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# Rental markets for cultivated land and agricultural investments in China

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**Abstract**

The purpose of this paper is to empirically track the progress and consequences of the emergence of cultivated land markets in China since 2000. We draw on a set of nationwide, household-level panel data (for 2000 and 2008) and find that the markets for cultivated land rental have emerged robustly. According to our data, 19 of China's cultivated land was rented in farm operators in 2008. We also find that the nature of China's cultivated land rental contracts has become more formal and lengthened the period of time that the tenant is able to cultivate the rented-in plots. While there may be benefits for lessors and tenants, our data show that there are falling rates of investment in organic manure. The farmers in our sample have reduced organic manure use from 13 tons/ha in 2000 to 5 tons/ha in 2008. Part of this fall is due to the rise of cultivated land rental markets. The analysis, however, does not find that improved property rights in cultivated land rental affect investment largely because property rights have largely been established by 2000, the first year of our sample. Our results, however, also show that there are forces that appear to be mitigating the negative consequences of rising cultivated land rental. After holding constant initial rental rates and other factors, we find that the gap between investment in organic manure in own land and rented-in land is narrowing. One interpretation of our findings is that if policymakers can find ways to even further strengthen the rights of lessors and tenants as well as lengthen contract periods, farmers—even those that rent—will invest more in their land, because they will be able to capture the returns to their investments.

*JEL classification:* Q15, Q18, P14

*Keywords:* Cultivated land rental markets; Organic manure, Investment; Contracting period

## 1. Introduction

After emerging from the commune period in the early 1980s, the next two decades saw China's small farm-based agricultural economy change from one in which resources were allocated by planners to one in which markets played a major role. Commodity, input and labor markets have been shown to gradually develop and lead to higher efficiency and welfare gains for the rural population (Rosen et al., 2004).

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**Data Appendix Available Online**

A data appendix to replicate main results is available in the online version of this article. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

Rental markets for cultivated land also appeared—although their appearance was most evident in the late 1990s. In the late 1980s and early 1990s few farmers engaged in rental activities (Brandt et al., 2004; Deininger and Jin 2005; Turner et al., 1998); however, after the mid-1990s, land rental activities expanded rapidly. According a national study by the China National Statistical Bureau in 2001, 9.5% of households nationwide rented land in. Most of the rental contracts during this time period were oral, informal and often seasonal (or at most annual) in nature.

Inside China—a country that through its 1980 reforms created an agricultural economy based on 200 million farms each with fewer than 0.5 hectares—leaders have consistently encouraged cultivated land rental transactions. Land rental is one of the main ways in which operational land holdings are supposed to be expanded (Cai et al., 2008). Policy documents clearly state that farmers should strive to rent land to increase farm size, raise farming efficiency and generate higher labor productivity (that is, output per laborer). Among the different major


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policy pronouncements, the directives of the late 1990s that extended household contracts until the late 2020s and the Cultivated Land Contracting Law of 2003 both spelled out the intentions of China's top leaders: cultivated land rental would play an important role in China's agricultural development strategy (Wen, 2010).

At the same time that productivity-conscious agricultural officials push cultivated land rentals, a set of critics have appeared warning of the adverse consequences of an agricultural economy in which too large of a share of cultivated land is tilled by tenants. For example, Cai et al. (2008) explicitly worry that farmers that rent land in will have less of an incentive to invest in agriculture and suggest that the government consider policies that will try to incentivize tenants to continue to invest in the land. Yu et al. (2003) have more direct empirical evidence, demonstrating that during the 1990s when a piece of land was rented to a tenant its fertility (measured in terms of organic matter) declined relative to plots that were not rented out. In short, although cultivated land rental may increase farm size, some officials and agricultural scientists are concerned that households that rent land in—especially under informal contracting arrangements—will have little incentive to invest in the land, which will itself lead to short and long run agricultural supply consequences.

While there is a fear that the rising rate of land rental will lead to falling investment in the land, the literature also has identified a force that possibly could mitigate the reduced incentives to invest in the land. Besley (1995) and Carter and Yao (1999, 2002) show land rental markets also have the potential to increase investment. Because improved property rights may spur rental markets, this could raise the option value of investment. Hence, although farmers might be less inclined to invest in rented-in land, they may invest more in their own land. When rental markets are allowed, farmers may invest more in their land since it will increase the future rents from the land. Therefore, the overall effect of land rental markets is at best unclear. This additional ambiguity makes an empirical analysis of this question even more of an imperative. The purpose of this study is fairly straightforward. We propose to empirically track the progress and consequences of the emergence of cultivated land markets in China—with a focus on the past decade (since 2000). Specifically, we draw on a set of nationwide, household-level panel data (for 2000 and 2008) and trace the changes in cultivated land rental since 2000. We also seek to understand if the nature of cultivated land rental contracts changed from the highly informal arrangements of the 1990s. We also analyze the effect of land rental on investment into land-specific investments and measure if the effect has changed (in its magnitude) during the 2000s as China's farm economy has matured and after officials have passed legislation to protect the security of lessors (or those that rent land out). Finally, we also seek to examine, if as found in Carter and Yao (1999, 2002) that as the rights to rent cultivated land improves, if farmers change their investment behavior on their own land in China.

There are several limitations to our work. There are many different things that will affect the way that cultivated land markets influence investment, including the 2003 Contracting Law. We will not be able to identify all of the forces that are behind any changes that we observe. In other words, many different things in China are changing simultaneously, and we will not be able to identify exactly which ones are causing the observed changes in the activity level of contracting land and the nature of the contracting arrangements.

In addition, in this article we only look at one type of investment—the application of organic manure. We are cognizant that there are many different types of plot-specific investments that might be affected by the emergence of rented cultivated land. In the spirit of Jacoby et al. (2002), however, we focus on the application of organic manure, which is still of interest. There are two reasons for this interest. First, even though organic fertilizer, a mixture of manure, dredged soil, decayed vegetable matter, and other farm-yard wastes, contains trace amounts of nitrogen and other minerals that promote healthy crop growth in the season during which it is applied, its primary benefit is in maintaining soil structure (China, Ministry of Agriculture, 1984). This benefit is long-lasting; a single application of organic fertilizer in most subtropical and temperate climatic zones (areas covering most of China and all of the sample locations) can have an effect on the soil for four to five years. In contrast, the effects of chemical fertilizers, principally nitrogen and phosphate, last only for a single growing season. Second, in China, we argue that soil quality improvement, while perhaps not the only investment in cropland responsive to plot-specific rights, is certainly one of the most important ones. Many fixed investments, such as surface irrigation, drainage and terracing, that our analysis ignores, either do not depend directly on rights to a specific piece of cultivated land, or are more efficiently organized at the communal or village level irrespective of the property rights regime (Jacoby et al., 2002).

## 2. Data

The data used in this study are a subset of a dataset that was collected during two rounds of nationwide surveys. The survey efforts were carried out by the authors in December 2000 (collecting data for the year 2000) and early 2009 (collecting data for the year 2008). In the 2000 survey, the dataset includes information from 60 randomly selected villages in six provinces of rural China selected as representative of China's major agricultural regions. The provinces are Hebei, Liaoning, Shaanxi, Zhejiang, Sichuan, and Hubei.

