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Land Rental Markets in the Process of Rural Structural Transformation:

Productivity and Equity Impacts in China

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Abstract

The importance of land rental for overall economic development has long been recognized in theory, yet empirical evidence on the productivity and equity impacts of such markets and the extent to which they realize their potential has been scant. Representative data from China's nine most important agricultural provinces illustrate the impact of rental markets on households' economic strategies and welfare, and the productivity of land use at the plot level. Although there are positive impacts in each of these dimensions, transaction costs constrain participation by many producers, thus preventing rental markets from attaining their full potential. The paper identifies factors that increase transaction costs and provides a rough estimate of the productivity and equity impacts of removing them.

This paper—a product of the Sustainable Rural and Urban Development Team, Development Research Group—is part of a larger effort in the group to assess the impact of land policies. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at kdeininger@worldbank.org and jins@anr.msu.edu.

Land Rental Markets in the Process of Rural Structural Transformation:

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1. Introduction

Although the importance well-functioning factor markets for increasing productivity and fostering structural change has long been recognized, much of the literature on land rental is based on settings with historically unequal access to land and power. In such environments, land rental was important to help transfer land from large owners to landless workers or small landowners and thus achieve outcomes that were more efficient than wage-labor based cultivation. With traditional technology, high levels of risk, and lack of alternative opportunities, the scope for potential renters to bargain was limited especially where population growth led to a decrease in the amount of land available.

However, economic growth, greater availability of off-farm employment, and the scope to add value by linking to supply chains and global markets all create opportunities to improve labor productivity in rural areas. Exploiting these fully will require well-functioning factor markets, including for land. It has long been noted that low-cost and flexible mechanisms to bring land to its most productive use can generate opportunities to transform rural economies and increase welfare (de Janvry *et al.* 2001). Compared to other options such as sale, land rental requires less capital outlay and provides greater inter-temporal flexibility while offering an opportunity to choose contractual forms to ameliorate the impact of imperfections in other markets and allowing even owners working off-farm to continue enjoying the benefits of land ownership (Otsuka and Hayami 1988). While the potential importance of rental markets in the context of structural change is well recognized in principle, empirical analysis is still limited, implying that it is difficult to assess the benefits from operation of such markets and the extent to which their performance may be constrained by policy. With near-universal land access and one of the fastest-growing economies in the world, China provides an opportunity to study an issue that is likely to be faced by countries in the not too far future.

In this paper, we use the case of land rental in this country to explore the productivity- and welfare-gains due to land rental, the factors determining participation, and the extent to which it lives up to its potential in fostering structural change. Information on the other party in land market transactions and the productivity of plots before and after having been transferred in the market allows inferences on the benefits from land rental in terms of diversification of income sources, household welfare, and agricultural productivity. A model of producers with given innate levels of agricultural ability, an exogenous non-agricultural wage rate, and transaction costs of land rental provides a basis for predictions on the impact of changed availability of non-agricultural employment opportunities and the level of transaction costs on land markets, occupational choice, agricultural productivity, and the distribution of income that can then be tested empirically.

Descriptive data point towards a surprisingly large effect of land rental on productive efficiency, with an estimated net revenue increase of almost 60% -one-third of which accrues to landlords and two thirds to tenants- thus providing a basis for increasing both parties' welfare. The importance of land

rental for non-agricultural employment, mostly through migration, is illustrated by the fact that 57% of sample landlords had their main income from agriculture before renting their land but only 17% continued to do so thereafter. Despite the economic benefits from land rental, local regulations and tenure insecurity increase the associated transaction cost, thus constraining participation by some households and the associated welfare gains. Respondents' subjective perceptions and the fact that - despite the significant productivity losses entailed in such *a priori* limitation of the set of possible transaction partners- a large part of them transact exclusively with relatives support this notion.

Econometric analysis based on an ordered probit model with variable thresholds allows not only identification of factors conducive to better land rental market operation but also appreciation of their relative importance. We find strong support for a factor equalization effect of land rentals whereby, as the better educated join the non-agricultural labor force, the poor and less educated will be able to gain by renting in additional land. A growth effect is visible from the fact that rental markets tend to be more active in area with more off-farm economic opportunities. Finally, although there is evidence that transaction costs and regulations have a statistically significant effect on land market participation, econometric estimates suggest that the magnitude of this effect is comparatively small and instead migration and occupational change emerge as key drivers of land rental.

