as we have described previously, informal land rental contracts, informational asymmetry, and gift transferring are prevalent in land rental market in field research area. Such a market environment may prevent the transfer of land efficiently, as will be seen.

Table 4.7 ANOVA of shadow price by efficiency group

Group	less efficient	moderate efficient	more efficient
Mean	269.24	354.47	555.56
Std.	55.61	23.24	187.24

ANOVA results

Source	SS	df	MS	F	Prob>F
Groups	1213524.9	2	606762.5	52.79	0.0000
Error	988531	91	11494.5		
Total	2202056	93			

In this study, we demonstrate the completeness of the land rental market by comparing the difference between shadow price of land and observed land rent. We use the Kolmogorov-Smirnov test (K-S test) to examine whether the shadow price of land and observed land rent are from two different distributions. We do the same for the shadow price of labor and observed off-farm labor wage. The results are presented in Table 4.8. Both tests reject the null hypothesis that the shadow price of land and observed land rent are from the same distribution, and that the shadow price of labor and observed off-farm wage are from the same distribution at 5% significance level.

As we have noticed in section 3.2, we interpret the difference between the factor’s shadow price and market price as a measurement of factor market imperfection. The construction is simple. In each village in every year, we calculate the mean of the shadow price of land and agricultural labor. The measurement of land rental market imperfection is the mean of the shadow price of land minus the mean of the market price at that year. The measurement of off-farm labor market imperfection is the mean of off-farm work wage minus the shadow price of agricultural labor. These two measures of market imperfection will be used in the following chapters. Note that in this study we use the measurement of market imperfection and transaction costs in the market interchangeably.

Table 4.8 K-S test for shadow price of land and labor and their observed prices

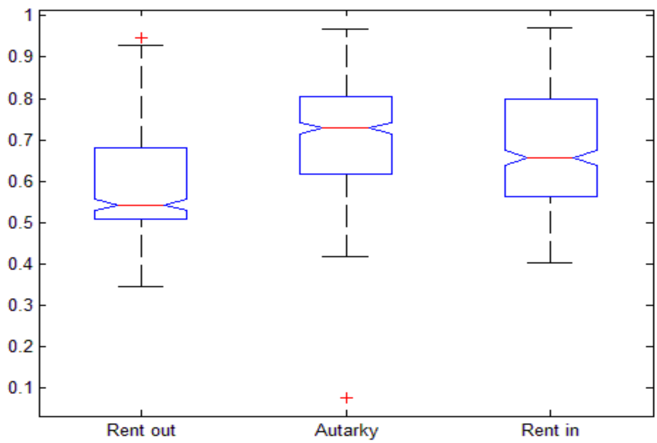
	shadow price of land (Yuan/Year)	observed land price (Yuan/Year)	shadow price of labor (Yuan/Day)	observed labor wage (Yuan/Day)
mean	382.25	161.66	3.91	18.54
std	263.51	152.15	5.36	11.77
K-S test	Hypothesis test result	Asympotic p-value	ks2stat	
land	1	0.0000	0.65	
labor	1	0.0000	0.85	

Apparently, on the one hand, the difference between the shadow price of land and observed land rent is due to the transaction costs in the land rental market; on the other hand, the difference may be derived from the compensation for tenants for the risks of land loss in case of the landlord reclaiming the land. The difference between shadow price of labor and observed off-farm wage may attribute to transaction costs in the off-farm labor market. The mean of observed off-farm wage is significantly higher than the shadow price of labor on farm. Therefore the landlord is likely to rent out land at a very low price because the opportunity cost for off-farm work is very low. The difference between the shadow price of factors and market prices may work as risk premium to let farmers involve in risky activities, for example rent land or doing off-farm work.

In the case of an incomplete land rental market and a referring incomplete off-farm labor market, can land be transferred from low efficient farm households to more efficient farm households as we have suggested above? We are trying to answer it by looking at the result of the land rental market operation in rural Chongqing, i.e. by comparing the technical efficiency level between rented farm households, farm households that do not participate in land rental market and rented out farm households. ANOVA was used to measure the difference statistically. The results show that the differences at the mean of technical efficiency among different household types are significant at 5% level. The results are depicted in Figure 4.6.

We can see from figure 4.6 that rented farm households are more likely to be more efficient than rented out farm households (note that rented out farm households have a lower technical efficiency score and rented farm households have a higher technical efficiency score, not because they participate in the land rental market; participation in the land rental market and the individual technical efficiency level is insignificantly correlated, rendering the conclusion in the end of last section useful). This proves the existence of the horizontal effect: from the land rental market, land can be transferred from less efficient farm households to more efficient farm households.

Figure 4.6ANOVA of technical efficiency level of different type of farm household



But farm households who rent land are not notably more efficient than the other two groups, which may imply that in rural Chongqing the land rental market can improve land use efficiency by transferring land from less efficient farm households to more efficient farm households. But the potential of the land rental market is not fully realized, because the most efficient farm households are more likely to stay in autarky due to land rental market imperfection.

4.5.4 Alternative hypothesis

Now we turn to test H2. The logic behind this hypothesis is that when farm households have different abilities to negotiate an off-farm work wage, the more efficient farmer might be the one who is likely to get the higher wage than the less efficient farmer. A higher off-farm work wage attracts more efficient farmers who then leave the agricultural sector and transfer their land. Note that an important precondition for this hypothesis is that land property rights are secure. In the case of China, it may also require that land use rights are secure. As we have discussed previously in the section on land reform in China, farm households in today's China enjoy a relatively secured land use right. Therefore, we assume that this precondition is met.

Table 4.9 Technical efficiency level and participation in the land rental market

(%)	Less efficient	Medium efficient	More efficient	Row sum
Rent out	14.03	3.39	3.39	20.81
Do not participate	11.09	19.91	8.60	39.59
Rent	8.14	9.95	21.49	39.59
Column sum	33.26	33.26	33.48	100.00

Following the strategy we have developed in section 3.2, we have tabulated farm households' technical efficiency level and their participation status in Table 4.9.

For the more efficient group, farm households are more likely to rent land, but the possibility of renting out land is not close to zero. In this group, 10.1% ($10.1\% = 3.39/33.48 \times 100\%$) farm households rent out land. Within this group, the KS test shows that the distribution of the technical efficiency level of rented out farm households is not significantly different from rented farm households, at 5% significance level; the difference between the technical efficiency level of rented farm households and non-participating farm households and the difference between rented out farm households and non-participating farm households within this group are also insignificant. Results of the KS test imply that within the more efficient group, rented out farm households and rented farm households are indifferent in terms of their technical efficiency level.

Therefore, more efficient farm households are more likely to rent land, but the possibility of renting out land is not totally ruled out. Thus, both H1 and H2 are plausible and not mutually exclusive. Apart from the technical efficiency level of farm households, there are other factors which affect the decision of farm households to participate in the land rental market. We are going to investigate the participation issues in chapter 5. We found that off-farm work wage significantly affects participation decisions of farm households. If H1 and H2 are both true, it might be that even for the more efficient farm households the abilities to find off-farm work are different and so the payments from off-farm work are also different.

4.6 Conclusions

In this chapter we distinguish two different effects of the land rental market on agricultural technical efficiency. One is the impact of the land rental market on land use efficiency in the market. That is the technical efficiency in the context of Pareto efficiency. Another is the impact of the land rental market on production technical efficiency of farm households. This is the technical efficiency in line with Farrell (1957). A competitive land rental market has the potential to improve these two kinds of technical efficiency. In the area of field research, however, the potential of the land rental market might be undermined by significant transaction costs, informational asymmetry, and opportunism of landlords in the market. But the land rental market still shows its capacity to improve agricultural production efficiency by using economies of scale and save the efficiency lose from labor migration.

Based on our empirical research, the land rental market can transfer land from LFHs to MFHs because MFHs have a higher willingness to pay for additional units of land. Therefore, land use efficiency can be improved by a competitive land rental market. Land rental participation can hardly affect technical efficiency of the production of farm households as we have measured. There are two possible explanations for this. One is that the land rental market cannot provide enough incentives for farmers to improve their management skills because of the imperfect market environment. Another explanation is that, as we have seen in the efficiency function, the major factors which affect the technical efficiency level of farms are individual effects. These factors are closely related to personal characters and are not likely to change quickly, which may explain the persistent technical efficiency domination in the overall technical efficiency level. Explanatory variables which can change in the short term may only affect time-varying technical efficiency, and contribute less to total technical efficiency change.

It is possible that more efficient farm households rent out land for the sake of higher off-farm work wage. But more efficient farm households may already have a higher land and labor productivity, thus the possibility to find off-farm work which can offer sufficiently attractive payment to attract their labor is low. As a result, more efficient farm households are more likely to rent land instead of renting out land.

To activate the potential of the land rental market, further reforms should aim at improving the market environment by reducing the searching and information costs in order to make the market more competitive. Moreover, they should provide unemployment insurance and social security for migrated agricultural labor to curb the opportunism of “migrated landlords” and thus minimize uncertainties faced by tenants while producing incentives to work in agriculture.

Chapter 5 Land rental market and income inequality

5.1 Introduction

The land rental market was developed as an alternative to administrative reallocation of land in China in the late 1980s. The equity effect of the land rental market is quite controversial. Deininger and Jin (2005)state that the land rental market is superior to administrative reallocation due to its redistributive effect, while Kung (1994), Turner et al. (1998) as well as Benjamin and Brandt (1998) hold the opposite point of view. In this study we do not try to solve this debate, instead we only look at the equity effect of the land rental market in China, its rapid development in recent years rendering it the most significant way of reallocating land in rural areas.

As we have analyzed in section 3.3, in order to measure the impact of participation in the land rental market on income distribution, we need to take correlations between income sources and land rental market imperfection into consideration.

At this point, a few more remarks have to be made about the effect of land rental market imperfection: In a perfect land rental market, land rent equals marginal return of land, and income generated by land is distributed exactly according to the neoclassical theory of income distribution (supposing homogenous land) (Kaldor, 1955). In this case, the land rental market has no effect on income distribution, only the initial distribution of land matters. While in developing countries like China, the land rental market cannot be treated as perfect because of informational asymmetry, transaction costs and, in some instances, administrative restrictions. This implies that the impact of the land rental market on income distribution will depart from the neutral status and create “winners” and “losers”. In this case, the land rental market affects income distribution. This effect depends on whether the land rental market will benefit the landlord or the tenant, as well as on the initial income distribution prior to participating in the land rental market.