To capture cultivated land rental activity by households (and regions) that are in different segments of China's income distribution we adopted a carefully implemented sampling strategy. Within each province, one county was selected randomly from within each income quintile for the province, as measured by the gross value of industrial output. Two villages were selected

Table 1
Total number of sample households, number of plots and the number/share of households and plots that have both own cultivated land and rented-in cultivated land in China, 2000 and 2008

| | Total sample | | Sample households with both own cultivated land and rented-in land | | | |
|---|---|---|---|---|---|---|
| | Number of households | Number of plots | Number of households | Number of plots | Share of rented-in plots of total number of plots (%) | Share of area of rented-in plots of total area of cultivated area (%) |
| 2000 | 1,189 | 6,049 | 182 | 793 | 31.7 | 35.0 |
| 2008 | 1,046 | 4,847 | 171 | 844 | 31.6 | 48.2 |

*Notes:* Own cultivated land includes all cultivated land that is given by the village (collective) to the farmer without a cash payment and which is cultivated by the farmer himself/herself (and is not rented out). In China own cultivated land includes private land (ziliudi) and responsibility land (zerentian).
*Sources:* Authors' surveys in 2000 and 2009.

randomly within each county. The survey teams used village rosters and our own counts to choose 20 households randomly. A total of 1,200 households were surveyed (6 provinces × 5 counties × 2 villages × 20 households). Of this total number of households, 1,189 households had full information (e.g., input data by plot) used in this study. In our 2,000 sample, exactly 11 sample households were not engaged in farming.

In the 2009 survey, we went back to the same villages that were surveyed in 2000 except for two earthquake-damaged villages in Sichuan, which reduced our 2,000 sample to 1,160 households. Among the remaining 1,160 households surveyed in 2000, we were able to find and resurvey 1,046 households in 2009. Of the 114 households that we could not find in the village, 89 of them had moved out of the village and resided in an urban setting.[1] The other 25 households either disappeared because all of the members died (in the case of seven households) or lived in the village and were not engaged in farming activities (in the case of 18 households). Column 1 in Table 1, presents information on the number of sample households by year.

The key block of the survey data for this study—which was exactly the same in both 2000 and 2008—was built around a table that elicited detailed information from the sample households on their farming activities by plot (Table 1, column 2). For each plot of cultivated land that farm households operated (or rented out) during the survey year we asked a series of plot-specific questions. Above all we wanted to know the tenure-usage status of the plot. There were four types of tenure-usage plots. Type 1 plots are those plots that were allocated to the household from the village (for no fee, given to the farmer because of the farmer's residency in the village) and cultivated by the farmer (that is, if the plot was the household's "own plot").[2] Type 2: if the plot was one in which the farmer rented out his own land to another farming household ("rented-out plots"); Type 3: if the plot was one in which the farmer rented in from another farmer ("rented-in plots"); and Type 4: if the plot was a plot that was rented from the village under a special program that is called *chengbaodi*. Plot Types 1 to 3 are included in the study. We do not include Type 4 plots. In 2008 only about 7% of the land in our sample households (in our sample villages) was Type 4 cultivated land.

After enumerating the plot tenure-usage type, the investment into each plot was recorded. Each farmer was asked by plot type how much organic manure was applied to the plot during 2000/2008. Composed largely of animal waste, organic manure provides variable amounts of three principal soil nutrients, nitrogen, phosphorous, and potassium as well as providing carbon and other soil structure-building elements. As noted by Jacoby et al. (2002), organic fertilizer is an investment that can improve the quality of the soil and has long-lasting impact effects, about four to five years. In addition, almost all effort spent in collecting, storing, preparing and using organic manure is under the control of the farm himself/herself.[3]

Finally, the enumerators asked farmers about a number of other characteristics of each plot because it is possible that these other characteristics also affect investment. For instance, the production activity (which crop) and the rotation was enumerated for the entire year as was each plot's soil quality

[1] In another part of the survey effort, our enumeration teams tracked down all 89 of the households and interviewed them with a special survey created for nonfarming households. Since these households were not engaged in farming, they were not part of this study's dataset.

[2] This type of cultivated land (Type 1) traditionally has been called in the literature "responsibility land" (*zeren tian*). This type of cultivated land was allocated to farm households by the village leadership on the basis of the number of family members, the number of laborers in each family and/or some other criteria decided upon by the village leadership. In the mid-1990s responsibility land was given to farmers in exchange for a promise that the farmer would pay an agricultural tax (either in cash or in-kind) and deliver a mandatory procurement quota (that is, part of the harvest of the farmer) to a state grain station at a below-market price. In other words, the farm household received use rights to the cultivated land as long as it fulfilled its "responsibilities." The mandatory procurement was eliminated in most villages in the late 1990s. The agricultural tax was eliminated in most villages in 2004. It is for this reason that in this study we call Type 1 land, *own cultivated land*. Today use rights belong to the farmer until the late 2020s and the farmer does not have any obligations in using the land. In the early 1980s and 1990s there was another type of plot called *private plots* (or *ziliudi*). Although at one time there was a difference in tenure security between private plots and responsibility land, by 2000 this distinction had faded. Because of this, in this study we include private plots as part of own cultivated land. For a more comprehensive description of China's land tenure, see Kung and Liu, 1996.

[3] The problem with using other investment activities (e.g., irrigation canals; terracing; land leveling; etc.) is that they often are done in concert with or at the direction of the village leadership and/or the local government (Zhao, 2007).

(low, medium, high fertility), nature of the terrain (flat plain or hilly/mountainous terrain), irrigation status (irrigated or rainfed), distance of the plot from the farmer's home (in kilometers), and size of the plot (in hectares). The characteristics of the plot are given in Table 2.

The survey contained two other blocks that were used in this study. If the farmer rented in or rented out land, the enumerators asked the respondents to fill out a form that elicited information on the nature of the contracting arrangement between lessor and tenant. For each plot that was rented in/rented out the tenant/lessor was asked about the relationship of the tenant and lessor (relative or not a relative), if the contract was written or oral, and the nature of the contract period (whether there was a contract period specified or not, and length of the period in years). In addition, all farmers (whether they rented in or rented out in 2000/2008) were asked about rental activities four years prior (1996/2004).

Although we use all of the households for charting the changes of rental area (as a proportion of total cultivated area) and nature of cultivated land rental arrangements, in the analysis of the impact of rental on investment we use only a subset of the households. To eliminate the effect of unobserved factors that affect investments and that are correlated with tenure status of a plot—that is, the propensity to cultivate one's own plot or rent land in or rent land out, we restrict our attention to the subset of households that *both* cultivate their own plot *and* rent in land. This empirical strategy has been widely used in other papers outside China (e.g., Shaban, 1987) and inside China (e.g., Li et al., 1998) to eliminate the endogeneity that might otherwise affect the measured relationship between cultivate and rental status and investment. In total in 2,000 there were 182 households that fit the criteria for inclusion into the study's multivariate analysis of the impact of rental on investment (that is, these 182 households cultivated at least one plot of their own land and rented in one plot); in 2008 there were 171 households (Table 1, column 3). In columns 4–6 of Table 1, we can see the total number of plots that are included in the study and the share of rented-in plots as well as the share of area. Since the size of the rented-in plot is slightly larger than the average own plot, the share of the number of plots (31.7% in 2000 and 31.6% in 2008) is smaller than the share of the area (35.0 in 2000 and 48.2% in 2008). From this we can also see that the average size of the rented-in plot is growing over time.

Table 2
Characteristics of cultivated land of the sample households in China, 2000 and 2008

| | Average | 2000 | 2008 |
|---|---|---|---|
| Soil quality | | | |
| Low (%) | 21.0 | 22.6 | 19.1 |
| Medium (%) | 53.6 | 51.3 | 56.5 |
| High (%) | 25.4 | 26.1 | 24.4 |
| Terrain of the plots | | | |
| Plain land (%) | 46.8 | 45.9 | 48.1 |
| Nonplain land (%) | 53.2 | 54.1 | 51.9 |
| Irrigation status of the plots | | | |
| Irrigated (%) | 59.0 | 56.5 | 62.2 |
| Rainfed (%) | 41.0 | 43.5 | 37.8 |
| Distance from home (in kilometers) | | | |
| <0.5 km (%) | 41.5 | 40.8 | 42.4 |
| 0.5–1 km (%) | 30.1 | 29.6 | 30.6 |
| 1–2 km (%) | 21.9 | 22.8 | 20.8 |
| >2 km (%) | 6.5 | 6.8 | 6.2 |
| Area of plot (in hectares) | | | |
| <0.1 ha | 62.6 | 64.2 | 60.6 |
| 0.1–0.15 ha | 16.0 | 15.9 | 16.1 |
| >0.15 ha | 21.4 | 19.9 | 23.3 |

*Note:* Sample of farm households includes 1,189 observations in 2000 and 1,046 observations in 2008.
*Source:* Authors' surveys in 2000 and 2009.