The paper is structured as follows. Section two motivates the paper by summarizing how the emphasis on productivity effects of contract choice may need to be complemented by analysis of participation decisions, summarizes the evolution of China's land tenure system, and describes available data. This is followed by evidence on the impact of rental markets on occupational choice, income levels of both parties, productivity effects, and the extent to which rental may fully exhaust available opportunities. Section three uses a household model to derive propositions on factor equalization, transaction cost, and growth effects of rental and to chart an empirical strategy for estimating these. This is followed by presentation and discussion of the econometric results. Section four concludes by drawing out implications for policy in China and other countries and by identifying areas for follow-up research.

2. Background and motivation

To motivate our analysis, we place the evolution of land tenure and land markets in China in the context of the literature, highlighting that the traditional emphasis on land rental as a means to equalize highly unequal factor endowments and on the efficiency properties of different contractual arrangements in such markets has limited applicability to China. We then use our data to describe general features of the rural economy, the emergence of rental markets and their large impact on diversification of income sources, household welfare, and productivity of land use to set the stage for a more in-depth discussion of the conceptual underpinnings of land rental.

2.1 Evolution of land tenure and land markets in China

A large literature on contract choice discusses properties of rental contracts in an environment characterized by multiple market imperfections and (implicitly) unequal ownership distribution of land which rental markets help to equalize. Considerable emphasis has been on efforts to reconcile the widespread incidence of sharecropping in many parts of the world with the prediction that this contractual form to be associated with large inefficiencies. Many studies have focused on identifying conditions under which, in an environment characterized by risk and uncertainty, wealth constraints, and moral hazard, sharecropping could be a second best choice that will be difficult to improve upon unless key environmental parameters change (Shetty 1988, Basu 1992, Otsuka *et al.* 1992, Laffont and Matoussi 1995, Banerjee *et al.* 2002, Dubois 2002). Considerable effort has been expanded to empirically quantify the extent to which share contracts will lead to productivity losses (Shaban 1987, Otsuka and Hayami 1988, Otsuka *et al.* 1992, Pender and Fafchamps 2006).

Although some contributions consider factors affecting tenants' and landlords' incentives to enter into specific contracts, a main focus is on contract properties and the decision to rent is often taken as given. In the context of economic development, more and more countries are expected to transfer labor out of the agricultural sector and rely on other sectors as the mainstay of their economy. How the rural sector deals with this will affect the rate and nature of economic growth (World Bank 2007). Complementing analysis of contractual forms with an assessment of the factors affecting functioning as well as productivity-and welfare impacts of rental markets will thus become of increasing interest and policy relevance. To provide the necessary background, we briefly review China's land history.

Before the communist revolution, most of China's farmers were poor tenants or owners of small plots of land. After taking over, the communist government confiscated large landlords' holdings and distributed land to households on an egalitarian basis (Prosterman *et al.* 1990). In the 1950s, a policy of collectivization that required farmers to surrender land to collectives was adopted, with negative consequences for output and rural welfare (Putterman and Skillman 1993, Yao 1999, Lin and Yang 2000). To increase production, the 1978 Household Responsibility System (HRS) made households residual claimants to output, setting off tremendous increases in output and productivity (McMillan *et al.* 1989, Lin 1992).[1] Structural change since then has been dramatic; agriculture's employment share is estimated to have dropped from more than 70% in 1978 to less than 50% by 2000 (Johnson 2002), in a process of structural change that is expected to continue in the future.

Instead of a big-bang reform, the land tenure system underpinning these changes evolved gradually in response to needs. In 1978, villages started issuing 15-year land use contracts to farmers. However, these contracts often remained verbal and rarely protected against administrative land reallocations (Rozelle *et al.* 2002). Land transfers were still expected to be administered by village leaders (Kung

[1] In urban areas, land was either allocated by the state or long term leases were acquired by private users upon payment of a fee. Land acquisition provided advantages by giving owners the ability to participate in the secondary land market, use the land as mortgage, and rent it to others. Between 1993 and 1998, the amount transacted annually increased from about 11,000 to almost 1.1 million ha and the amount of land mortgaged rose from about 1,000 to 884,000 ha (Ho and Lin 2003).

and Liu 1997),[2] whose failure to capitalize on rapidly increasing opportunities led to productive inefficiency (Benjamin and Brandt 2002). Initially on an informal basis, decentralized land transfers thus complemented and gradually overtook administrative mechanisms (Yao 2000, Kung 2002). Still, renting out of land by a migrant or a person engaging in local off-farm activities could be perceived as a signal that the land was no longer required and could be subjected to administrative reallocation (Yang 1997, Brandt *et al.* 2004). Higher tenure security therefore emerged as precondition for more active rental markets to foster evolution of a vibrant off-farm economy.