The structure of this chapter is organized as follows: in section 5.2 we provide a descriptive analysis of income data used in this chapter. Section 5.3 elaborates research methods used in this study. Section 5.4 presents the result of the conducted empirical research. Section 5.5 summarizes and concludes this chapter.

5.2 Descriptive analysis

We present income of farm households and its components from 2003 to 2010, with data from 2007 which is not included, in table 5.1. Farm household income is classified into five income sources: land rental income, other agricultural income, income from labor migration, local off-farm work income, and other income sources[22]. Share of land rental income in total income of farm households increased from 3.33% in 2003 to 10.52% in 2010. Income from labor migration contributes mostly to family income in rural Chongqing. Agricultural income (land rental income plus other agricultural income) still accounts for a significant share of total income of farm households.

Table 5.1 Income of farm household and its components

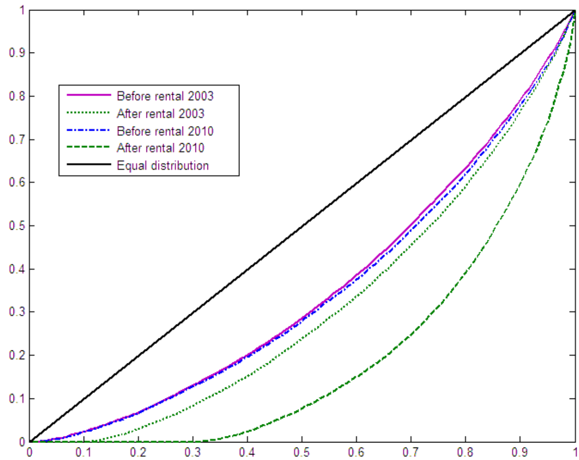
Income	2003	2004	2005	2006	2008	2009	2010
Mean income of farm household (2003 Constant Yuan)	8432.191	11350.46	12997.98	13561.92	15884	12864.99	14854.65
Std	5473.145	10242.7	13108.85	13647.49	14171.31	12346.5	11978.94
Share of income source (%)							
Land rental income	3.33	4.23	4.08	5.01	5.49	8.95	10.52
Other agricultural income	18.74	19.14	16.98	16.47	15.28	23.44	22.32
Income from labor migration	36.77	27.20	43.89	35.37	35.50	33.24	37.06
Local off-farm income	22.60	25.47	19.37	27.46	10.66	20.90	12.91
Other income	18.54	23.96	15.67	15.70	33.08	13.48	17.18
Nobs: 998							

Data source: Research Center of Rural Economy, and Chongqing Statistic Yearbook 2012. Income data are deflated to the price of 2003 by using the CPI.

[22]For rented farm households, we first measure crop income by the profit of crop production without deduction of costs of rented land. Land rental income is derived from the share of rented land times agricultural income minus cost of rent, and the rest plus profit of livestock is defined as other agricultural income. For rented out farm households, land rental income is measured by the revenues from renting out land. Other agricultural income equals profit of cropping plus profits of livestock. Other income sources are defined identically across rented farm households. Rented out farm households and farm households do not participate in the land rental market

Land concentration is increasing as can be observed in figure 5.1.

Figure 5.1 Land distribution before and after land rental transactions in 2003 and 2010



Data source: RCRE

We describe operational land distribution by using the Lorenz curve (this figure is different from Figure 4.3, not only as it shows land distribution changes before and after land rental transactions, but also land distribution over time). Land holding of farm households before land rental transactions were made is measured by the contracted land area. Land distributions in 2003 and 2010, before land rental transaction, are almost the same (the Gini coefficients before land rental transactions are 0.30 and 0.31 in 2003 and 2010 respectively). The slight gap might be due to different observations which were used to plot in these two years. The land distribution following the land rental transactions from 2003 and 2010 shows great differences (Gini coefficients in 2003 and 2010 after land rental transaction are 0.37 and 0.61 respectively). We can confidently say that land distribution is much more unequal after land rental transactions, and the inequality of land distribution has increased significantly from 2003 to 2010.

Land concentration does not necessary mean income concentration. Because the effect of land rental transactions on income distribution depends not only on how land rental income is distributed among farm households and how land rental income correlates with other income sources, but also, as previously discussed, on land rental market conditions. Next we show the methods to investigate these two aspects.

5.3 Research Strategy

There are two ways to investigate the impact of the land rental market on income inequality: decomposition and regression. Decomposition of inequality measures can be conducted either by subgroups or by income components[23]. Presumably it is more convenient to decompose inequality measures by income components than by subgroups because land rental can be

[23] For a formal definition of decomposability of inequality measures see Cowell (2011), pp.161-166.

considered straightforwardly as an income generating activity for both landlord and tenant. Suppose that total income of farm household i is $Y_i (i = 1, \dots, N)$ consists of K components $Y_i^j (j = 1, \dots, K)$, one of which is income from land rental activity, so that $Y_i = \sum_{j=1}^{K} Y_i^j$.

Shorrocks (1982) and Cowell (2011) show that the coefficient of variation, variances, the Herfindahl index as well as the square of coefficient of variation can be decomposed in the same manner. These are the variance based inequality measures. Contribution of income source j to overall inequality in the decomposition of this family of inequality indexes can be consistently represented by the variances of income source j (or ordinal transformation of variances) plus correlations between income source j and other income sources (or corresponding ordinal transformation of this correlation). But decomposition of the variance family indexes are rarely used in empirical studies except for the square of the coefficient of variation, or Generalized Entropy (GE) index for which the weight parameter equals 2, which satisfies the income scale independence principle (Litchfield, 1999). GE index with $\alpha = 2$ has the form

$$GE(2) = \frac{1}{2} \frac{\sigma^2(Y)}{\bar{y}^2} \qquad (5.1)$$

where $Y = (y_1, \dots, y_N)$ is distribution of farm household income, $\bar{y}$ denotes the mean income. Shorrocks (1982) has shown that,

$\sigma^2(Y)$ can be expressed as

$$\sigma^2(Y) = \sum_{j=1}^{K} \sigma^2(Y^j) + \sum_{m \neq j}^{K} \sum_{m=1}^{K} \rho_{jm}\sigma(Y^j)\sigma(Y^m)$$

where ρ_{jm}isthe correlation coefficient between income source j and income source m. Substituting this result into the definition of $GE(2)$, we get

$$GE(2) = \frac{1}{2}\frac{\sum_{j=1}^{K}\sigma^2(Y^j)}{\bar{y}^2} + \frac{1}{2}\frac{1}{\bar{y}^2}\sum_{m \neq j}^{K} \sum_{m=1}^{K} \rho_{jm}\sigma(Y^j)\sigma(Y^m)$$

That is the natural decomposition noticed by Cowell and Fiorio (2011). And a natural way to represent contribution of distribution of income source j to total income inequality is given by

$$GE(2)_j = \frac{1}{2\bar{y}^2}\left(\sigma^2(Y^j) + \sum_{m \neq j}^{K} \rho_{jm}\sigma(Y^j)\sigma(Y^m)\right) \qquad (5.2)$$

and $\sum_{j=1}^{K} GE(2)_j = GE(2)$.

In this formulation we have $\rho_{jm}\sigma(Y^j)\sigma(Y^m)$ to denote correlations between different income sources. From equation (5.2) we can get income inequality caused by land rental income and interactions of land rental income with other income components. With $GE(2)$ measures on multiple periods, we can get an impression of how land rental income affects income inequality changes.

The decomposition of Gini coefficient by income components is used frequently in empirical research. Fei *et al*. (1978) and Lerman and Yitzhaki (1985) provide two different ways for decomposition by income sources base on different expressions of the Gini index. These decompositions, however, do not show interactions of different income components. There are also other methods of decomposition of inequality measures between income components, for example the Shapley value based decomposition proposed by Chantreuil and Trannoy (2011), which also suffers from the same problem.

It seems that if we employ different ways of decomposition we will get different measurements on the contribution of a particular income source to overall income inequality. Nevertheless if the inequality measure $I(Y)$ satisfies the six assumptions stated by Shorrocks (1982) and is continuous, symmetric, and $I(Y) = 0$ if all individuals receive the same income, then the relative contribution of the income component j to overall income inequality (or share of overall income inequality accounted by income component j) is given by

$$s_j = \mathrm{cov}\left(Y^j, Y\right) / \sigma^2\left(Y\right)$$

$$s.t. \sum_{j=1}^{K} s_j = 1$$

which is indifference between inequality measures. We can show that $GE(2)_j / GE(2) = cov\left(Y^j, Y\right) / \sigma^2(Y)$. Therefore the decomposition of the $GE(2)$ index can produce consistent results.

Decomposition analysis can fulfill our interests on how distribution of income generated from land rental activities affects total income distribution, and how interactions of land rental income and off-farm income affects total income distribution. But in decomposition we cannot control other income sources and distributions of other income. And we cannot incorporate the land rental market imperfection. Therefore, we turn to regression analysis next.

As discussed before, land rental market imperfection and off-farm labor market imperfection became evident by means of differences between marginal return of factors and market factor prices. Furthermore, we have constructed measures for imperfect market condition. An immediate way to investigate the impact of the incomplete land and labor market on income inequality is to do regression of the inequality indexes on measurements of land and labor market imperfection, together with other explanatory variables.

Suppose that $I(Y)_{v,t}$ is measured inequality index in group (or village) v at time t. We run the regression as follows:

$$I(Y)_{v,t} = \alpha_v + X_{v,t}\beta + \varepsilon_{v,t} \quad (5.3)$$

where α_v is group specific constant term, β is the unknown slope parameter vector, and $\varepsilon_{v,t}$ is the error term. $X_{v,t}$ is the explanatory variables vector which includes measures of land rental market imperfection and off-farm labor market imperfection (see section 4.5.1). Furthermore, we include market participation rate as explanatory variables. Those are proportions of farm households participating in the land rental market in village v at time t, and proportions of labor participating in the off-farm labor market in village v at time t.