## 3. Emerging cultivated land rental markets

### 3.1. Evolving contractual forms

The expansion of the cultivated land rental market that began in the 1990s, according to our data, has continued through the late 1990s and the 2000s. From 3% in the mid-1990s. the farmers in our sample villages were renting in 10% of the land that they cultivated in 2000. Between 2000–2004 and 2004–2008, cultivated land rental markets accelerated—especially in the last years of the study period. By 2008 our data show that 19% of cultivated land that farmers were cultivating was rented in (Table 3).

Not only is this growth relatively fast, 20% of cultivated land being rented in is not low by international standards. While in some countries such as the United States and some European nations, more than 40% of cultivated land is rented (Deininger et al., 2003), in many countries in Latin America (e.g., Columbia—7%). in Southeast Asia (e.g., Vietnam—16%), and South Asia (e.g., India—12%), the rate is below 20% (Deininger and Jin, 2008; Deininger et al., 2008; Vranken and Swinnen, 2006).

The fast growth rates of rental markets for cultivated land, while not occurring in all provinces, are occurring in most provinces, though faster in some than others (Fig. 1).

Table 3
Trends in shares of own cultivated land and rented-in cultivated land in China, 1996–2008

| | Own cultivated land | Rented-in cultivated land |
|---|---|---|
| 1996 | 97 | 3 |
| 2000 | 90 | 10 |
| 2004 | 88 | 12 |
| 2008 | 81 | 19 |

*Notes:* (1) Own cultivated land includes all cultivated land that is given by the village (collective) to the farmer without a cash payment and which is cultivated by the farmer himself/herself (and is not rented out). In China own cultivated land includes private land (ziliudi) and responsibility land (zerentian). (2) Sample of farm households includes 1,189 observations in 2000 and 1,046 observations in 2008.
*Sources:* Authors' surveys in 2000 and 2009.

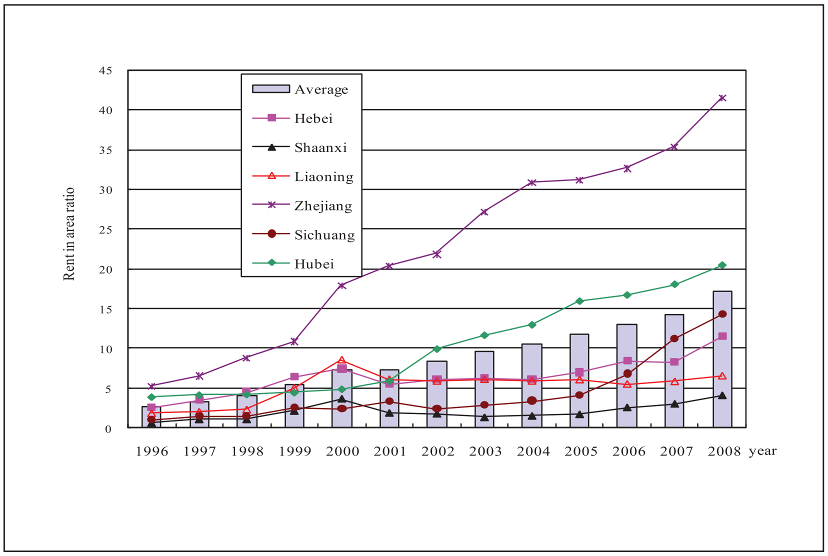


Fig. 1. Trends in shares of rented-in cultivated land in China and the sample provinces, 1996–2008

According to our data, Zhejiang province, the province with the richest rural economy and one of the most active off-farm labor employment markets, has the highest shares of cultivated land that is being rented in. By 2008, more than 40% of the cultivated land in the province was being rented in. Hubei (from 5% to 20% between 2000 and 2008), Sichuan (from 2% to 14%) and Hebei (from 7% to 12%), provinces with high rates of out-migration, also have high rates of growth in cultivated rental markets. Only (relatively) land-rich Liaoning and poverty-stricken Shaanxi provinces have been relatively stagnant in the growth of cultivated land rental markets.

While we explicitly stated above that we are unable to identify (in any cause-effect sense) the determinants of changes in cultivated rental markets, nationally (and in the case of several of the provinces) there appears to be an acceleration after 2003. One possible interpretation of this could be that the National Contracting Law, which was in effect after 2003 and explicitly provided secure rights for those that rent out their cultivated land, gave rise to more rental transactions. Of course, the data show that it has not affected all provinces the same. In addition, it must also be realized that many other things are changing during the mid-2000s. For example, rising wage rates and increasingly amounts of off-farm employment opportunities—especially in China's cities—might also be behind the rise in cultivated land rental transactions.

### 3.2. *Evolving contractual arrangements*

Our data also demonstrate that—beyond the rise in the number of cultivated land rental transactions—the nature of the contractual arrangements is clearly changing, albeit slowly (Table 4, rows 1–4). Specifically, rental transactions between relatives, while accounting for fully two-thirds of all transactions (67%) in 2000, fell slightly to 64%. In addition, whereas

Table 4
Nature of the contracting arrangements of rented-in cultivated land in China, 2000 and 2008

| | Average | 2000 | 2008 |
|---|---|---|---|
| Rented in cultivated land from | | | |
| Relatives (%) | 65 | 67 | 64 |
| Nonrelatives (%) | 35 | 33 | 36 |
| Contractual type | | | |
| Oral (%) | 94 | 96 | 92 |
| Writing (%) | 6 | 4 | 8 |
| Contractual period | | | |
| Share of contracts with NO specified number of years (%) | 90 | 91 | 88 |
| Average number of years that tenant has rented in the plot | 5.3 | 4.7 | 5.9 |
| Share of contracts with a specified number of years (%). Of which | 10.2 | 8.8 | 11.6 |
| Average number of years that tenant has rented in the plot | 1.8 | 1.0 | 2.4 |
| Average years specified in the contract | 3.1 | 2.0 | 3.9 |
| Share of contracts by contract length | | | |
| 1 year or less (%) | 47 | 68 | 32 |
| 1–5 years (%) | 43 | 27 | 55 |
| 5–10 years (%) | 8 | 5 | 10 |
| More than 10 years (%) | 2 | 0 | 3 |

*Sources:* Authors' surveys in 2000 and 2009.

the number of oral contracts—which are clearly nearly universal (96% in 2000)—have fallen to 92% in 2008. In other words, more formal written contracts have risen from covering only 4% of all cultivated land contracting arrangements in 2000 to 8% in 2008.

The length of the contract period is also becoming longer—a significant factor, especially given our interest in the relationship between cultivated land rental and investment (Table 4, rows 5–13). It is true that in 2000 when considering all contracts—both oral and written—that 91% of contracts did not specify the length of the contract period. However, by 2008, the number, while still high, had fallen to 88%. Moreover, and perhaps more significantly, in cases where the length of the contract period was not specified, the average length of time that the tenant rented in the lessor's land rose from four years seven months in 2000 to five years nine months in 2008.

In cases in which the lessor and tenant specified the length of time for the contract period (rising from 9% in 2000 to 12% in 2008), the actual length of time that the tenant was cultivating the lessor's land was growing, and the length of the specified contract period was rising. The length of time that the tenant actually rented in the lessor's land more than doubled between 2000 and 2008 from one year to two years four months. The length of the contract period specified in the contract also doubled from two to four years. Whereas in 2000 68% of contracts that specified the length of the contract period was for one year or less, by 2008 this was the case in only 32% of the contracts. The number of one to five year contracts rose from 27% to 55% and the number of contracts of five or more years rose from 4.5% in 2000 (4.5 + 0.0) to 12.9% (9.7 + 3.2).