To respond to this, and in line with results from local land tenure experiments (Kung 2006), legal measures to strengthen tenure security were put in place, first through the 1998 Land Management Law and then the 2003 Rural Land Contracting Law. In response, land rental markets, which had been virtually non-existent by the mid-1990s, emerged rapidly, with participation rates above 10% in 2001 (Deininger and Jin 2005). Migration and non-farm employment motivate an increasing number of households to move out of agriculture (Rozelle *et al.* 1999b, de Brauw *et al.* 2000), with far-reaching social and economic implications (Zhao 2002). China thus provides an ideal setting to explore impacts of land rental on productivity and household welfare and factors determining participation in such markets in settings where non-agricultural growth and differential ability are emerging as main drivers of adjustments through factor markets (Liu *et al.* 1998, Zhai and Wang 2002).

2.2 Data and descriptive evidence

Our empirical investigation is based on a 4-period panel (2001-2004) of almost 8,000 households in about 800 villages that is representative of China's 9 agriculturally most important provinces.[3] Household level information is from the ongoing consumption survey conducted by the Rural Survey Team of China's National Bureau of Statistics (NBS) that includes detail on demography, assets, income, expenditure, agricultural production, and land market participation and is generally considered to be a very high quality survey (Jalan and Ravallion 1999). These data are complemented by a village level schedule, answered by local leaders based on administrative records, that obtains information on levels of income, migration, key endowments, institutional arrangements (e.g. no. of land use certificates issued) and land use regulations and land market restrictions from 1999 onwards. Finally, a supplemental questionnaire administered to households involved in land transactions elicits information on contractual details, current and past occupation and income levels by the respondent and his or her partner, and revenue from agricultural production on the land plot before it was rented.[4]

[2] Exchanges of land within the village had been prohibited before the 1986 Land Management Law legalized them. Transfers to outsiders remained illegal until allowed in 1998, although without clarifying specific modalities to be followed (Li 2003).

[3] Earlier analysis of rental markets in China assessed differences in outcomes between rental markets and government reallocation whereas here the emphasis is on the size of the efficiency impact of land rental and factors that could prevent market operation. Correspondingly, in this paper determinants of renting in and out are modeled and estimated jointly rather than through simple probit models as was done earlier. Moreover, data coverage is greatly expanded, covering the China's 9 key agricultural provinces over a 4-year period rather than just three poor southwestern ones for a much shorter panel.

[4] The fact that these data rely on recall and in part refer to income or productivity by another household may lead to concern about bias. For panel households, checking the consistency of recall against earlier income levels pointed towards some noise (see below). In cases where both parties were present, cross checks conducted during the pre-test of the survey instrument pointed towards a high level of consistency

Descriptive statistics for key variables at the national and regional level as reported in table 1,[5] point towards differences in income, migration, endowments, and local policy across regions and highlight the increasing importance of land markets. While primary education has become almost universal, 52% and 18% of households have a head with secondary or high school education, respectively. Schooling attainment is lower in the Southwest (46% with secondary and 9% with high school), followed by the Center (45% and 18%, respectively) and the North and Coast regions. The mean per capita land endowment is 1.68 mu,[6] a figure that ranges from 1.13 in the Southwest to 2.30 in the Northeast. The amount of non-land assets, about 27,000 Y on average,[7] varies across provinces, from 36,000 in the Coast to 17,000 in the Southwest, the country's poorest region. With a contribution of about 58% to total income, agriculture remains the most important source of income overall, ranging from almost-two thirds (63%) in the Southwest to slightly less than half of the income in the Coast.