As the data used in this study is available at household level rather than individual level, the impact of family size or economies of scale of consumption should be accounted for. Family scale economies arise when some family consumption can be shared among family members, making larger households achieve certain levels of welfare at lower per capita expenditure (Logan, 2011). This may render direct comparisons between income data from households with different sizes misleading. Thus, in income inequality measurement it is necessary to adjust household income according to family size. Rather than calculating the equivalence scale for each family member as in Pollak and Wales (1979), in this study we use the method suggested by Yin and Wan (2006). Supposed that family size is denoted by n, then the normalized family size is given by n^{δ}, and adjusted household income per capita is $Y_i^* = Y_i / n^{\delta}$, where $\delta \in [0,1]$. If $\delta = 0$, then there are complete economies of scale in consumption which means everything can be shared within the family without losing utilities. $\delta = 1$ means there is no economy of scale in consumption. In this study, we take δ as 0, 0.5, 0.8, and 1 respectively to reveal effects of economies of scale in consumption on inequality measurement. In the following analysis we include Gini coefficient as reference.

5.4 Empirical results

5.4.1 Measurement and decomposition of income inequality

First we show effects of household scale economies on the measurement of the income inequality index. Before we interpret these results, we should note that generalized entropy index with $\alpha = 2$ is more sensitive to changes in higher incomes, while the Gini index puts more weight on income changes near the mean income.

With $\delta = 0$ which means household income data were used directly in measurement of income inequality without account for differences in family size, both $GE(2)$ the index and the Gini coefficient indicate a trend of income inequality change that increases first and then decreases as shown in figure 5.2. The measured inequality index reaches its peak in 2006. The effects of family economies of scale are obvious in this figure. Generally speaking, income inequality index which treats households as individuals tend to overestimate the real inequality level, except for the year 2010 with the $GE(2)$ index. This appears more systematically with the Gini index as it is shown in the right figure in figure 5.2.

Correlations coefficients between land rental income and other income sources are presented in table 5.2. A negative value of the correlation coefficient implies that land rental income can reduce income inequality caused by local off-farm income and income from labor migration, and vice versa (see equation (5.2)), even though the correlation between land rental income and local off-farm income is weak given the small absolute value of correlation coefficients. As we shall see, however, land rental income is positively correlated with other agricultural income and income from other sources, which means income generated by land rental activities may enhance the contributions of other agricultural income and other income to income inequality, and vise verse.

Figure 5.2 Estimated $\mathrm{GE}(2)$ and Gini index from 2003 to 2010 with different economy of scale

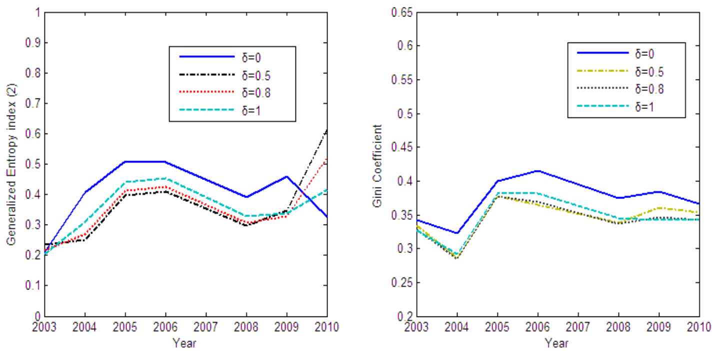


Table 5.2 Mean correlation coefficients of land rental income and other income components

	Land rental income			
	$\delta = 0$	$\delta = 0.5$	$\delta = 0.8$	$\delta = 1$
Other agricultural income	0.378	0.325	0.291	0.271
Income from labor migration	-0.145	-0.163	-0.167	-0.166
Local off-farm income	-0.035	-0.033	-0.027	-0.021
Other income	0.142	0.125	0.118	0.116

The overall contribution of land rental income to income inequality was increasing from 2003 to 2010 at different levels of economies of scale in consumption as it is shown in table 5.3. With an increase of δ or decrease of economies of scale in consumption, this contribution becomes smaller, expect for the year 2010. That means after accounting for family size, land rental income is distributed more equally. This is consistent with the findings that larger households are more likely to rent land (see Appendix Table 1).

Table 5.3 Absolute and relative contributions of land rental income to income inequality

	2003	2004	2005	2006	2008	2009	2010
Inequality caused by land rental income							
$\delta = 0$	0.004	0.003	0.010	0.005	0.013	0.031	0.074
$\delta = 0.5$	0.003	0.002	0.006	0.003	0.008	0.017	0.106
$\delta = 0.8$	0.003	0.002	0.004	0.002	0.006	0.011	0.138
$\delta = 1$	0.003	0.002	0.003	0.001	0.004	0.009	0.163
Relative contribution							
$\delta = 0$	0.017	0.007	0.021	0.011	0.032	0.066	0.228
$\delta = 0.5$	0.013	0.006	0.014	0.006	0.023	0.049	0.255
$\delta = 0.8$	0.012	0.006	0.010	0.004	0.018	0.034	0.263
$\delta = 1$	0.011	0.007	0.008	0.003	0.015	0.024	0.265

5.4.2 Results of regression

We construct a small panel data for estimation. We calculate income inequality indexes for each village in every year. Finally we get 21 observations for each δ value for $GE(2)$ and Gini indexes respectively. We use a fixed effect model in this estimation (for we assume that some time invariant village characteristics may correlate with land and labor market imperfection). Results are shown in Table 5.4.

Note that there is no village effect reported in Table 5.4. A dummy variable can be used to get the village effect, but it will reduce two degrees of freedom. Considering the small sample size, we prefer to save two degrees of freedom and neglect village effects.

Table 5.4 Estimated models for determines of income inequality

Parameters	$GE(2)$				Gini index			
	$\delta = 0$	$\delta = 0.5$	$\delta = 0.8$	$\delta = 1$	$\delta = 0$	$\delta = 0.5$	$\delta = 0.8$	$\delta = 1$
Constant	0.440 **	0.606 **	0.795 **	0.969 **	0.417 ***	0.446 ***	0.470 ***	0.494 ***
	(5.42)	(5.36)	(4.77)	(4.45)	(106.25)	(24.91)	(20.02)	(21.02)
Proportion of participation in the land rental market	-0.076	-0.131	-0.186	-0.231*	-0.003	-0.022	-0.035	-0.037
	(0.43)	(1.07)	(2.15)	(3.65)	(0.03)	(0.21)	(0.30)	(0.33)
Proportion of participation in labor migration	-0.155	-0.326	-0.513*	-0.680**	-0.024	-0.042 **	-0.060	-0.067
	(0.45)	(1.25)	(2.92)	(5.91)	(0.99)	(5.74)	(2.30)	(1.69)
Land rental market imperfection	0.019	0.044	0.073	0.099	-0.007	-0.019	-0.024	-0.026
	(0.48)	(0.65)	(0.86)	(1.03)	(-0.35)	(-0.67)	(-0.730)	(-0.71)
Off-farm labor market imperfection	-0.311*	-0.716**	-1.121**	-1.473*	-0.104**	-0.167***	-0.207***	-0.235***
	(-4.15)	(-5.09)	(-4.29)	(-4.14)	(-4.39)	(-28.31)	(-22.56)	(-27.62)
R^2	0.000	0.190	0.504	0.660	0.003	0.048	0.156	0.248

Note: *Statistically significant at the 10%-level. **Statistically significant at the 5%-level. ***Statistically significant at the 1%-level. Values in parentheses are t-value.

The first impression of these results is that fitness of the model can be largely improved with decrease of family economies of scale. Therefore, if income data is only available at household level, it is necessary to adjust income by family size in inequality analysis.

Then we find that the $GE(2)$ index regression model can generally produce a higher fitness than the Gini index model. Not only R^2 is higher when $GE(2)$ was used, but also we note that the value$t$ of the coefficients of participation in land and off-farm labor market is higher when $GE(2)$ was used. Some of the coefficients (when $GE(2)$ is used and $\delta = 0.8$) are insignificant because our sample size is relatively small. So with a large data set, we can get more favorable results. The reason seems to be that the $GE(2)$ index ranges from 0 to positive infinite, while the Gini index would confine itself within the interval of $[0,1]$. Hence, a linear regression may favor $GE(2)$ index. So the following inferences are based on the results of $GE(2)$ index regression.

We can see that only the coefficient of off-farm labor market imperfection is consistently significant with alternative δ values. A negative value of this coefficient means that an increase in the gap between off-farm wage and shadow price of agricultural labor will reduce income inequality. A possible explanation is that farm households with migrated labor are initially poor before their labor left the agriculture sector (Du et al., 2006). A higher off-farm wage can raise their labor income and narrow the income distance with other farm households.

The impact of the land rental market imperfection on income inequality is insignificant, and the magnitude of the coefficient of land rental market imperfection is only marginal compared to the coefficients of off-farm labor market imperfection. Despite the obvious imperfection in the land rental market, it has insignificant impact on the income distribution, probably due to land rental income only accounts for a small share of total income.

Participation in the land rental market has significant impact on income inequality in the case of $\delta = 1$. A negative value of this coefficient implies that participation in the land rental market may reduce income inequality. We would like to combine the explanation with land rental market imperfection. Given the land rental market imperfection, the more households participate in the land rental market, the more income is transferred from landlord to tenant. This may reduce the inequality of income distribution. Participation in labor migration also leads to an increase in the inequality index.

5.5 Summary and Conclusion

From the decomposition of the income inequality index by its components, we found that the contribution of land rental income to total income distribution is increasing over the observation period. By the results of regression, we found that participation in the land rental market may lead to an increase in income inequality, because the incomplete land rental market will create “winners” and “losers” through the income transfer effect.

As income from the non-agriculture sector becomes increasingly important, the land rental market may be used as a tool to reduce income inequality caused by labor migration and off-farm work, provided that we can remedy land rental market failures.

Empirically we found that in regression analysis of income inequality, $GE(2)$ index could be preferable in terms of model fitness compared to the Gini index, given that$GE(2)$ provides a far more wide range to fit than the Gini index. Other inequality indexes in a generalized entropy family could also possess the same property.

Chapter 6 Land rental market imperfection and participation

6.1 Introduction

China is in the process of transition from a centrally planned economy to a market economy. Developing a functioning land rental market is a crucial aspect of this transition process as it changes the land distribution from administrative reallocation to market based mechanisms. As we examined in the last two chapters, participation in the land rental market can significantly improve land use efficiency and production efficiency of farm households. But inadequate competition in the land rental market and off-farm labor market failure prohibited the potential of the land rental market and exacerbated income inequality in rural Chongqing.

Our desire is to fully explore the potential of the land rental market in promoting rural economic development. So it is necessary to investigate what factors determine farm household participation in the land rental market. On the one hand, some of the farm households who have higher efficiency levels are detached from the land rental market. Identifying the reasons for not participating in the land rental market is a major concern for policy-makers. On the other hand, we consider the imperfect land rental market and the off-farm labor market as possible reasons why some of the most efficient farm households are staying out of the land rental market. It is needed to test this hypothesis empirically.