In summary then, when looking at our data, there is reason to be concerned about the effect of cultivated land rental on investment and there is reason for optimism. One would expect the tenant to be less enthusiastic, under normal circumstances (oral contracts of unspecified number of years), to invest in the land. Therefore, with the rise of cultivated land rental transactions that we have observed, it is easy to see why some officials are worried about China's long run productivity due to the possible negative investment effects. At the same time, however, cultivated land rental contracts, while still quite informal (between relatives, oral, without a specified length of the time) are moving in a direction—indeed gradually—that would remove the negative incentive (at least in the medium run) keeping the tenant, himself/herself, from investing. In the next two sections we will undertake the empirical analysis to see if these expected relationships are present and which of these forces is dominating.

## 4. Organic manure investments

### 4.1. Trends and correlations

The sounds of alarm about falling use of organic manure come from many quarters. The State Council, China's higher governmental body, has consistently flagged the falling use of soil structure-building organic manure as a major problem. Since 2004 in each of the State-of-the-Nation reports that are issued each year by the State Council calling attention to the major issues confronting the government for the year (frequently referred to as each year's Document Number 1, since it is chronologically the first policy statement issued each year), the government has stated its goal is to maintain the fertility of the nation's soil. Soil scientists likewise decry falling rates of use of organic manure (Zhang and Zheng, 2009). One of

Table 5
Organic manuring trends (tons/hectare) on cultivated land plots of varying types in China, 2000 and 2008

| | Average | 2000 | 2008 |
|---|---|---|---|
| Soil quality | | | |
| Low | 7.5 | 8.5 | 5.9 |
| Middle | 7.4 | 9.8 | 4.8 |
| High | 9.1 | 10.5 | 7.2 |
| Terrain of the plots | | | |
| Plain land | 5.9 | 6.8 | 4.9 |
| Nonplain land | 9.6 | 12.1 | 6.3 |
| Irrigation status of the plots | | | |
| Irrigated | 7.5 | 9.6 | 5.0 |
| Rainfed | 8.5 | 9.8 | 6.5 |
| Distance from home (in kilometers) | | | |
| <0.5 km | 9.8 | 12.8 | 6.1 |
| 0.5–1 km | 7.0 | 8.5 | 5.2 |
| 1–2 km | 6.5 | 7.5 | 5.2 |
| >2 km | 4.1 | 3.5 | 4.9 |
| Area of plot (in hectares) | | | |
| <0.1 ha | 9.4 | 11.9 | 6.0 |
| 0.1–0.15 ha | 6.3 | 7.1 | 5.3 |
| >0.15 ha | 4.7 | 4.7 | 4.8 |

*Note:* Sample of farm households includes 1,189 observations in 2000 and 1,046 observations in 2008.
*Source:* Authors' surveys in 2000 and 2009.

the areas targeted for campaigns in the 12th Five Year Plan for the national agricultural extension system is to try to arrest and even reverse the falling trends in organic manure use (CPCCC, 2010).

Without reference to the role of rising cultivated land rental (which may or may not be affecting the use of organic manure), our data make it clear that reports of concerns about falling uses of organic manure appear to be true. In 2000, the average farmer in our sample of 1,189 farmers (including both those in and not in the special subsample of farmers that were cultivating own cultivated plots and rented-in plots) used 13 tons of organic manure per hectare. By 2008, the use of organic manure fell for the average farmer (during 2008 there were 1,046 farmers in the sample) to 5 tons/hectare. In other words, organic manure use fell by 61% among our sample farmers.

While there are likely many reasons for the fall between 2000 and 2008 (e.g., rising wages—Cai and Du 2008; falling real prices of chemical fertilizers with China's accession to the World Trade Organization—Qian, 2007), descriptive statistics using our data demonstrate that the fall in organic manure use is occurring in all types of farms. Table 5 shows that organic manure use has decreased on cultivated land no matter what the soil type (rows 1–3). Farmers working plots on the plain and in hilly/mountainous terrain also have reduced organic manure use (rows 4 and 5). Similar falling trends are seen when farmers have differential access to water control (rows 6 and 7); across different types of plots—regardless of their location relative to the farmer's house (rows 8–11); or the size of the plot (rows 12–14).

Table 6
Organic manure use (tons/hectare) on own cultivated land plots and one rented-in plots in China, 2000 and 2008

| | Own land (1) | Renting in land (2) | Difference of (2)–(1) | Percentage difference of [(2) – (1)]/(1) × 100 |
|---|---|---|---|---|
| Average | 6.1 | 3.8 | −2.3 | −37.7 |
| 2000 | 8.7 | 5.1 | −3.6 | −41.4 |
| 2008 | 3.7 | 2.5 | −1.2 | −32.4 |

*Note:* Sample of farm households includes 182 observations in 2000 (those households that cultivated both their own cultivated plots and rented in plots) and 171 observations in 2008.
*Sources:* Authors' surveys in 2000 and 2009.

### *4.2. Cultivated land rentals and organic manure investments*

Examining only the sample of farmers across China that cultivated both their own cultivated plots and rented-in plots during the same year, two trends are clear (Table 6, rows 2 and 3). First, when focusing on either own cultivated land (column 1) or rented-in plots (column 2) across 2000 and 2008, organic manure investment fell sharply. When cultivating their own plot in 2000, the subsample of farmers that were simultaneously cultivating both their own plot and rented-in plots used 8.7 tons/hectare. The same subsample of farmers (i.e., those that were simultaneously cultivating both their own plot and rented-in plots) only invested 3.7 tons/hectare in 2008, a fall of 57%. When cultivating rented-in plots in 2000 and 2008, the same subsample of farmers reduced their investment into organic manure by 51% from 5.1 to 2.5 tons/hectare (column 2). In other words, the trends in organic manure investment are more similar for these farmers on both types of plots (own cultivated plots and rented-in plots) than in the general sample as a whole.

Second, and most salient for this study, it is clear that when farmers cultivate their own plot and rent-in a plot during the same year, they use less organic manure on the rented-in plots (columns 3 and 4). In 2000 the difference between own cultivated and rented was 3.6 tons/hectare. In other words, farmers invested 41.4% less on their rented-in plots relative to their own cultivated plots in 2000. In 2008 the difference was 1.2 tons/hectare or 32.4%. While there may be systematic differences in the nature of own cultivated plots (in terms of their characteristics—e.g., soil quality. terrain, irrigation. location, size), it does appear as if renting-in does diminish the enthusiasm for farmers to investment in organic manuring. If this is so (as we will examine in our multivariate analysis in the next section), then those that worry about the impact of the rise in rental on investment may have a valid concern.

The descriptive statistics in Table 6 do contain one possible piece of evidence that may allay concerns of those worried about falling investments. Although farmers invested in less organic manure on rented-in plots relative to own cultivated plots in both 2000 and 2008, the rate of underinvestment was lower in 2008. While there may be different reasons, this trend (from −41.4% in 2000 to −32.4% in 2008) is possibly due to the increased security that the 2003 Cultivated Land Contracting Law bestowed on farm households. While difficult to prove with our data, we nonetheless return to a discussion of this issue later.

## 5. Multivariate analysis: cultivated land rental and organic manure investment

In this section there are five subsections. The first defines the econometric model. The second discusses our approach for dealing with endogeneity. The third spells out our estimation strategy. The fourth reports the results. The fifth examines the findings of several robustness checks.