Not surprisingly, as land had been distributed on an egalitarian basis in the 1980s and many villages had conducted land reallocations to respond to demographic changes since then (Rozelle *et al.* 2002), the Gini coefficient of the land ownership distribution is, with 0.41, lower than the 0.75 or 0.89 found in India or Brazil (Deininger and Squire 1998). 13% and 10% of producers rented in or out, respectively during 2002-2004. Still, most rental transactions remained informal; 60% of participants reported to have a contract, less than 10% of contracts were in writing and 75% open ended while the remaining 25% were for about 3 years. Interestingly, almost 40% of producers (54% in the Southwest and 59% in the Northeast) rent in from a relative. With participation rates of 21% and 15%, land rental is most active in the Central and Southwest regions which also have the highest levels of migration, suggesting links between these phenomena (Kung 2002). 18% of households -from 25% in the Center to 10% in the Northeast- include at least one migrant and while 17% of migrants crossed provincial boundaries in the Coast, more than two thirds did so in the Center. Institutional arrangements likely to be of relevance for rental decisions differ across regions. While the 1998 land law mandates issuance of land use certificates, only 81% -from 74% in the Northeast to 92% in the Southwest- had certificates. In 2001, about 10% of villages, from 4% in the Southwest to 16% in the Coast, had a policy allowing the village to take back land left uncultivated for one season and 14% (from 26% in the Coast to 5% in the Southwest) prohibited land rental to outsiders.

Splitting the sample by type of land market participation (appendix table 1) illustrates such trends. With per capita land endowments of 2.1 mu for 'landlords' vs. 1.5 mu for tenants, rental equalizes factor ratios. Also, as 'landlords' rely less on agricultural income than tenants (53% vs. 65%) but

between information obtained from the tenant and the landlord. This is not surprising as potential contracting partners have strong incentives to obtain good information on the productive potential of specific plots they are going to rent or the economic situation of potential partners. While there may be some residual noise in the data, this strongly argues against potential systematic bias.

[5] The four regions are defined as follows: North and Northeast includes Liaoning and Henan provinces, Coastal Zhejiang and Shandong, the Center Henan and Hubei, and the Southwest Hunan, Sichuan and Guizhou provinces. In table 1, information in the two top panels is from NBS' household survey while panels 2 and 3 are based on the follow-up survey of those renting land and panel 5 on our village survey.

[6] One mu equals 1/15th of a hectare.

[7] At the time of the survey, the exchange rate was approximately 8 Y to 1 US dollar.

derive higher parts of income from migration/transfers (24% vs. 19%), wages (12% vs. 7%), and non-farm self-employment (11% vs. 9%) land rental facilitates diversification of the occupational structure.

2.3 Impacts of rental market participation

Although the above is suggestive, robust inferences on occupational shifts and welfare or productivity effects of land rental markets require analysis of changes for the same household or plot over time. Its shortcomings notwithstanding, our supplemental survey of rental participants and their partners can provide such evidence. We focus on changes in main occupation to gains in income and productivity and evidence on whether or not land markets realize their full potential.[8]

Changes in main income sources by households renting out land (table 2) point to land rental as basis for income diversification. Before renting out land, the vast majority (57%) of these households relied on agriculture, followed by local non-farm employment (23%) and migration (20%). The ability to engage in land rental completely changed this; after renting out land, the share of households deriving their main income from migration had increased by 35 points to 55%, followed by 29% in local off-farm employment, and only 17% who remain in agricultural production, i.e., a total of 40 points less than before land rental. Inspection of the transition matrix highlights that virtually all of the change was due to households shifting out of full-time agriculture to migration (33 points) and local non-farm employment (8 points), complemented by some shift from non-farm employment to migration (3%).

Levels of net per capita income in broad categories before and after land rental for those renting out and in, respectively, provide a better understanding of welfare effects from land rental. The top panel of table 3 shows that rental participation allowed many landlords to increase their incomes: 45% moved up by at least one category, 54% remained in the same category, and less than 1% moved down. While the need to rely on ranges rather than exact figures makes it impossible to compute the impact on average income; the share of landlord households with a per capita income of less than 1,500 Y dropped by 20 points, from 30% to 10%, consistent with evidence that those with low asset endowments engage in migration (Deininger and Jin 2006). The share of households with incomes above 3,000 Y increased from 26% to 47% of the total. The transition matrix for tenants' income (bottom panel of table 3) before and after land rental also signals improvement; although some two thirds remained in the same income bracket, about one third moved up and only about 1% moved down. With the majority of impacts concentrated at the bottom of the distribution, the distributional impact was unambiguously positive: the share of households in the poorest group (< 1,500 Y) declined from 21% to 10%, a 5 point decrease is observed in the share of households in the 1,500-3,000 Y bracket, and the share of those obtaining more than 3,000 Y increased from 27% to 42%.

[8] Note that the evidence provided is cumulative. While it is very easy to give the sector of employment, estimates of income categories or productivity are likely to be more noisy.