We have elaborated the theoretical framework in section 3.4. In the following, we describe the explanatory variable in more detail and the data used in this analysis in section 6.2. Section 6.3 presents estimation strategies and results which are followed by discussions and conclusions in section 6.4.

6.2 Variable explanations and data descriptions

6.2.1 Variable explanations

For the sake of presentation, we reproduce the reduced form of the land rental supply and demand function in section 3.4.

$$R_I^* = R_I^*\left(P_y, r, C, w, \bar{D}, M, T, V\right) \tag{6.1}$$

and

$$R_O^* = R_O^*\left(P_y, r, C, w, \bar{D}, M, T, V\right) \tag{6.2}$$

Consider the first order Taylor series expansion for renting in equation (6.1):

$$R_{i,I} = \beta_0 + \left(\frac{\partial R_{i,I}}{\partial P_y}\right)P_y + \left(\frac{\partial R_{i,I}}{\partial r}\right)r + \left(\frac{\partial R_{i,I}}{\partial C}\right)C + \sum_{j=1}^{J}\left(\frac{\partial R_{i,I}}{\partial X_{i,j}}\right)X_{i,j} + \varepsilon_i \tag{6.3}$$

where $X = [X_1, \dots, X_J]$ denotes explanatory variables other than output price, land rent, and transaction costs. Denote $\beta_1 = \partial R_{i,I}/\partial P_y$, $\beta_2 = \partial R_{i,I}/\partial r$, $\beta_3 = \partial R_{i,I}/\partial C$, and $\beta_j = \partial R_{i,I}/\partial X_{i,j}$, it follows that equation (6.3) can be expressed as

$$R_{i,I} = \beta_0 + \beta_1 P_y + \beta_2 r + \beta_3 C + \sum_{j=1}^{J} \beta_j X_{i,j} + \varepsilon_i \qquad (6.4)$$

Following the same manner, we can develop an estimable linear renting out equation from (6.2).

Among the independent variables, P_y is measured with the agricultural output price index by using data from the Chongqing Statistical Year Book, r is measured by the average of land rent in all three villages in each year, while transaction costs in the land rental market are the same as the ones we used before. Additionally, we add transaction costs in the off -farm labor market as an explanatory variable. In terms of land endowment, we use land area per family labor. We do not directly use the monetary value of intermediate input as an explanatory variable in the estimation function because a decision on intermediate input is likely to be made following the land rental transaction. Instead we use family wealth as a proxy for intermediate input since rich families are likely to spend more on intermediate input than poor families. We use non-agricultural assets as a measurement of family wealth. Capital stock of agricultural production is measured in the same way as we did in the production function analysis. Regarding family labor endowment, we group family labor into three groups: age between 17-34, age between 35-54 and age between 55-65. The number of laborers in each group is used as explanatory variables.

We also include experiences and education in regression, because experiences and education affect the quality of labor and then impact the marginal product of land, which in turn affects the land rental decisions of farm households. In this study we use the age of household heads and years of schooling as a proxy for experience and education.

In the estimation we use the multinominal Logit model to study the “if or not” decision (the options are renting land, renting out land, or refraining from participating in the land rental market), and the Tobit model to analyze the second “how much” decision (how much land is rented or rented out). Testing if land rental market imperfection and off-farm labor market imperfection have an impact on the land rental decision of farm households can be conducted by post-estimation tests if the corresponding coefficients are zero.

6.2.2 Data descriptions

In the research area 60.4% of farm households participate in the land rental market either by renting or renting out land (see table 6.1). The participation rate, however, differs among villages. In village 1 the participation rate is the lowest (48%) and rented land area per farm household is lower than the average rented out land area. Village 2 has the highest participation rate and the same participation pattern as village 1. In village 3, the participation rate is relatively high, and the average farm household is renting more land than it is renting out.

Table 6.1 Summary of land rental market participation

	Overall		Xiehe		Changshui		Tianba	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Share of households participate in land rental market (%)	60.40		48.00		68.62		64.41	
Rented land area per household (mu)	0.98	2.40	0.16	0.86	0.46	2.17	2.45	3.06
Rented out land area per household (mu)	0.50	0.93	0.59	0.94	0.79	1.12	0.08	0.39
Average operational farm size (mu)	3.61	3.49	1.38	1.41	2.80	2.67	7.02	3.36
Land endowment per households (mu)	3.30	1.84	1.78	0.93	3.08	1.15	4.54	1.88

Data source: RCRE

Participation status of farm households in the land rental market is fairly persistent as we can observe in table 6.2. 72.57% of the observed non-participants do not participate for two periods in a row. For farm households who rented land for one period, 75.49% remained renting land for the next period. And for farm households who rented out land for one period, 75.53% remained renting out land for the next period.

Table 6.2 Transition probabilities of land rental market participation

	Non-participants	Rent in	Rent out	Total
Non-participants	208(72.47)	31(10.8)	48(16.72)	287(100)
Rent	33(16.18)	154(75.49)	17(8.33)	204(100)
Rent out	28(14.89)	18(9.57)	142(75.53)	188(100)
Total	269(39.62)	203(29.9)	207(30.49)	679(100)

Note: figures in parentheses refer to percentage. Data source: RCRE

We describe variables that will be used to study farm household decisions of participation in the land rental market in table 6.3. These variables include household factor endowments, household characteristics, and conditions of the land rental market and off-farm labor market. On average, a household has 3.8 members. The average family size differs among the villages. The village Tianba has the largest family size. On average one farm household has 4.6 members. This number is 3.6 and 3.1 in Changshui and Xiehe respectively. Household head age in the village Xiehe is higher than in the other two villages, but the household head educational level is the lowest in Xiehe on average.

Agricultural assets are measured by the sum of the monetary value of agricultural tools, equipment and facilities. We do not have direct measures for non-agricultural assets of farm households. Instead, we use annual consumption as a proxy for non-agricultural assets of farm households. All monetary values are converted to 2004 prices by using the price index for agricultural production and the consumer price index respectively.

Table 6.3 Description of Farm Households and Village Characteristics

	Overall		Xiehe		Changshui		Tianba	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
HH population 17-34 years	0.86	0.92	0.72	0.82	0.81	0.87	1.08	1.02
HH population 35-54	1.09	0.91	0.98	0.89	0.91	0.94	1.39	0.84
HH population 55-65	0.53	0.76	0.52	0.75	0.56	0.81	0.5	0.72
family size	3.76	1.41	3.13	1.18	3.62	1.3	4.64	1.31
Age of HH head	49.88	16.91	53.57	12.9	49.64	23.34	46	10.51
Year of schooling of HH head	6.19	2.43	5.27	2.74	6.5	2.14	6.89	2
Agricultural assets (Yuan)	1676.61	1927.26	502.4	901.22	2630.72	2353.35	1960.7	1545.86
Non-agricultural assets (Yuan)	8832.81	11674.96	6996.95	4455.66	5296.83	3663.62	14758.35	18708.15
Land labor ratio (mu/labor)	1.30	0.84	0.82	0.49	1.43	0.74	1.7	0.99
Share of migrated labor (%)	31.90		47.91		24.11		23.68	
Off farm wage (Yuan)	21.86	6.37	16.66	3.66	26.34	5.23	22.58	6.34
Div_land (Yuan)	224.59	92.66	188.66	75.63	209.05	83.2	276.06	107.4
Div_labor (Yuan)	13.63	3.45	13.39	2.14	16.12	0.35	11.37	4.7

Data source: RCRE

The land labor ratio is measured by land endowment divided by the number of laborers on farm households. On average, each laborer owns 1.3 mu land in the research area. Land endowment is relatively strong in the village Tianba with each laborer owning 1.7 mu of land. The village Xiehe has the lowest land labor ratio with 0.82.

On average 31.9% of laborers are employed in the off-farm sector. The village Xiehe has the highest off-farm labor market participation (47.91%), followed by Changshui (24.11%) and Tianba (23.68%). On average, an off-farm worker earns 21.86 Yuan per labor-day. Return to off-farm labor differs among the villages. Off-farm laborers earn 16.66, 26.34, and 22.58Yuan per day in Xiehe, Changshui, and Tianba respectively. *Div_land* and *Div_labor* denote transaction costs in the land rental market and off-farm labor market respectively.

6.3 Empirical results

First we show the results of the analysis of factors which determine whether farm households will participate in the land rental market. As we have used a panel data set, the problem of data attrition is examined first. Following Greene (2012), we use the entire sample of data to estimate a pooled multinomial Logit model. We add $WAVE$ to the pooled model, where $WAVE$ is the number of waves at which the individual is present. Significant coefficient of $WAVE$ means the null hypothesis of missing at random can be rejected. Regression results are listed in table 6.4. The results show that at least for renting land decisions, data attrition is a problem. Then we use impute probability weight to correct the data attrition problem.

Table 6.4 Results of pooled multinomial Logit model

	Rent in		Rent out	
Variables	Coef.	Std.	Coef.	Std.
HH population 17-34 years	-0.520***	0.126	-0.189	0.127
HH population 35-54	-0.124	0.169	-0.077	0.144
HH population 55-65	0.170	0.182	-0.167	0.151
Age of HH's head	-0.008	0.010	0.000	0.006
Year of schooling of HH's head	-0.013	0.046	0.057	0.039
Land labor ratio	-1.071***	0.172	-0.018	0.131
Output price index	-0.021*	0.010	0.031***	0.010
Agricultural assets (Yuan)	0.321***	0.054	-0.094***	0.036
Non-agricultural assets (Yuan)	0.889***	0.179	0.089	0.143
Land rent	-0.004*	0.002	0.006***	0.002
Off-farm wage (Yuan)	0.017	0.021	0.027	0.025
Div_land (Yuan)	-0.003**	0.001	-0.002	0.001
Div_labor (Yuan)	-0.152***	0.043	0.341***	0.067
Share of migrated labor (%)	-7.590***	1.354	2.991**	1.337
Wave	-0.176**	0.081	-0.081	0.101
_cons	1.063	2.197	-11.212***	2.072
Pseudo R2=0.231				
Log likelihood = -717.955 LR chi2(30) = 430.03				

Note: *Statistically significant at the 10%-level. **Statistically significant at the 5%-level. ***Statistically significant at the 1%-level.