### *5.1. Econometric model*

To isolate the effect of cultivated land rental on organic manure investment, we can specify the following empirical model:

$$M_{ip} = \alpha + \beta RP_{ip} + \sum_{j=1}^{6} \delta_j D_{ip}^{j} + g_i(Z) + \varepsilon_{ip}, \quad (1)$$

where subscript $i$ represents $i$th household, $p$ represents $p$th plot. The dependent variable, $M_{ip}$, is organic manure intensity (tons/hectare); and $RP_{ip}$ is the key independent variable of interest on the right-hand side of Eq. (1). In our analysis $RP_{ip}$ is a dummy variable which measure whether the plot is rented ($RP_{ip} = 1$, if the plot is rented; and $RP_{ip} = 0$ if the plot is the farmer's own cultivated plot). In Eq. (1) the superscript $j$ represents $j$th plot-specific characteristic (on each plot $i$) and in our analysis there are five characteristics (as seen in Tables 2 and 5), including soil quality (including three levels of quality), the terrain of the land, irrigation access, distance from the home and the plot size, that are represented by the variable $D_{ip}^{j}$. Summary statistics of the dependent and independent variables are in Appendix Table 1.

There are several other variables and parameters in Eq. (1) that need addressing. The variable $g_i(Z)$ represents a set of household-level characteristics that potentially affect organic manure investment but which have identical effects on the choice of organic manure investment when a farmer is simultaneously cultivating his/her own cultivated and rented-in plots. The term$\varepsilon_{ip}$is the plot-specific error term. The coefficients to be estimated include $\alpha$, $\beta$, and $\delta_j$. We are interested in the coefficient $\beta$, which captures the impact of tenure security on the tenant's organic fertilizer investment on his leased plot vis-à-vis his owned plot. We anticipate that $\beta$ has a negative coefficient, indicating that when a farmer rents in cultivated land that he/she has less incentive to invest in organic manure.

To be able to try to identify any change in the investment gap of organic fertilizer between own cultivated land and rented-in plots, we specify the following empirical model:

$$M_{ip} = \alpha + (\beta_0 + \gamma * Y_i)RP_{ip} + \eta Y_i + \sum_{j=1}^{6} \delta_j D_{ip}^j + g_i(Z) + \varepsilon_{ip}, \quad (2)$$

where the variable, $Y_i$, is a dummy variable, which equals 1 in 2008 and 0 in 2000. The variable, $RP_{ip} * Y_i$, is a variable that controls for the interaction of $RP_{ip}$ and $Y_i$, and is included to be able to measure the "double difference" or the change in the difference of organic manure between own cultivated land and rented in plots in 2000 and 2008. If the 2003 Cultivated Land Contracting Law (and other factors) have increased the security of lessors and helped extend the length of contract periods, allowing tenants to be more willing to invest in organic manure; we would expect the coefficient of $RP_{ip} * Y_i$ (that is, $\gamma$) to be positive.

### 5.2. Endogeneity

In trying to produce the unbiased estimates of $\beta$ and $\beta_0$ there are several considerations. First, as noted by studies, such as Jacoby and Mansuri (2006), we must consider the adverse selection effect. If a plot's quality is private information to its owner and some fraction of each of farmer's plots are "good" quality and some fraction are "bad" quality, then it is possible that the farmer will prefer to rent out the "bad" plots and cultivate the "good" plots. If this is true, it is possible that these quality characteristics are correlated with $RP_{ip}$, which could make estimates of $\beta$ and $\beta_0$ biased. Of course, if there is not complete asymmetric information between farmer and tenant (as might be the case in a village in which many of the rental transactions are among relatives or fellow villagers), the degree of adverse selection could be reduced (or even zero). In fact, in our sample, as seen above, most cultivated land rental transactions do occur among relatives (65%). Much of the rest occur among friends (about 25–30%). Hence, it might be because of the nature of the relationships among lessors and tenants that this form of endogeneity is not particularly serious.

Even if there is a certain degree of asymmetric information, as long as plot quality is controlled for, the effect of the unobserved heterogeneity can be minimized. Of course, truly unobserved plot quality is not measured. However, to the extent that unobserved plot quality is correlated with the five plot-specific characteristics (six variables), the magnitude of the bias will be reduced.

Second, bias can also be introduced if unobserved household characteristics are related to both $RP_{ip}$ and the dependent variable, $M_{ip}$. In traditional cross section analysis this is a problem because, while it is possible to control for some household characteristics, there will be many unobservable characteristics that will not be measurable. Fortunately, in our analysis, as seen in Table 1 and discussed above, we have a subsample of our households that cultivate both their own cultivated plots and at least one rented-in plot. Because of this we are able to use a fixed-effects approach to capture all observed and unobserved household characteristics and eliminate this possible source of bias. As a consequence, we are fairly confident that our estimates of $\beta$ and $\beta_0$ will be unbiased.

### 5.3. Estimation approach

In the remainder of the article, no matter what estimation approach is used, we construct our data sets consistently. Whenever we estimate Eq. (1), we will use the 2000 data and 2008 data separately. Whenever we estimate Eq. (2), we will use a set of pooled data with both 2000 and 2008. The number of observations will be consistent also: 793 observations when estimating Eq. (1) with 2000 data; 844 observations when estimating Eq. (1) with 2008 data; and 1637 observations when estimating Eq. (2) with the pooled 2000/2008 data.

All equations are estimated by two alternative approaches. In our first approach, we assume that the independent variables in the model affect the dependent variable in a linear way. When doing so, we can estimate the equations with ordinary least squares (OLS). Therefore, our first set of estimates of the coefficients of Eqs. (1) and (2) are reported in tables in which our models are called OLS—2000 and OLS—2008 (for the two estimates of Eq. 1) and Pooled OLS (for the estimate of Eq. 2). These are displayed in Table 7(columns 1–3).

We also use a second approach, since we are concerned about the effects of household unobservables. We account for household unobservables by including a set of fixed effects (FE) in each of our models. Therefore, our second set of estimates of the coefficients of Eqs. (1) and (2) are reported in tables in which our models are called FE/OLS—2000 and FE/OLS—2008 (for the two estimates of Eq. 1) and FE/Pooled OLS (for the estimate of Eq. 2). These will be displayed in Table 7(columns 4–6).

### 5.4. Results of the multivariate analysis

In general, the signs of the estimated coefficients on the control variables demonstrate that the dataset was producing results that are consistent with expectations and reasonable (Table 7, rows 4–9). In both the OLS and fixed effects (FE/OLS) results, farmers are shown to apply more organic manure on higher quality plots. Ceteris paribus, farmers also appear to be investing organic manure in plots that require the building of soil and can use better water retention—plots on hillsides (non-plains) and rainfed plots. The results demonstrate that farmers are minimizing effort in transportation by reducing investment in organic manure on plots that are further away from a farmer's home. Small plots (which tend to be closer to home) receive more organic manuring than larger plots.

Importantly, the results of all of the models produce results that are consistent with one another and that are consistent with the descriptive results (in the previous section). Both the OLS and FE/OLS models using 2000 data show that, holding all other plot characteristics constant, farmers put between