While rent-out households may have moved out, tenants will remain in the sample, allowing us to independently check the above results and to derive a more robust measure of the income change due to land rental. We do so by running a household fixed effect regression of net income (after rental fees) on area rented in and year dummies to control for time varying factors, we find that, while year dummies are highly significant, renting in increases incomes for the same household by about 10% (t of 4.56). Concerns that reliance on land markets would have a negative equity impact as compared to making land available "for free" through administrative means thus have little empirical foundation.

As any sustained income gains beyond zero-sum redistribution need to be supported by higher levels of productivity, closer scrutiny of this variable will be of interest. Data on net revenues excluding family labor from a plot before and after it had been rented support the hypotheses of significant improvements in productivity through land rental (Table 3). With a gain of 267 or 283 Y/mu amounting to an increase in net revenues of 84% or 83%,[9] figures obtained from tenants and landlords, respectively, are surprisingly consistent.[10] With rental payments inclusive of taxes amounting to about 90 Y/mu, about two thirds of the surplus from land rental accrues to tenants and one third to those renting out. With a mean of 3 mu per land transaction, the increase in net income for the tenant due to rental market participation amounts to about 550 Y. Although the difference used above nets out unobservable but time invariant plot characteristics such as soil quality, the estimated productivity impact of land rental will be biased upwards by any independent changes in productivity, e.g. due to technical change. To adjust this, we pool data for changes in net income at the plot level as reported by rental market participants with the difference in net revenue between 2001 and 2004 per mu (Δy) for the 6100 households who remained in autarky throughout the period (essentially treating the entire household as one plot), to obtain a sample of 7,968 observations.[11] Letting R^{in} and R^{out} be dummies for renting in and out and D a vector of regional dummies, the coefficients α_1 and α_2 in a regression of the form $\Delta y = \alpha_0 + \alpha_1 R^{in} + \alpha_2 R^{out} + \beta D$ provide an estimate of net productivity increases due to rental. With values of 186 Y/mu for α_1 and 180 Y/mu for α_2 (t-statistics of 4.75 and 3.24; R^2 of 0.56), estimates suggest productivity increase of slightly below 60% due to land rental.

To assess whether rental fully capitalized on available opportunities, we use households' subjective perception of constraints and systematic differences in productivity changes between land rented to relatives and non-relatives. Concerning perceptions, households were asked whether they ever wanted to rent out (or in) more than they could obtain in the market and whether they feel confident that in the future they will be able to use rental to fully adjust to the desired level of operational land holding.

[9] If both apply equivalent amounts of family labor, the change in net revenue is equivalent to an increase in productivity. As, with 81 versus 91 days per mu, renters actually spend slightly less time on agricultural activities than autarkic cultivators, this assumption seems justified.
[10] Recall that, in cases where the landlord migrated out, asking the tenant is the only feasible way of obtaining such information. As we are using brackets and broad job categories, information obtained from both partners in the pre-test for cases where doing so was feasible was internally very consistent.
[11] If higher managerial ability by rent-in households imply a systematic difference in the *rate*, rather than just the *level* of productivity growth, this estimate may still be biased. As information on agricultural inputs is available only at the household level, it was not possible to conduct the more appropriate comparison between changes in net revenue for owned and rented in plots by the same household.

Responses, in the bottom panel of table 3, suggest friction on both sides of the market. Almost 40% had unsatisfied demand at some point in the past and 12% wanted to supply more land than the market could absorb.[12] The share of households who are "not confident" about being able to rent in their desired amount is, with 45%, slightly above the share of those rationed in the past and 23% are concerned to not be able to rent out the desired amount of land in the future.

If partner choice in rental markets is guided only by productivity considerations, there should be no systematic difference in productivity changes due to rental between plots rented to relatives and non-relatives. However, tenure insecurity and a perceived greater scope to either enforce contracts with relatives or conceal rentals with the former and thus avoid being caught in violation of existing regulations and facing the consequence of possible land loss could be a reason for households entering into contracts with relatives with lower productivity as the "price" they are willing to pay for these advantages. Comparing productivity changes between plots rented to relatives and non-relatives (table 3, cols 2 and 3) indeed points towards large and significant differences, with productivity gains from renting to non-relatives almost 80% higher than from transactions involving relatives. Of course, part of the gap could be explained by altruistic motives or informational imperfections rather than policy constraints. To gain further insight into this, we include actual policies into our econometric analysis.