After inverse probability weights were imputed, we use a mixed effects multinomial logistic model to study choices of farm households. The Hausman test for the random effect model versus fixed effect model is replaced by a more general latent response model

$$y_{is}^{*} = \beta_{s}^{'} x_{i} + \eta_{i} + \varepsilon_{is} \qquad (6.5)$$

where η_i is latent variables, $s = 1,2, \dots, S$ is unordered categories. Response s is chosen

$$y_i = y_{is}$$

if $y_{is}^{*} > y_{ik}^{*}, \forall k, k \neq s$. η_i represents individual heterogeneities and may correlate with $\mathbf{x}_i$. Mundlak's (1978) approach uses the mean of $\mathbf{x}_i$toaccount for the correlation between $\mathbf{x}_i$and η_i (note that the mean of time-varying variables is included). Let $\bar{\mathbf{x}}_i$ denote the mean of time varying covariates. We can specify the latent variables as

$$\eta_i = \alpha + \gamma^{'} \bar{x}_i + \xi_i \qquad (6.6)$$

One way to estimate model (6.5) and (6.6) is to substitute (6.6) with (6.5) and use the multinomial Logit model for the estimation only with one latent variable $\xi_i$which is orthogonal to $\mathbf{x}$. Simulated maximum likelihood estimation can be employed to estimate this model as in Carter and Yao (2002). Another approach would be to treat functions in (6.6) as structural equations, combined with (6.5), and the overall model can be estimated by methods used in the structural equations model, which usually is a maximum likelihood estimation (Rabe-Hesketh et al., 2004). There is no theoretical criterion to discriminate against one approach to the advantage of the other. But from a practical point of view, the latter is preferred because there are well-established commands in Stata to perform a structural equations model. In Stata we can estimate the structural equations model by using *gllamm* command which is a user developed program (*gllamm* stands for Generalized Linear Latent And Mixed Models), or by using *gsem* command which is a new feature of Stata 13 (*gsem* stands for Generalized Structural Equations Model).

Nonzero of $\boldsymbol{\gamma}$ indicates evidence against the random effect model. The test statistics is $H' = \hat{\gamma}'[Est.Asy.Var(\hat{\gamma})]^{-1}\hat{\gamma}$ which has a chi square distribution. First we test the assumption of the random effect model. The value of H' is 29.1088, which is larger than the critical value of chi squared distribution at 5% level of significance with eleven degrees of freedom, 21.026. Therefore, the random effect model assumption is rejected. Results of the multinomial Logit model were presented in table 6.5. Farm households do not participate in the land rental market and are chosen as base outcome.

The estimated variance of the random effect is 3.06, which means the standard deviation is 1.75. Thus a 1 standard deviation change in the random effect amounts to a $\exp(1.75) = 5.75$ change in the relative risk ratio.

In terms of the demographic structure, farm households with more members in the age group between 17-34 and with a well-educated household head are more likely to stay away from the land rental market than to rent land.

As expected, the land labor ratio has significant impact on rental decisions of farm households. Farm households which have a higher land labor ratio are more likely to stay away from the land rental market than to rent land. It therefore seems unlikely that land is transferred to land-rich farm households in the land rental market. This means there is only a low probability that the market mechanism of land reallocation leads to a concentration of land. The coefficient of the land labor ratio in the rent out equation, however, is insignificant.

Farm households with more agricultural assets and non-agricultural assets are more likely to rent land than to not participate in the land rental market. The coefficient of land rent is significant in the renting out equation and is positive. These results are in line with our expectations.

At this point it should be noted that significance and magnitude of coefficients in the renting equation and renting out equation are asymmetric. Especially the coefficients of the household population between 17-34 years, years of schooling of household head, land labor ratio, agricultural assets, non-agricultural assets, and land rent. One possible explanation is that these variables differ greatly between rented farm households and farm households that do not participate, but differ less between rented out farm households and farm households that do not participate.

Table 6.5 Estimated Multinomial Logit model

Variables	Rent in Coefficients	Rent in Std	Rent out Coefficients	Rent out Std
HH population 17-34 years	-0.550**	0.236	-0.223	0.230
HH population 35-54	-0.115	0.290	-0.025	0.275
HH population 55-65	0.150	0.309	-0.043	0.294
Age of HH's head	0.015	0.017	0.017	0.016
Year of schooling of HH's head	-0.122*	0.067	-0.059	0.061
Land labor ratio	-1.300***	0.269	-0.139	0.231
Output price index	-0.030**	0.013	0.021	0.013
Log of Agricultural assets (Yuan)	0.353***	0.079	-0.058	0.066
Log of Non-agricultural assets (Yuan)	0.760***	0.253	-0.058	0.211
Land rent	0.000	0.003	0.008***	0.003
Off-farm wage (Yuan/Day)	-0.024	0.027	-0.010	0.031
Div_land (Yuan)	0.000	0.002	0.000	0.002
Div_labor (Yuan)	-0.168***	0.058	0.347***	0.086
Share of migrated labor (%)	-1.324	2.136	9.654***	2.128
Cons	12.150	10.874	0.552	10.860
Group means	**Coefficients**		**Std**	
Variance of random effect	3.060		0.759	
HH population 17-34 years	-0.153		0.328	
HH population 35-54	0.005		0.428	
HH population 55-65	0.186		0.470	
Age of HH's head	-0.031		0.023	
Output price index	-0.110		0.074	
Agricultural assets (Yuan)	-0.141		0.116	
Non-agricultural assets (Yuan)	0.620		0.497	
Land rent (Yuan)	-0.035**		0.025	
Off-farm wage (Yuan)	0.715		0.300	
Div_land (Yuan)	-0.016		0.010	
Div_labor (Yuan)	-0.660		0.330	
Share of migrated labor (%)	5.837		8.955	

Note: *Statistically significant at the 10%-level. **Statistically significant at the-5% level. ***Statistically significant at the 1% level.

Output price changes only affect renting decisions significantly, which may imply that farm households who rent land are more sensitive to changes of the output price, given that many farm households rent out land at zero explicit costs.

The off-farm labor market has an important effect on farm household participation in the land rental market. Note that off-farm work wage has no significant impact on renting decisions, but *div_labor*, the difference between off farm work wage and shadow price of labor, does affect renting and renting out land. If the marginal product of agricultural labor is kept constant, rising off-farm work wages make farm households more likely to rent out land instead of renting land.

We use the share of migrated laborers in the village as an indicator of farm household decisions of participation in the off-farm labor market. It has a significant effect on farm households' decisions to rent out land: the more likely farm households participate in off-farm labor market, the more likely they rent out land.

In the following, we present the results of the Tobit model. We estimate the land area that is rented and the land area that is rented out separately. The "rent" estimation used the whole sample with positive values for the rented land area and zero otherwise. The "rent out" estimation set the land area rented out as positive and zero for other observations.

Table 6.6 Estimation of the Tobit model

	Rent		Rent out	
	Coefficient	Std	Coefficient	Std
HH population 17-34 years	-0.617	0.402	-0.079	0.129
HH population 35-54	-0.203	0.490	-0.120	0.149
HH population 55-65	-0.215	0.521	-0.161	0.186
Age of HH's head	0.009	0.036	0.003	0.003
Years of schooling of HH's head	0.025	0.118	-0.050	0.033
Land labor ratio	-1.691***	0.427	0.213	0.151
Output price index	0.004	0.020	-0.009**	0.004
Log of Agricultural assets (Yuan)	0.553***	0.153	-0.063*	0.034
Log of Non-agricultural assets (Yuan)	1.500***	0.407	-0.221**	0.104
Land rent (Yuan)	-0.006	0.005	0.015***	0.002
Off-farm wage (Yuan/Day)	0.008	0.044	-0.002	0.016
Div_land (Yuan)	-0.005	0.003	0.003***	0.001
Div_labor (Yuan)	-0.108	0.075	0.099**	0.049
Share of migrated labor (%)	-6.325	4.495	7.139***	1.068
Group means				
HH population 17-34 years	-0.182	0.555	0.081	0.262
HH population 35-54	0.400	0.767	-0.018	0.297
HH population 55-65	0.438	0.838	0.263	0.323
Age of HH's head	-0.010	0.043	-0.008	0.015
Output price index	-0.164*	0.085	0.003	0.096
Agricultural assets (Yuan)	-0.007	0.242	-0.124*	0.074
Non-agricultural assets (Yuan)	-0.901	0.831	1.390***	0.367
Land rent (Yuan)	0.050	0.039	-0.068***	0.024
Off farm wage (Yuan)	0.085	0.273	0.674*	0.354
Div_land (Yuan)	0.019	0.019	-0.017**	0.007
Div_labor (Yuan)	-0.352	0.382	-0.164	0.334
Share of migrated labor (%)	-5.791	9.195	12.140	10.911
Constant	11.789	18.012	-17.553	8.690
/sigma_u	2.661***	0.297	1.268***	0.126
/sigma_e	3.111***	0.159	1.024***	0.055
Rho	0.422	0.060	0.605	0.053

Note: *Statistically significant at the 10% level. **Statistically significant at the 5% level.
***Statistically significant at the 1% level.

We use the Tobit estimator in this estimation. Results of the Tobit estimation were presented in table 6.6.

Results show that participation in the off-farm labor market tends to increase the prediction for the rented out land area. *div_labor* only affects the predicted rented out land area significantly. The leveling effect of the land rental market on operational farm size among farm households in renting can easily be observed with the help of the Tobit model. For an increase of one unit in the land labor ratio, there is a 1.69 *mu* decrease in the predicted value of land rent in the area.

Both agricultural and non-agricultural asset possession have positive contributions on the predicted value of land rent in the area. For the rented out land area, farm households with more agricultural assets and non-agricultural assets tend to rent less land out.

Div_land has a significantly positive effect on rented out land area, while the long-term effects of land rental market imperfection on renting out land area are negative and the magnitude is larger (see the coefficient of *div_land* in the group mean in the renting out equation). A mix of these two effects might show that *div_land* negatively affects the land rent out area.

We further conduct a simulation analysis about how changes in the output price and participation in the off-farm labor market affect the participation in the land rental market in a partial equilibrium framework in a closed economy (no international capital flows to the land rental market in China). By using data from the *China Rural Fixed Observation Point: Survey Summary,* we find that the calibrated average annual growth rate of rural labor migration from 2000 to 2009 was 1.06%. The agricultural output price index is estimated to grow annually at 6.1% from 2000 to 2011 by using data from the China Statistic Yearbook.