Table 7
Ordinary least squares (OLS) and fixed effects OLS (FE/OLS Pooled) estimates of the impact of cultivated land rental on organic manure investment in China, 2000 and 2008

| | OLS models[a] | | | FE/OLS[a] | | |
|---|---|---|---|---|---|---|
| | 2000 | 2008 | Pooled (2000 and 2008) | 2000 | 2008 | Pooled (2000 and 2008) |
| Rented-in plot (RP) (yes = 1; no = 0) | −3.09*** | −1.02** | −3.29*** | −2.30*** | −0.73* | −2.50*** |
| | (0.78) | (0.50) | (0.80) | (0.69) | (0.38) | (0.56) |
| RP × $Y_{2008}$ | | | 2.76*** | | | 2.03*** |
| | | | (0.95) | | | (0.78) |
| $Y_{2008}$ (2008 = 1; 2000 = 0) | | | −4.94*** | | | |
| | | | (0.63) | | | |
| Soil quality: medium (medium = 1; others = 0) | 4.15*** | −2.43** | 1.04 | 2.19* | −0.67 | 0.86 |
| | (1.07) | (0.94) | (0.73) | (1.12) | (0.75) | (0.69) |
| Soil quality: high (high = 1; others = 0) | 5.04*** | −1.31 | 2.14*** | 1.65 | 1.43* | 1.42* |
| | (1.12) | (1.04) | (0.80) | (1021) | (0.83) | (0.76) |
| Land terrain of plots (plains = 1; nonplain = 0) | −3.95*** | −3.08*** | −3.93*** | −3.87** | −3.85** | −3.80*** |
| | (0.91) | (0.52) | (0.52) | (1.68) | (1.60) | (1.16) |
| Irrigation status (irrigated = 1; rainfed = 0) | −7.24*** | −0.98* | −4.11*** | −3.68*** | −1.77* | −3.33*** |
| | (0.96) | (0.54) | (0.55) | (1.16) | (0.91) | (0.76) |
| Distance of plot from home (km) | −2.40*** | 0.00 | −1.04*** | −2.22*** | −0.46 | −1.20*** |
| | (0.49) | (0.29) | (0.28) | (0.70) | (0.33) | (0.36) |
| Area/size of plot (hectares) | −11.01*** | −0.45 | −2.29*** | −11.26*** | 0.01 | −2.49** |
| | (2.32) | (0.39) | (0.86) | (2.70) | (0.88) | (1.09) |
| Constant | 14.51*** | 7.96*** | 13.20*** | 13.97*** | 7.30*** | 10.37*** |
| | (1.26) | (1.03) | (0.95) | (1.44) | (1.18) | (0.94) |
| Observations | 793 | 844 | 1,637 | 793 | 844 | 1,637 |
| Adjusted $R^2$ | 0.16 | 0.05 | 0.13 | 0.15 | 0.06 | 0.08 |
| *F* value | 18.35 | 9.11 | 18.79 | 6.22 | 2.68 | 6.11 |

*Note:* All numbers in parentheses are robust standard errors. ***, ** and * represent statistically significant at 1%, 5%, and 10%, respectively.
[a]Columns 1 and 2; Columns 4 and 5 contain estimates of parameters that are specified in Eq. (1) from the text. Column 3 and column 6 contain estimates of the parameters that are specified in Eq. (2).

3.09 and 2.30 tons less on each hectare of rented-in cultivated land when compared to their own cultivated plots (Table 7, row 1, columns 1 and 4). Since the smaller figure has accounted for all household effects (both observed and unobserved), these results are strong evidence that farmers indeed choose to use significantly less organic manure on plots that are rented in. Given that the average investment of organic manure is about 5.4 tons/hectare (Table A1), which means that the negative rental effect can be considered to be significant in magnitude.

The effect, however, falls sharply by 2008 (Table 7, row 1, columns 2 and 5). As before, both the OLS and FE/OLS models using 2008 data show that, holding all other plot characteristics constant, farmers put between 1.02 and 0.73 tons less on each hectare of rented-in cultivated land when compared to their own cultivated plots. This decrease—due to the rental effect—is significantly less than in 2000. One explanation, undoubtedly, is that farmers are putting less organic manure on all plots—which, as discussed above, is true. However, there also may be an effect of strengthening the confidence of tenants as they are enjoying longer contract periods so that they can continue using the contracted land while the benefit of the organic manure investment is still being enjoyed.

The pooled models, OLS-pooled and FE/OLS pooled (and the estimates of the interaction terms from Eq. 2 that they produce) provide more evidence that the gap between organic manure investment on own cultivated plots and rented in plots is narrowing (Table 7, rows 1 and 2, columns 3 and 6). The signs on the coefficient of the rent-in plot variable (RP) are still negative and significant. In other words, our results still find a negative and significant effect of renting-in on organic manure investment. In fact, the magnitudes of the coefficients (–3.29 to –2.50) are larger than either the 2000 or 2008 estimates by themselves (the Eq. 1 estimates). However, the interaction terms in both equations (row 2, columns 3 and 6) show that over time (between 2000 and 2008) the effect of rental is attenuating. The positive and significant signs on the variables suggest that holding all plot characteristics constant (rows 4–9); holding the renting in effect constant (for 2000—Row 1) and holding the general downward trend in organic manure use constant (row 3), the gap between the use of organic manure on own cultivated plots and rented-in plots is shrinking.

### 5.5. Robustness checks: accounting for censoring with FE/Tobit

Although the estimates of the coefficients are similar when using either OLS or FE/OLS estimation approaches, it is possible to show that the consistency of our findings holds up to a number of other estimation approaches. In particular, we might

Table 8
Tobit fixed effects (Tobit/FE) estimates of the impact of cultivated land rental on organic manure investment in China, 2000 and 2008

| | Tobit/FE[a] | | | Marginal effects implied by Tobit/FE estimated coefficients ($E(M\|X)$)[b] | | |
|---|---|---|---|---|---|---|
| | 2000 | 2008 | Pooled (2000 and 2008) | 2000 | 2008 | Pooled (2000 and 2008) |
| Rented-in plot (RP) (yes = 1; no = 0) | −5.69*** | −2.04** | −5.88*** | −2.45 | −0.72 | −2.29 |
| | (1.39) | (0.92) | (1.19) | | | |
| RP ∗ $Y_{2008}$ | | | 4.01** | | | 1.56 |
| | | | (1.69) | | | |
| Soil quality: medium (medium = 1; others = 0) | 4.30** | −0.63 | 2.41* | 1.85 | −0.22 | 0.94 |
| | (2.11) | (1.84) | (1.45) | | | |
| Soil quality: high (high = 1; others = 0) | 4.70** | 4.53** | 4.94*** | 2.02 | 1.59 | 1.93 |
| | (2.16) | (2.01) | (1.53) | | | |
| Land terrain of plots (plains = 1; nonplain = 0) | −9.19*** | −7.85*** | −8.57*** | −3.95 | −2.76 | −3.34 |
| | (3.22) | (2.99) | (2.21) | | | |
| Irrigation status (irrigated = 1; rainfed = 0) | −9.90*** | −5.16*** | −8.57*** | −4.26 | −1.82 | −3.34 |
| | (2.16) | (1.94) | (1.50) | | | |
| Distance of plot from home (km) | −6.99*** | −0.99 | −2.98*** | −3.01 | −0.35 | −1.16 |
| | (1.67) | (0.76) | (0.81) | | | |
| Area/size of plot (hectares) | −32.36*** | −4.86 | −21.75*** | −13.91 | −1.71 | −8.48 |
| | (6.67) | (4.36) | (4.59) | | | |
| Observations | 793 | 844 | 1,637 | | | |
| Number of groups | 182 | 171 | 353 | | | |
| Wald $\chi^2$ | 616.14 | 483.22 | 1133.19 | | | |
| Prob >Wald $\chi^2$ | 0.00 | 0.00 | 0.00 | | | |

*Note:* All numbers in parentheses are robust standard errors. ***, ** and * represent statistically significant at 1%, 5%, and 10%, respectively.
[a]Columns 1 and 2 contain estimates of parameters that are specified in Eq. (1) from the text. Column 3 contain estimates of the parameters that are specified in Eq. (2).
[b]The marginal effects are estimated using method described in Jacoby and Mansuri (2006).

be concerned since many farmers do not use organic manure any more than the estimated coefficients using OLS, which does not account for the left hand censoring, might be biased. Without going into details of estimation, for brevity (see Jacoby et al., 2002, for details), Table 8 presents the estimates of the impact of cultivated land rental using a fixed effects Tobit estimator. In all cases the signs of the coefficients for all of the key variables (columns 1 to 3, rows 1 and 2) are the same as in the case of the fixed effects/OLS model (Table 7).