3. Conceptual framework, econometric approach, and key results

Although the descriptive evidence suggests a positive impact of rental markets, identifying factors that encourage or discourage participation in such markets and assessing their importance requires econometric analysis. Following the presentation of a household model of rental market participation, we discuss the ordered probit framework for estimation and some of the results relevant in our context.

3.1 Conceptual framework

To capture factors affecting participation in land rental markets, we use a simple model of agricultural production. Let household *i* be endowed with fixed amounts of labor $\overline{L_i}$ and land $\overline{A_i}$, and a given level of agricultural ability α_i (Carter and Yao 2002). Agricultural production follows a production function $f(\alpha_i, l_{ia}, A_i)$ with standard properties, i.e. $f'>0$, $f''<0$ with respect to all arguments and $f_{lA}>0$. Labor supervision constraints and the egalitarian distribution of land endowments imply limited scope for emergence of agricultural labor markets (Binswanger *et al.* 1995). Households thus allocate their labor between farming on own or leased land $l_{i,a}$ and off-farm employment $l_{i,o}$ at an exogenously given wage *w*. We abstract from credit market imperfections, noting that these can be overcome through

[12] One of the reasons is likely to be that, despite legal provisions to the contrary, land reallocations by village leaders continued at surprisingly high rates (Deininger *et al.* 2006). At the same time, more than 80% indicated that the 2003 rural land contracting law (RLCL) has made transfers of land through the market easier, although it did not fully eliminate constraints to participation.

appropriately structured rental contracts. [13] While $f(\alpha_i, l_{i,a}, A_i)$ is subject to constant return to scale (e.g. $f(\alpha_i, l_{i,a} A_i) = \alpha_i^{1-\beta_1-\beta_2} l_{i,a}^{\beta_1} A_i^{\beta_2}$ in the Cobb-Douglass case) but that, as ability is not tradable, $f(l_{i,a} A_i) = l_{i,a}^{\beta_1} A_i^{\beta_2}$ is subject to decreasing return to scale in land and labor (Conning and Robinson 2007).

In the above setting, households' decision variables are $l_{i,a}$ and $l_{i,o}$, the amount of labor devoted to farming and wage employment, and the amount of land to be farmed, which implies the amount of land rented in or rented out. Renting of land incurs transaction costs which can be different for renting in (TC^{in}) and for renting out (TC^{out}). Standard elements of transaction cost such as the expense of acquiring information on potential partners and negotiating and enforcing contracts affect both parties equally. As the risk of land loss, most likely because rental is understood as a signal that could trigger land redistribution (Rozelle *et al.* 2002) is of relevance only for landlords, i.e. it will affect only TC^{out}. Letting transaction costs be proportional to the amount of land transacted, [14] household *i*'s decision problem is to choose A_i, $l_{i,a}$ and $l_{i,o}$ to solve

$$\underset{l_{i,a}, l_{i,o}, A_i}{Max} \; pf(\alpha_i, l_{i,a}, A_i) + w l_{i,o} - I^{in}[(A_i - \overline{A}_i)(r + TC^{in})] + I^{out}[(\overline{A} - A_i)(r - TC^{out})] \qquad (1)$$

$$\text{s.t.} \;\; l_{i,a} + l_{i,o} \le \overline{L} \qquad (2)$$

where, in addition to the variables defined earlier, p is the price of agricultural goods, I^{in} is an indicator for renting in (1 for rent-in, and 0 otherwise) and I^{out} is a similarly defined indicator for renting out (1 for rent-out and 0 otherwise). Assuming that (2) holds with equality, the optimal choices, $l_{i,a}^{*}$ and A_i^{*} solve the first order conditions (FOCs)

$$pf_{l_i,a}(\alpha_i, l_{i,a}, A_i) = w \qquad (3)$$

and for households who rent in ($A^{*} > \overline{A}_i$), $\quad pf_{A_i}(\alpha_i, l_{i,a}, A_i) = r + TC^{in}$ (4)

for households who rent out ($A^{*} < \overline{A}_i$), $\quad pf_{A_i}(\alpha_i, l_{i,a}, A_i) = r - TC^{out}$ (5)

and for autarkic households ($A^{*} = \overline{A}_i$), $\quad r - TC^{out} < pf_{A_i}(\alpha_i, l_{i,a}, A_i) < r + TC^{in}$ (6)

Comparative statics based on equations (3)-(6) allow us to derive three propositions relating to factor equalization, transaction cost, and growth effects that provide the basis for our empirical hypotheses as follows (see the appendix for detailed proofs).