Table 6.7 Simulation of the effects of changes of labor migration and of the output price for land rental market participation

Simulation results	t=0	t=1	t=2	t=3	t=4	t=5
Probability of renting	0.284	0.222	0.166	0.119	0.081	0.052
Probability of renting out	0.282	0.345	0.414	0.486	0.560	0.632
Probability of not participating	0.434	0.433	0.420	0.395	0.359	0.316
Predicted rent area (mu)	1.931	1.922	1.914	1.906	1.899	1.892
Predicted rent out area (mu)	0.624	0.624	0.624	0.623	0.620	0.616
Simulated demand and supply by representative farm household (probability of rent or rent out times predicted rent or rent out area)						
Demand (mu)	0.548	0.427	0.318	0.226	0.153	0.099
Supply (mu)	0.176	0.215	0.258	0.303	0.347	0.389
Land rental market equilibrium						
Demand=Supply (mu)	0.224	0.221	0.213	0.200	0.179	0.153
Equilibrium land rent (Yuan)	485.992	400.731	311.153	218.375	122.075	21.992

The simulation results for changes of the agricultural output price and participation in the off-farm labor market are reported in table

6.7. The predicted participation rate from the multinomial Logit model shows that the probability of farm household participation in the land rental market has increased with changes of output prices and perception of labor migration. In terms of participation in the land rental market, farm households are far more likely to rent out land than rent land. Combined with the results of the Tobit model simulation, we predict that there will be more land rented out than rented if other factors are not changed. That means that the land rental market supply will exceed demand and equilibrium land rent would be very low as it is shown in the bottom of table 6.7.

This context implies low land use efficiency. To improve land use efficiency, it is necessary to introduce “outsiders” to the local land rental market, as we have seen that the land rental market is constrained within the village. Outsiders like farmers from other villages and agricultural enterprises may generate sufficient demand for the local land rental market and promote land rental market development and land use efficiency. Indeed, there were agricultural enterprises involved in large scale land transfer in Chongqing for the production of Chinese red pepper, oranges, and lotus root. And the rent paid by agricultural enterprises is more likely higher than the rent paid by farmer (Zhang, 2010).

6.4 Concluding remarks

We found that variables like the land labor ratio, agricultural assets, non-agricultural assets, participation in the off-farm labor market, land rental market imperfection and off-farm labor market imperfection all have significant impacts on farm household decisions concerning the participation in the land rental market. But all these factors work differently for tenants and for landlords. Changes in these variables will promote the participation of one side of the land rental market, while restraining another side from participating.

One of the consequences of these observed processes could be land concentration in agricultural production, not only in the hand of farmers, but also in the hand of agricultural enterprises. But these two groups of actors have their own difficulties in renting land. Financial market constraints and output market volatility can be obstacles for small farm households to rent (most Chinese farm households are initially small). For agricultural enterprises, transaction costs in dealing with an enormous amount of small farm households could be the major challenge.

Finally we would like to emphasize the importance of linkage between the land rental market and the off-farm labor market. As we already know from the above empirical study, the participation rate of rural labor in the off-farm work and off-farm labor market imperfection have a significant impact on the probability of participation in the land rental market and on the predicted renting area of farm households. A well-functioning land rental market cannot be developed without a well-functioning off-farm labor market. Thus, further reforms which intend to improve the performance of the land rental market should not only focus on the market itself, but also on the related off-farm labor market.

Chapter 7 Conclusions

In November 2013, the *Third Plenum of the 18th Chinese Communist Party Congress* convened. On this occasion, the party announced several reform plans which included assigning more property rights to famers. However, land ownership was still not mentioned. This reluctance is not necessarily surprising, given that many local governments in China are heavily indebted and rely on land as their major source of revenue.

Although only the use right of land is in the hand of farmers, the land rental market can be developed. How does such a land rental market affect the rural economic development?

From a historical perspective, the relationship between the land rental market and agricultural productivity is obscure. The emergence and spread of permanent tenancy might increase the incentives for tenants to decide for long-term investments in land, but at the same time decrease the incentives for landlords to invest. Data pertaining to the provincial level data during the period of the Republic of China may demonstrate a positive correlation between agricultural productivity and share of land rental, but we cannot be certain about it unless we can control other possible factors which may affect contemporary productivity and land rental participation.

With free access to the land rental market in the Republic of China, the land rental market was not benefitting the poor as land was transferred from small stakeholders to larger stakeholders. This reminds us of the importance of developing a well-functioning rural credit market and insurance market which can smooth consumption fluctuation of poor farmers and enable them get loans for production. But as we have discussed in chapter 2, whether poor farm households gain or lose from renting out land depends on whether land can be evaluated correctly and whether they rent out land due to shift of occupation from agriculture to non-agricultural sectors.

As discussed in chapter 3 the farm household model is the basic tool enabling us to study the impact of decisions pertaining to land rental market participation, agricultural productivity and income distribution, as well as factors affecting market participation. To investigate the impact of land rental market participation on agricultural productivity, we developed two alternative hypotheses: participation in the land rental market can improve agricultural productivity by transferring land from less efficient farmers to more efficient farmers; participation in the land rental market may also impair the agricultural productivity due to more efficient farmers renting out land in order to work off-farm. But the overall welfare may as well be improved by more efficient use of labor. Examining the land rental market and income distribution, we have emphasized the income diversifying effect of off-farm labor market participation and land rental market incompleteness on income inequality. In the analysis of factors affecting land rental market participation, off-farm labor market participation is the primary concern. Furthermore, we have discussed the endogenous relationship between agricultural productivity and evolvement of the land rental market and its implication for empirical analysis.

Building upon this theoretical approach, this study has provided a quantitative analysis using data from rural Chongqing. Our study shows that participating in the land rental market does lead to improvements of land use efficiency by transferring land from less efficient farm households to more efficient farm households. But market informational asymmetry, opportunism, and transaction costs may prevent the land rental market to fully realize its potential in promoting land use efficiency given that a significant share of efficient farm households are stay outside the market. In terms of production efficiency for a specific farm household, participation in the land rental market has not significant impact on the efficiency level of farm households. This may suggest that in a less competitive land rental market where most explicit land rents are zero, incentives for farm households to improve their farm management level are low.

We found that some of the more efficient farm households indeed rent out land and engage in off-farm work, but the share of this kind of farm households is small. It may suggest that both hypotheses are true. However, more efficient farm households are more likely to rent land instead of renting land out, which strongly indicates an efficiency enhancing effect of the land rental market.

In the analysis of the land rental market and income inequality, we show that contribution of income from land rental activities to overall income inequality has grown over time and participation in the land rental market also raises income inequality, presuming an incomplete land rental market. As more farm households leave the agricultural market and join the off-farm labor market, distributional effects of the land rental market generates bias; the imperfect land rental market creates “winners” and “losers” due to marginal returns to land is significantly higher than observed land rent.

Overall, the land rental market has a positive effect on land use efficiency, but the incomplete market environment impedes releasing the potential of the land rental market and contaminates the distribution effect of the land rental market.

Regarding factors that impact land rental market participation, we discovered an equalization effect of the land rental market on the distribution of land, but its most pronounced influence pertains to the off-farm labor market. So as changes in off farm work market, we expect that farm households are more likely to rent out land and less likely to rent in land, which lead to a low equilibrium land rent in a closed economy.

Therefore, to release the potential of the land rental market in promote agricultural production efficiency, to reverse the effect of the land rental participation on income distribution, and to avoid inefficient use of land, policies should focus on the following aspects:

We suggest that informational asymmetry might be the reason why some of the more efficient farm households refrained from land rental market. So policies should be interested in reduce informational asymmetry. Enactment of *Rural Land Contract Law* is a good start, but this law is not well enforced. In spite of Rural Land Contract Law requires that a land rental transaction should call for a written contract, oral contract still dominating in the area of research. A written contract of land rental transaction could assign the rights and liabilities between landlord and tenant, therefore an enforceable written contract should reduce informational asymmetry. Therefore government should strengthen the implementation of *Rural Land Contract Law*.

Another source of informational asymmetry might be inconvenient accessibility of land rental information. That might be the reason why most land rental partners are acquaintances in the area of research. Given the development of information technology, the accessibility of information has greatly improved. Spread land rental information through internet could be an efficiency way to increase accessibility to land rental market. But for rural people it might be difficult to get the resource to access to internet, and hence, to the information of land rental. So it might be more applicable to find someone to be the intermediary between potential landlord and tenant. In this case, village cadres could be a candidate.

We mentioned that risks from off farm labor market might be a reason why oral contract be preferred. Therefore, policies intend to reduce information asymmetry should also focus on reform in off farm labor market. The reform should include registering migrated laborers in the cities they moved in and enjoy the social security system. So the incentive of migrated landlord to make informal contract can be reduced. However, this suggestion might be unpractical for two reasons. One is that the registered residents of the city may fear that this reform can compromise their social welfare. Or the city's government may against this reform for it increase the financial burden to the city.

It is also important to improve the tenure security for farm households. Even though we said farm households in China enjoy a relatively secure land use right, it is not total secure, mainly because of government expropriation. As long as government has the exclusive right to change land use type, attempts to restrict government appropriation could be useless. Without a doubt, deprive this exclusive right of government is a big challenge. But increase the compensation to farmers who land was expropriated could be an effective way to reduce government incentive to expropriate land, because it reduce the revenue government can obtain from land appropriation.

Is land privatization going to be an option of reforms? Like we discussed previously, it depends on the reforms in other area. For example, build a fully covered social security system so that land no longer needs to be used as a social security system; reform agricultural input and output markets and rural credit system so that land can be correctly evaluated and monetized; rural insurances market also need to be reformed so that farmers can avoid selling land due to unexpected shocks, and so on. If land privatization was included in the bundle of reforms, it should not be implemented unless other reforms have been implemented.

Future researches can be extended to the following points. Firstly, from the estimation of efficiency function we find that farm size is positively correlated with technical efficiency level of farm households. But the relation between farm size and productivity still unclear, for technical efficiency only account for a part of productivity. Then further research should be extended to identify whether there is an “inverse relationship” between farm size and productivity. We predict that as development of land rental market and off farm labor market, farm size will increase. So it is significant to find out the effect of increase in farm size.

Secondly, in China government officers' promotion is closely related to economic growth of the region they governed (Xu and Wang, 2010). This promotion mechanism provides strong incentive for local government to expropriate agricultural land for development (Zhang et al., 2011). It will be interesting to look into the economic growth if government give up its exclusive rights to change land use type and how this going to affect poorer.