Most importantly, when we calculate the marginal effects that are implied by the fixed effects Tobit estimated coefficients, the robustness of our estimates becomes clear (Table 8, columns 4 to 6, rows 1 and 2). In 2000, the coefficient of the rented-in plot variable demonstrates that organic manure use is 2.45 tons lower on rented-in land than on own cultivated land, ceteris paribus. The marginal impact is also negative but much smaller in 2008 (–0.72 tons/hectare). These levels are almost exactly the same as in the case of fixed effects/OLS (−2.30 and −0.73). And not only are the pooled 2000 and 2008 marginal effects for the fixed effects Tobit of the rented-in land effect (−2.29 in Table 8) also the same as in the case of the fixed effects/OLS (−2.50 in Table 7), the coefficient on the RP ∗ Y variable is also positive, significant (Table 8, column 3, row 2) and the implied marginal effects (+1.56—Table 8, column 6, row 2) is also similar (+2.03—Table 7, column 6, row 2). Taken as a whole, the results in Tables 7 and 8 paint a consistent picture of the relationship between contracting land rental and organic manure use: There is a negative effect on investment in organic manure by increasing cultivated land rental transactions, and the severity of the effect appears to be attenuating between 2000 and 2008.

## 6. Property rights, cultivated land, and investment in farmers' own plots

While we have identified that the rise in cultivated land rental likely has led to falling investment, it is possible that, if property rights encouraging cultivate land rental have improved, increased possibilities for rental have the potential to increase investment (Besley, 1995; Carter and Yao, 1999, 2002). To test this additional effect, one that might offset some of the negative effects of the rise of cultivated land rental, we will undertake two empirical exercises. First, to the model in Eq. (2) we add a variable, *Rentlim*, and the follow:

$$M_{ip} = \alpha + (\beta_0 + \gamma * Y_i)RP_{ip} + \eta Y_i + \rho Rentlim_{ip} + \sum_{j=1}^{6} \delta_j D_{ip}^{j} + g_i(Z) + \varepsilon_{ip}. \quad (3)$$

*Rentlim* is a variable that is similar to that used in Carter and Yao (1999, 2002) that measures the restrictions put on cultivated land rental by village leaders. *Rentlim* equals 1 if farmers

Table 9
Ordinary least squares (OLS) estimates of the impact of cultivated land rental on organic manure investment in China using the sample of households that have both rented-in plots (RP) and own-cultivated plots, 2000 and 2008

| | 2000 | 2008 | Pooled (2000 and 2008) | 2000 | 2008 | Pooled (2000 and 2008) |
|---|---|---|---|---|---|---|
| Rented-in plot (RP) (yes = 1; no = 0) | −3.10*** | −1.02** | −3.30*** | −3.25*** | −1.07** | −3.43*** |
| | (0.78) | (0.50) | (0.80) | (0.84) | (0.51) | (0.84) |
| RP ∗ $Y_{2008}$ | | | 2.76*** | | | 2.86*** |
| | | | (0.95) | | | (0.98) |
| $Y_{2008}$ (2008 = 1; 2000 = 0) | | | −4.88*** | | | −4.91*** |
| | | | (0.64) | | | (0.65) |
| *Rentlim* (restriction on rental within village) (yes = 1; no = 0) | 1.15 | −0.39 | 0.71 | 0.68 | −1.18 | 0.30 |
| | (1.22) | (1.00) | (0.96) | (1.57) | (1.00) | (1.24) |
| RP ∗ *Rentlim* | – | – | – | 1.43 | 2.04 | 1.19 |
| | | | | (2.40) | (2.12) | (1.92) |
| Soil quality: medium (medium = 1; others = 0) | 4.07*** | −2.43** | 1.01 | 4.06*** | −2.44** | 0.99 |
| | (1.08) | (0.94) | (0.74) | (1.08) | (0.94) | (0.74) |
| Soil quality: high (high = 1; others = 0) | 4.99*** | −1.31 | 2.11*** | 4.98*** | −1.32 | 2.11*** |
| | (1.13) | (1.04) | (0.80) | (1.13) | (1.04) | (0.81) |
| Land terrain of plots (plains = 1; nonplain = 0) | −4.06*** | −3.06*** | −3.97*** | −4.05*** | −3.07*** | −3.97*** |
| | (0.91) | (0.53) | (0.52) | (0.91) | (0.53) | (0.52) |
| Irrigation status (irrigated = 1; rainfed = 0) | −7.26*** | −0.98* | −4.11*** | −7.27*** | −0.99* | −4.12*** |
| | (0.96) | (0.54) | (0.55) | (0.96) | (0.54) | (0.55) |
| Distance of plot from home (km) | −2.33*** | 0.01 | −1.03*** | −2.33*** | 0.02 | −1.03*** |
| | (0.49) | (0.29) | (0.28) | (0.49) | (0.29) | (0.28) |
| Area/size of plot (hectares) | −11.41*** | −0.46 | −2.35*** | −11.45*** | −0.45 | −2.35*** |
| | (2.27) | (0.39) | (0.88) | (2.24) | (0.39) | (0.88) |
| Constant | 14.58*** | 7.96*** | 13.17*** | 14.58*** | 7.99*** | 13.22*** |
| | (1.26) | (1.03) | (0.95) | (1.26) | (1.03) | (0.96) |
| Observations | 793 | 844 | 1,637 | 793 | 844 | 1,637 |
| Adjusted $R^2$ | 0.16 | 0.06 | 0.14 | 0.16 | 0.06 | 0.14 |
| *F* value | 16.97 | 8.04 | 17.56 | 15.27 | 7.15 | 15.97 |

*Note:* All numbers in parentheses are robust standard errors. ***, ** and * represent statistically significant at 1%, 5%, and 10%, respectively.
[a]Columns 1 and 2; columns 4 and 5 contain estimates of parameters that are specified in Eq. (1) from the text. Column 3 and column 6 contain estimates of the parameters that are specified in Eq. (2).

require the approval of village leaders before being able to negotiate and conclude cultivated land rental transactions; and 0 if they can rent-in and rent-out cultivated land without any limitations.[4] If improved property rights were to lead to a mitigating effect by inducing farmers to invest more, then, the sign should be negative (since of variable measures poor property rights).

An even cleaner test can be made to isolating the effect on own cultivated land. If we only add *Rentlim* to Eq. (2), we are asking if property rights affect either the rented-in plot or the cultivated plot. To isolate the effect on the own plots of farmers, we not only add the *Rentlim* variable, we also add an additional variable, *RP ∗ Rentlim*, which is the interaction between poor property rights variable (*Rentlim*) and a dummy variable for rented in plots as the follow:

$$M_{ip} = \alpha + (\beta_0 + \gamma * Y_i)RP_{ip} + \eta Y_i + \rho Rentlim_{ip} + \theta(RP \; * \; Rentlim)_{ip} + \sum_{j=1}^{6} \delta_j D_{ip}^{j} + g_i(Z) + \varepsilon_{ip}. \quad (4)$$

If improved property rights were to lead to a mitigating effect by inducing farmers to invest more in their own land, then, holding the effect of the property rights on rented in land constant (using *RP ∗ Rentlim*), the sign on the *Rentlim* should capture the effect of property rights restrictions on own cultivated land (and, as such, would be negative if this were an important effect).

Finally, we can run a model using only own cultivated plots, a regression that will have many more observations since (it should be recalled) the entire analysis to this point only used households that cultivated both rented in plots and own cultivated plots. In this case the model is similar to Eq. (2) except we drop the two variables *RP* and $RP * Y_{2008}$ and add *Rentlim* and $Rentlim{*}Y_{2008}$.

When running our new models to test the effect of improved rights to engage in cultivated land rental, Tables 9 (rows 4

[4]The measure that we use in this paper, in fact, is a bit different than that used by Carter and Yao (1999, 2002). In their paper, the variable equaled 1 if all cultivated land rental transactions were prohibited; and 0 otherwise. In our 2000 survey (the first wave of the survey) we also asked a question that was patterned after that used in Carter and Yao (1999). In the results of our survey, there were zero villages that had such restrictions. Hence, the exact same analysis cannot be carried out in either 2000 or 2008. Clearly, cultivated land rental markets had improved between the early 2990s, the time of the survey that was used in Carter and Yao, and our survey.