Proposition 1: The amount of land rented in (out) is strictly increasing (decreasing) in households' relative agricultural ability, α_i, and strictly decreasing (increasing) in their land endowment $\overline{A}_i$. Land

[13] The notion that households are able to structure rental contracts flexibly to overcome liquidity constraints is supported by the fact that, according to our data, 86% of contracts at the national level, and more than 90% in the poor Southwestern provinces, involve rental payment at harvest time.

[14] Although the relationship between transaction costs and area transacted is not necessarily fully proportional, we treat transaction costs for either side of the markets as variable cost, following other examples in the literature (Kimura *et al.* 2007)

rental will transfer land to efficient, but land-poor producers thereby contributing to higher levels of productivity and more efficient factor use in the economy and inclusion of (relative) ability implies a role for land markets even in environments with egalitarian land ownership distributions.

Proposition 2: The presence of transaction costs defines two critical levels of ability $\alpha_l(TC^{out}, ..)$ and $\alpha_u(TC^{in}, ..)$ such that households with ability $\alpha_i \in [\alpha_l, \alpha_u]$ will remain in autarky. Any increase in TC^{in} or TC^{out} will expand the autarky range, thus reducing the number of producers participating in rental markets and the number of efficiency-enhancing land transactions. Compared to a situation with no transaction cost, this will decrease productivity and social welfare.

Proposition 3: Increases of the exogenously given wage for off-farm employment will imply that higher amounts of land are transacted in rental markets as households with low agricultural ability who join the off-farm labor market will supply more land. This "growth effect" will lead to a decrease in the equilibrium rental rate which will prompt those with high-ability (who specialize in agricultural production) to rent in more land.

3.2 Estimation strategy

Testing the above predictions quantitatively requires measures of agricultural ability and transaction costs. To obtain a measure for the former, we use the time variation in the data to estimate a household fixed effect Cobb-Douglas production function.[15] Let technology be represented by

$$Q_{ijt} = \exp(\alpha_i + \alpha_j) A_{ijt}^{\theta_1} L_{ijt}^{\theta_2} K_{ijt}^{\theta_3} X_{ijt}^{\theta_4} \exp(\phi t) \qquad (9)$$

where Q_{ijt} is the value of agricultural output produced by household i in village j in year t; A_{ijt}, L_{ijt} and K_{ijt}, X_{ijt} are total cultivated area, labor for crop production, value of agricultural assets, and amounts of chemical fertilizer, organic manure, pesticides, and seeds used in production, θ_1, θ_2, θ_3, and θ_4 are technical coefficients to be estimated, α_j is a time invariant village level efficiency parameter that reflects, among others, access to markets, infrastructure, and other factors that change only slowly such as climate, α_i is the time invariant household fixed effect which serves as our measure of ability, and t is a time dummy so that $exp(\phi t)$ measures productivity changes over time. To estimate (9), we take logarithms on both sides, add an *iid* error term, and let $\alpha_{ij} = \alpha_i + \alpha_j$ to obtain

$$q_{ijt} = \alpha_{ij} + \theta_1 a_{ijt} + \theta_2 l_{ijt} + \theta_3 k_{ijt} + \theta_4 x_{ijt} + \phi t + \varepsilon_{ijt} \qquad (10)$$

where a, l, and k denote logarithms of A, L, and K with appropriate subscripts. Multiple observations per household allow to subtract means. Denoting demeaned variables by ~ (i.e. $\tilde{q}_{ijt} = q_{ijt} - \bar{q}_{ij}$) yields

[15] As information is aggregated at the household level, we need to rely on inter-temporal variation to identify household fixed effects. The fact that, for households engaging in land rental, we are unable to separate rented from owned plots could also constitute a source of bias. If, as is commonly assumed, productivity on rented plots is lower than on owned ones, this would impart a downward bias on estimated ability of tenants while leaving estimated ability of landlords unaffected, implying that the estimated coefficient in table 5 would be a lower bound. As out of the 8,451 households for which information is available continuously for all 4 years, only 262 rented in land for 3 or more years, another way of eliminating bias is to estimate ability only for the sample with at least two observations of production on owned land only. Results from doing so are reported in column 3 of table 5 and discussed in the text accordingly.