Finally, in stochastic frontier analysis, we use two step procedures to estimate stochastic frontier production function and efficiency function separately in order to keep the assumption that technical efficiency consist of persistent part and time varying part. Further studies should investigate how to maintain this assumption and avoid estimation bias due to two step procedures in the meantime.

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Appendix

Appendix I: Bayesian inference of stochastic frontier model

1. The likelihood function

A stochastic production frontier includes time variant and invariant technical inefficiency can be represented as follows:

$$y_{it} = f(x_{it};\boldsymbol{\beta}) + \alpha_i + v_{it} - u_{it} - z_i \qquad \text{(A1)}$$
$$\alpha_i \sim i.i.d.\, N(0,\sigma_\alpha^2)$$
$$v_{it} \sim i.i.d.\, N(0,\sigma_v^2)$$
$$u_{it} \sim i.i.d.\, G(1,\eta_t)$$
$$z_i \sim i.i.d.\, G(1,\gamma)$$

where $\alpha_i (i = 1, \ldots, N)$ represents firm effect, v_{it} denotes stochastic error which contain measurement error and external shocks, z_i denotes persistent inefficiency of firm i and has a gamma distribution with parameter γ, and u_{it} is time varying inefficiency of firm i and has a gamma distribution at time t with parameter η_t. We assume these distributions independent of one another. This is the generalized true random effect model (GTRE) specified in Tsionas and Kumbhakar (2012), whereas we consider different distribution assumption about inefficiency terms. That is we assume the inefficiency terms were distributed exponentially, because exponential distribution assumption about the one side error was proved to be stable to prior change (van den Broeck, et al., 1994).

To improve the efficiency of exploration of conditional posterior distribution of Gibbs sampler, Tsionas and Kumbhakar (2012) developed two re-parameterizations[24]. In this study we follow their ξ -Parametrization which is to denote $\varepsilon_{it} = \alpha_i + v_{it}$, then $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$, where $\sigma_\varepsilon^2 = \sigma_v^2 + \sigma_\alpha^2$. Let $h = 1/\sigma_\varepsilon^2$, then $\varepsilon_{it} \sim N(0, 1/h)$.

Then we have the stochastic frontier production function of the form:

$$\boldsymbol{y_i} = f(\boldsymbol{x_i}; \boldsymbol{\beta}) + \boldsymbol{\varepsilon_i} - \boldsymbol{u}_i - z_i \boldsymbol{\iota}_T$$

where $\boldsymbol{y_i} = (y_{i,t=T}, \dots, y_{i,t=T})'$, and $\boldsymbol{\varepsilon_i} = (\varepsilon_{i,t=1}, \dots, \varepsilon_{i,t=T})'$ implying $\boldsymbol{\varepsilon_i}$ has a multivariate normal distribution with mean $\boldsymbol{0_T}$ and covariance matrix $h^{-1} I_T$. $\boldsymbol{u}_i = (u_{i,t=T}, \dots, u_{i,t=T})'$, and $\boldsymbol{\iota}_T$ is a $1 \times \mathrm{T}$ vector of 1. The likelihood function is given by

$$\mathrm{p}(y|\beta, X, h, u, z) = \prod_{i=1}^{N} \left(\frac{h}{2\pi}\right)^{\frac{T}{2}} \left\{exp\left[-\frac{h}{2}(y_i - f(x_i; \beta) + u_i + z_i \iota_T)'(y_i - f(x_i; \beta) + u_i + z_i \iota_T)\right]\right\} \quad \text{(A2)}$$

2. The hierarchical prior

For the inefficiencies, we use a hierarchical prior. As we already shown in equation (1), u_{it} and z_i are assumed to have an exponential distribution. The hierarchical prior implies that we

[24] α_i and z_i are both time invariant, therefore in MCMC scheme it's hard to distinguish α_i and z_i because they are correlated. Re-parameterization was used to group correlated variables and remove this correlation in MCMC process (refer toTsionas and Kumbhakar (2012) for detail).

trate $\eta_t$andγ as parameters which need their own priors. Because in exponential distribution the parameters η_t and γ are supposed to be positive, we assume a two parameter Gamma distribution for η_t and γ repectively,

$$\gamma \sim G(\underline{c}, \underline{p})$$

$$\eta_t \sim G\left(\underline{f_t}, \underline{r_t}\right), for\ t = 1, \ldots, T$$

where $\underline{c}$ and $\underline{f_t}$ are shape parameters and $\underline{p}$ and $\underline{r_t}$ are rate parameters. The values of these hyper-parameters are determined by researchers before estimation which reflect prior information about parameters and can be determined by considering efficiency distribution.

The prior assumption of $\boldsymbol{\beta}$ should incorporate regularity conditions: homogeneity, monotonicity and concavity. Without prior information about monotonicity and concavity, we use a non-informative prior for $\boldsymbol{\beta}$:

$$\boldsymbol{\beta} \sim 1(\boldsymbol{\beta} \in M)$$

where $1(\boldsymbol{\beta} \in M)$ is an indicator function equals 1 if the parameter vector $\boldsymbol{\beta}$ in the set defined by monotonic and concave conditions or 0 otherwise. Note that we have implemented homogenous condition by normalization.

For the parameter error precision h we assume it has a two parameter Gamma prior:

$$h \sim G(\underline{s}, \underline{q})$$

where $\underline{s}$ is shape parameter and $\underline{q}$ is rate parameter.

3. The posterior density function

By using Bayes' rule, the full posterior density distribution with data augmentation is given by

$$p(\boldsymbol{\beta}, h, \boldsymbol{u}, \boldsymbol{z}, \gamma, \boldsymbol{\eta} | y, \boldsymbol{X}) \propto \left[\prod_{i=1}^{N} p(\boldsymbol{y_i} | \boldsymbol{\beta}, \boldsymbol{X_i}, h, \boldsymbol{u}_i, z_i) p(\boldsymbol{u_i} | 1, \boldsymbol{\eta})\, p(z_i | 1, \gamma)\right] p(\gamma) p(\boldsymbol{\beta}) p(h) \prod_{t=1}^{T} p(\eta_t)$$

More explicitly,

$$p(\boldsymbol{\beta}, h, \boldsymbol{u}, \boldsymbol{z}, \gamma, \boldsymbol{\eta} | y, \boldsymbol{X}) \propto \prod_{i=1}^{N} \frac{h^{\frac{T}{2}}}{(2\pi)^{\frac{T}{2}}} \left\{ \exp\left[-\frac{h}{2} \left(\boldsymbol{y_i} - \boldsymbol{X}_i \boldsymbol{\beta} + \boldsymbol{u}_i + z_i \boldsymbol{\iota}_T \right)' \left(\boldsymbol{y_i} - \boldsymbol{X}_i \boldsymbol{\beta} + \boldsymbol{u}_i + z_i \boldsymbol{\iota}_T \right) \right] \right\}$$

$$\left\{ \prod_{t=1}^{T} \eta_t \times \exp(-\eta_t u_{it}) \right\} \{ \gamma \times \exp(-\gamma z_i) \} (\gamma)^{\underline{c}-1} \exp(-\underline{p}\gamma) h^{\underline{s}-1} \exp(-h\underline{q})$$

$$1(\boldsymbol{\beta} \in M_i) \prod_{t=1}^{T} \left\{ (\eta_t)^{\underline{f_t}-1} \exp\left(\underline{r_t}\, \eta_t \right) \right\}$$

Our Bayesian posterior inference is based on Metropolis-within-Gibbs sampling with data augmentation. All we need to do is to formulate the full posterior conditional distributions.

For the parameter in translog production function, we get

$$\boldsymbol{\beta} | h, \boldsymbol{u}, \boldsymbol{z}, \gamma, \boldsymbol{\eta} \sim \boldsymbol{N}(\overline{\boldsymbol{\beta}}, \overline{\boldsymbol{V}}) 1(\boldsymbol{\beta} \in M) \qquad \text{(A3)}$$

where

$$\overline{\boldsymbol{V}} = \left(h \sum_{i=1}^{N} \boldsymbol{X}_i' \boldsymbol{X}_i \right)^{-1}$$

and

$$\overline{\boldsymbol{\beta}} = \left(\sum_{i=1}^{N} \boldsymbol{X}_i' \boldsymbol{X}_i\right)^{-1} \left(\sum_{i=1}^{N} \boldsymbol{X}_i' \left[\boldsymbol{y}_i + \boldsymbol{u}_i + z_i \boldsymbol{\iota}_T\right]\right)$$

For the error precision *h*, we have

$h|\boldsymbol{\beta}, \boldsymbol{u}, \boldsymbol{z}, \gamma, \boldsymbol{\eta} \sim G(\overline{s}, \overline{q})$ (A4)

where

$$\overline{s} = \frac{NT}{2} + \underline{s}$$

and

$$\overline{q} = \frac{\sum_{i=1}^{N}(\boldsymbol{y}_i - \boldsymbol{X}_i\boldsymbol{\beta} + \boldsymbol{u}_i + z_i\boldsymbol{\iota}_T)'(\boldsymbol{y}_i - \boldsymbol{X}_i\boldsymbol{\beta} + \boldsymbol{u}_i + z_i\boldsymbol{\iota}_T)}{2} + \underline{q}$$

The conditional posterior distribution for $\boldsymbol{u}_i$, the time varying inefficiencies, are independent random vectors for $i \neq j; i, j = 1, \ldots, N$, its posterior p.d.f given by

$p(u_{it}|\boldsymbol{\beta}, h, \boldsymbol{z}, \gamma, \boldsymbol{\eta}) \propto f_N(X_{it}\beta - y_{it} - z_i - \eta_t/h\, , 1/h)1(u_{it} \geq 0)$ (A5)

where $1(u_{it} \geq 0)$ is an indicator function equals to 1 if $u_{it} \geq 0$ is satisfied and 0 otherwise.

The conditional posterior distribution of z_i, with independent assumption for $i \neq j (i, j = 1, \ldots, N)$, has the truncated normal form

$p(z_i|\boldsymbol{\beta}, h, \boldsymbol{u}, \boldsymbol{z}_{-i}, \gamma, \boldsymbol{\eta}) \propto f_N\left(\overline{X}_i\beta - \overline{y}_i - \overline{u}_i - \gamma/Th\, , 1/Th\right)1(z_i \geq 0)$

(A6)

where $1(z_i \geq 0)$ is an indicator function equals to 1 if $z_i \geq 0$ is satisfied and 0 otherwise. $\overline{X}_i$ is a $1 \times k$ vector which containing the average value of each independent variable for individual i, $\overline{u}_i = T^{-1}\sum_{t=1}^{T} u_{it}$ and $\overline{y}_i = T^{-1}\sum_{t=1}^{T} y_{it}$.