Table 10
Ordinary least squares (OLS) estimates of the impact of rent-limitation on organic manure investment in own cultivated land in China, 2000 and 2008

| | 2000 (1) | 2008 (2) | Pooled (2000 and 2008) (3) |
|---|---|---|---|
| Rentlim (yes = 1; no = 0) | −0.46 | 0.70 | −0.36 |
| | (0.59) | (1.47) | (0.54) |
| $Y_{2008}$ (2008 = 1; 2000 = 0) | | | −3.43*** |
| | | | (0.34) |
| Rentlim$*Y_{2008}$ | | | 2.36 |
| | | | (1.80) |
| Soil quality: medium (medium = 1; others = 0) | 1.55** | −0.59 | 0.77* |
| | (0.61) | (0.57) | (0.43) |
| Soil quality: high (high = 1; others = 0) | 2.23*** | 1.24* | 1.83*** |
| | (0.70) | (0.66) | (0.49) |
| Land terrain of plots (Plains = 1; nonplain = 0) | −3.52*** | −1.67*** | −2.90*** |
| | (0.49) | (0.44) | (0.34) |
| Irrigation status (irrigated = 1; rainfed = 0) | −2.21*** | −2.46*** | −2.24*** |
| | (0.49) | (0.43) | (0.33) |
| Distance of plot from home (km) | −2.02*** | 0.14 | −1.35*** |
| | (0.27) | (0.30) | (0.20) |
| Area/size of plot (hectares) | −14.10*** | 0.68 | −5.30*** |
| | (2.02) | (1.42) | (1.24) |
| Constant | 13.41*** | 7.75*** | 12.35*** |
| | (0.64) | (0.60) | (0.47) |
| Observations | 3,816 | 2,880 | 6,696 |
| Adjusted $R^2$ | 0.06 | 0.02 | 0.05 |
| *F* value | 33.44 | 8.88 | 38.35 |

*Note:* All numbers in parentheses are robust standard errors. ***, ** and * represent statistically significant at 1%, 5%, and 10%, respectively.

and 5) and 10 (rows 1 and 2) show that property rights do not have a significant effect on increasing investment of organic manure. Moreover, over time, there is no increasing or decreasing effect. All of the coefficients in all of the models are insignificant (including those in which we interact with the 2008 year dummy). In villages with restrictions on cultivated land rental and in villages without restrictions, investment of organic manure on own cultivated plots is statistically the same. Such a finding is in stark contrast to the findings of Carter and Yao (1999, 2002).[5]

Why might our results differ from those of Carter and Yao (1999, 2002)? Almost certainly the absence of significant results is due to the fact that property rights for cultivated land rental had already improved markedly since the early 1990s when the data that were used in Carter and Yao's studies. In 100% of the villages in our sample in 2000, farmers were allowed to rent in and rent out cultivated land. In addition, the restrictions imposed by village leaders on cultivate land rentals were almost all gone. According to our data, in only 18% of villages did village leaders require farmers to get approval for cultivated land rental (that is, the value of *Rentlim* = 0.18). In the other 82% of the villages, there were zero restrictions. By 2008, only 2% of the villages had restrictions. Hence, not only was the share of villages in which there were any restrictions in 2000 (2008) low (almost nonexistent), the nature of the restrictions were less prohibitive. It is no wonder then that we find no impact of improved property rights on investment in our sample. By 2000 property rights were more or less complete in the case of cultivate land rentals.

[5]The results are robust to two alternative ways of measuring the relationship. First, if instead of *Rentlim*, we used an alternative measure of village level restrictions on cultivated land area, Rent-Share, which is measured as the share of cultivated land in the village that is rented in/out, we get a similar result. Second, using village level data for two years (the number of observations equals 58 villages × 2 years = 116), when we regress the average village level of organic fertilizer use on the share of cultivated land in the village that is rented (controlling for a number of other time-varying, village-level variables and a set of village dummy variables), the coefficient also is zero. We do not show the results in this paper in order to save space, but the results are available upon request to the authors.

## 7. Summary and conclusions

The objective of this study has been fairly simple and we have accomplished most of what we have set out to do. The markets for cultivated land rental have emerged robustly. Indeed, according to our data, 19% of China's cultivated land is being rented for farm operations, a figure that is high internationally—especially among developing countries. Assuming that cultivated land rental produces benefits for farmers, including gains from economies of scale and higher labor productivity, rising cultivated land rental markets are contributing to the welfare of China's farming population.

However, there are those that express concern that rising cultivated land rental rates may also have a cost in terms of decreasing investment in the land, including the application of organic manure. Indeed, our data show that there are falling rates of investment in organic manure. The farmers in our sample have reduced organic manure use from 13 tons/hectare in 2000 to 5 tons/hectare in 2008. While we know there are many other factors that are affecting investment, we examined whether or not increasing cultivated land rental transactions is contributing to the decreasing levels of investment in organic manure. Both descriptive statistics and multivariate analysis demonstrates that, in fact, when farmers rent-in land, organic manure investment does fall significantly. Our results have identified many other factors that affect investment in organic manure, while also suggesting other nonincluded factors, e.g., rising wage rates and the commercialization of hog and other livestock production. Therefore, when counting the benefits of cultivated land rental to farmers—of which there are many—there are also costs.

Our results, however, show that there are forces that appear to be mitigating the negative consequences of rising cultivated land rental. After holding constant all factors that we can, we find that the gap between investment in organic manure in own cultivated land and rented-in land is narrowing. We do not know definitively why. However, we did show that the nature of rental agreements between lessor and tenant is changing and that the length of the contract period is becoming longer—both according to the agreements and in actuality. It seems plausible that if the contract period lengthens, farmers—even those that rent—will invest as they are able to capture the returns to their investment.

The policy implications of these findings, however, must be carefully drawn as the results are still tentative and inconclusive. The negative impact of cultivated land rental transactions needs to be balanced by the benefits. We have not documented the benefits here, but other authors have. The results of all such studies need to be weighed together.

In addition, the apparent positive impact of evolving contractual terms (if that is what is indeed driving our results) needs to be explored further. If it is found that giving more secure rights to farmers when they rent their land out (as the 2003 Contracting Law does) does lead to longer contract periods and longer contract periods lead to higher investment by tenants, it is clear that further improving contractual rights of farmers (and enforcing the rights that are already present) could be win-win. The better rights will lead to more cultivated land rental, which will benefit all parties, and any negative effects of land rental can thereby be reduced. Certainly, issues of this type need careful study in the future.

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## Appendix

Table A1
Descriptive statistics of the dependent and independent variables used in the regression analysis

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Organic manure (tons/hectare) | 5.4 | 10.3 | 0 | 60 |
| Share of rented-in plots, *RP* (yes = 1; no = 0) | 0.32 | 0.47 | 0 | 1 |
| $Y_{2008}$ (2008 = 1; 2000 = 0) | 0.52 | 0.50 | 0 | 1 |
| Rentlim (yes = 1; no = 0) | 0.06 | 0.24 | 0 | 1 |
| Soil quality: medium quality (Medium quality = 1; other = 0) | 0.56 | 0.50 | 0 | 1 |
| Soil quality: high quality (High quality = 1; other = 0) | 0.28 | 0.45 | 0 | 1 |
| Land terrain (plain land = 1; nonplain or hilly/mountainous = 0) | 0.58 | 0.49 | 0 | 1 |
| Irrigation status (irrigated = 1; rainfed = 0) | 0.64 | 0.48 | 0 | 1 |
| Distance of plot from home (km) | 0.64 | 0.68 | 0 | 7.5 |
| Area/size of plot (hectares) | 0.12 | 0.22 | 0.0013 | 3.3 |

*Note:* the size of sample is 1637.

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