The posterior conditional distribution of γ has a Gamma form

$$p(\gamma|\boldsymbol{\beta}, h, \boldsymbol{\theta}, \boldsymbol{z}, \gamma, \boldsymbol{\eta}) \sim G(\overline{c}, \overline{p}) \quad \text{(A7)}$$

where

$$\overline{c} = N + \underline{c}$$

and

$$\overline{p} = \sum_{i=1}^{N} z_i + \underline{p}$$

The posterior conditional distribution of η_t is given by

$$p(\eta_t|\boldsymbol{\beta}, h, \boldsymbol{\theta}, \boldsymbol{z}, \alpha, \gamma, \boldsymbol{\lambda}) \propto G(\overline{f}_t, \overline{r}_t) \quad \text{(A8)}$$

where

$$\overline{f}_t = N + \underline{f_t}$$

and

$$\overline{r}_t = \sum_{i=1}^{N} u_{it} + \underline{r_t}$$

4. Bayesian Computation

Drawing random sample from the conditional posterior distributions of parameter h , γ , and $\eta_t (t = 1, \dots, T)$ is straightforward. While the conditional posterior distributions of $\boldsymbol{\beta}$, $\boldsymbol{u}_i$ $(i = 1, \dots, N)$, and z_i do not have a standard form and need different sampling strategy.

To generating random draws from the posterior conditional distribution of $\boldsymbol{u}_i$ and z_i, we use random walk Metropolis-Hastings algorithm. Multivariate normal distribution for $\boldsymbol{u}_i$ and normal distribution for $z_i$were employed as candidate generating density. We adjust the covariance of multivariate normal distribution and the variance of normal distribution to make sure the acceptance probability in the range of 0.23-0.45 (Roberts *et al*., 1997).

The way we used to impose curvature conditions on stochastic frontier production function is independent Chain Metropolis and Hastings algorithm. To implement this procedure we need to find an appropriate candidate generating density. Here cross entropy can be employed to do that job. In the first step, we estimate the stochastic frontier without constraints by using Metropolis within Gibbs sampler (Metropolis-Hastings algorithm was used to infer the conditional density distribution of inefficiency terms). We get the posterior density function of function parameters. The algorithm used by Terrell (1996) to impose curvature conditions is based on this posterior density function of function parameters to find out the parameter vectors which satisfy monotonicity can concavity. As noted by O'Donnell and Coelli (2005), Terrell's algorithm was inefficiency to generate a qualified parameter vector. This is true especially when the parameter vectors which satisfy curvature conditions only account for a very small proportion of the whole distribution. Then it takes time to generate a qualified draw. In this case cross entropy (CE) method can be used to explore this "rare event" and improve the efficiency of posterior inference. CE method is an adaptive algorithm and can be used to simulate rare event (de Boer, et al., 2005). In the second step, CE method was used to simulate the properties (mean and covariance) of parameters which fulfill curvature conditions. Then we can formulate an appropriate candidate generating density by using these properties. Finally, we re-estimate the function's parameters by using Metropolis within Gibbs sampler in which inference of posterior conditional density of $\boldsymbol{\beta}$ is based on independence chain Metropolis-Hastings algorithm using the candidate generating density we obtained in step two. After we draw a random parameter vector from candidate generating density we calculate an acceptance probability and accept this draw randomly.

There is no specific information about the extent of inefficiency in rural Chongqing. We assume a 40% output loss due to technical inefficiency. And we assume time varying technical inefficiency and time persistent technical inefficiency contribute equally to the total inefficiency level, which imply $E(u_{it}) = 0.2$, and $E(z_i) = 0.2$. For u_{it} and z_i both have a gamma distribution. We can obtain that $\frac{1}{\gamma} = 0.2$, and $\frac{1}{\eta_t} = 0.2$. Apparently, $\gamma = 5$, and $\eta_t = 5$, for $t = 1, \ldots, 7$. Then we have $\mathrm{E}(\gamma) = \frac{\underline{c}}{\underline{p}} = 5$. Set $\underline{c} = 1$ and $\underline{p} = 0.2$. Inference about $\underline{f_t}$ and $\underline{r_t}$ are the same, and we $\underline{f_t} = 1$and $\underline{r_t} = 0.2$. For the hyper-parameters of h, we set $\underline{s} = 1$ and $\underline{q} = 100$, which is relatively non-informative about the distribution of h.

In practice, we use MATLAB to implement the Bayesian inference described above. We take 70,000 iterations and discard the first 20,000 draw as burn-in. We use Monte-Carlo integration to infer the posterior mean of each parameters and 90% highest probability interval. The convergence of each algorithm was checked by using the method suggested by Geweke (1992).

Appendix Table 1 Comparing family size of different type of farm household, 2010

	rent out	no rent	rent in
Mean family size	3,22*	3,68*	4,75*
Standard error	1,26	1,43	1,34

Note: * means the differences of group mean are significant at 5% level.

Appendix Table 2 Land rental contract forms in China, 1936

Province	Fixed cash contract		Fixed graincontract		Sharecropping		Others		Total	
	No. obs	%	No. obs	%	No. obs	%	No.obs	%	No. obs	%
Jiangsu	26,639	47.54	23,054	41.13	6,171	11.01	178	0.32	56,033	100.00
Zhejiang	14,047	33.96	26,330	63.54	1,036	2.50	-	-	41,439	100.00
Anhui	6,607	14.44	30,722	67.13	8,428	18.41	9	0.02	45,766	100.00
Jiangxi	241	92.42	3,937	5.68	81	1.90	-	-	4,259	100.00
Hunan	5,032	9.30	38,898	71.93	9,967	18.43	186	0.34	54,083	100.00
Hubei	6,514	18.50	14,537	76.51	943	4.96	5	0.03	18,999	100.00
Hebei	6,107	62.62	1,719	17.62	1,912	17.01	4	0.05	9,752	100.00
Shandong	2,676	22.14	4,420	36.58	4,988	41.28	-	-	12,084	100.00
Henan	996	8.81	2,152	19.02	8,137	71.94	26	0.23	11,311	100.00
Shanxi	11	7.86	69	49.28	60	42.86	-	-	140	100.00
Shaanxi	969	13.81	5,626	80.16	424	6.03	-	-	7,019	100.00
Chahaer	-	-	23	47.92	25	52.08	-	-	48	100.00
Suiyuan	39	92.85	3	7.15	-	-	-	-	42	100.00
Fujian	2,594	16.03	12,210	75.45	1,379	8.52	-	-	16,183	100.00
Guangdong	1,345	15.34	7,416	84.60	2	0.02	3	0.04	8,766	100.00
Guangxi	207	7.94	2,020	77.52	378	14.50	1	0.04	2,606	100.00
Total	71,050	24.62	173,127	60.01	43,941	15.23	412	0.14	288,530	100.00

Data source: Outline of National Land Survey, edited by Land Committee of Republic of China, 1936.

Appendix Table 3 Length of land rental contract in China, 1936

Province	No. obs	Permanent Tenancy		Fixed length Contract		Length flexible Contact		Others	
		No. obs	%	No. obs	%	No. obs	%	No. obs	%
Jiangsu	54,544	22,284	40.86	5,009	9.18	27,251	49.96	-	-
Zhejiang	39,277	12,000	30.59	3,972	10.13	23,096	58.88	159	0.4
Anhui	43,012	18,990	44.15	5,536	12.87	18,482	42.97	4	0.01
Jiangxi	4,139	96	2.29	13	0.31	4,084	97.4	-	-
Hunan	56,100	566	1	263	0.41	55,270	98.52	1	0.01
Hubei	17,354	2,326	13.4	792	4.57	14,236	82.03	-	-
Hebei	9,726	383	3.94	2,281	23.45	7,062	72.61	-	-
Shandong	11,845	530	4.47	663	5.6	10,652	89.93	-	-
Henan	11,389	292	2.56	884	7.76	10,211	89.66	2	0.02
Shanxi	144	6	4.17	60	41.67	78	54.16	-	-
Shaanxi	6,879	36	0.52	194	2.82	6,649	96.66	-	-
Chahaer	122	96	78.69	5	4.1	21	17.21	-	-
Suiyuan	564	530	93.97	22	3.9	12	2.13	-	-
Fujian	14,967	776	5.18	1,294	8.65	12,897	86.17	-	-
Guangdong	8,971	151	1.68	1,386	17.66	7,236	80.66	-	-
Guangxi	2,651	311	11.73	302	11.39	2,036	76.8	2	0.08
Total	281,488	39,373	21.08	22,874	8.12	199,073	70.74	168	0.06

Data source: Outline of National Land Survey, edited by Land Committee of Republic of China, 1936.

Appendix Table 4 Description of data used in technical efficiency analysis

	Tianba		Changshui		Xiehe		overall	
	mean	std	mean	std	mean	std	mean	std
Stochastic production frontier								
output(Yuan)	1355.41	1199.29	2333.41	1593.80	7074.75	8132.45	2612.99	3890.37
capital(Yuan)	191.82	628.51	672.12	1002.36	745.88	954.85	472.74	885.61
sown area(mu)	3.13	2.78	6.63	4.76	7.98	3.61	5.31	4.29
labor(days)	78.16	90.71	246.57	144.29	253.68	206.25	174.17	160.09
inter(Yuan)	407.56	362.84	686.78	485.47	1289.74	955.96	654.79	614.06
Efficiency function								
participation rate(%)	0.01	0.08	0.10	0.21	0.24	0.27	0.08	0.19
household head age	53.79	11.07	52.58	24.99	51.08	10.14	52.88	18.11
herfindal index	0.14	0.13	0.28	0.17	0.43	0.21	0.24	0.19
plots	3.89	3.76	3.14	1.86	12.05	4.64	4.80	4.48
Machinery (%)	0.48	0.50	0.09	0.28	0.04	0.19	0.25	0.43
farm size (mu)	1.54	1.18	2.94	2.66	6.33	3.16	2.83	2.75

Data source: RCRE. Note: all monetary values were deflated into the price level of 2003.