$$\tilde{q}_{ijt} = \theta_1 \tilde{a}_{ijt} + \theta_2 \tilde{l}_{ijt} + \theta_3 \tilde{k}_{ijt} + \theta_4 \tilde{x}_{ijt} + \phi \tilde{t} + \tilde{\varepsilon}_{ijt} \quad (11)$$

We can then estimate θs and ϕ to recover an composite efficiency parameter α_{ij} composed of households' idiosyncratic farming ability and unobserved village characteristics. Noting that the village effect can be defined as the average of all household fixed effects in the village, i.e. $\hat{\alpha}_j = (\sum_i \hat{\alpha}_{ij})/n_j$ (Mundlak 1961) allows us to obtain an estimate of ability for each producer in the sample by subtracting $\hat{\alpha}_j$ from $\hat{\alpha}_{ij}$.

A second empirical issue is to specify an appropriate econometric framework for transaction costs and parameterize it. According to our model, rental market participation will depend on the households' endowments of land ($\overline{A}$) and family labor ($\overline{L}$), their assets (*K*), and opportunities for off-farm employment (*O*). Let $g(\alpha, A, \overline{L}, K, O)$ be a household's net earning function that includes all farm and non-farm earning activities except the net rental income including transaction costs for market participants, and $g'(a, \overline{A}, \overline{L}, K, O)$ be the first derivative of $g(a, A, \overline{L}, K, O)$ with respect to land evaluated at $\overline{A}$. Then, the three market participation regimes can be expressed as:

$$\left.\begin{array}{ll} \text{I. Rent - in regime } (A_i^* > \overline{A}_i): & g'(\alpha, \overline{A}, \overline{L}, K, O) + \varepsilon_i > r(TC^{in}) \\ \text{II. Autarky regime } (A_i^* = \overline{A}_i): & r(TC^{out}) \le g'(\alpha, \overline{A}, \overline{L}, K, O) + \varepsilon_i \le r(TC^{in}) \\ \text{III. Rent - out regime } (A_i^* < \overline{A}_i): & g'(\alpha, \overline{A}, \overline{L}, K, O) + \varepsilon_i < r(TC^{out}) \end{array}\right\} \quad (12)$$

where A^*_i denotes the optimal operational land size. This switching regime model can be estimated using ordered probit with variable upper and lower thresholds. Transformation of (12) yields

$$\left.\begin{array}{l} pr(A_i^* > \overline{A}_i) = pr\{\varepsilon_i > r(TC^{in}) - g'(\alpha, \overline{A}, \overline{L}, K, O)\} \\ pr(A_i^* = \overline{A}_i) = pr\{\varepsilon_i \ge r(TC^{out}) - g'(\alpha, \overline{A}, \overline{L}, K, O) \cap \varepsilon_i \le r(TC^{in}) - g'(\alpha, \overline{A}, \overline{L}, K, O)\} \\ pr(A_i^* < \overline{A}_i) = pr\{\varepsilon_i < r(TC^{out}) - g'(\alpha, \overline{A}, \overline{L}, K, O)\} \end{array}\right\} \quad (13)$$

While similar approaches to market participation have been taken by other studies (Goetz 1992, Key *et al.* 2000, Carter and Yao 2002, Bellemare and Barrett 2006), our approach differs from these in that we look at participation only[16] and specify thresholds as functions of, among others, policy variables and do not require symmetry of these effects. In terms of our model, this is justified by the notion that certain policy variables (e.g. tenure security) will affect transaction costs *r(.)* for renting out but not renting in and are unlikely to affect individual producers' marginal product *g'(.)*.

Under the assumption that $g'(\alpha, \overline{A}, \overline{L}, K, O)$, $r(TC^{in})$ and $r(TC^{out})$ are linear, this can be expressed as

$$g'(\alpha, \overline{A}, \overline{L}, K, O) = \beta_0 + \beta_1 \alpha + \beta_2 \overline{A} + \beta_3 \overline{L} + \beta_4 K + \beta_5 O \quad (14)$$

$$r(TC^{in}) = \delta_0 + \delta_1 \boldsymbol{V} + \delta_2 \boldsymbol{S} \quad (15)$$

[16] The fact that information on the amount of land rented was not included in our data before 2004 and is quite noisy even for this year precludes us from modeling the quantity of land transacted conditional on rental market participation.

$$r(TC^{out}) = \eta_0 + \eta_1 \boldsymbol{V} + \eta_2 \boldsymbol{S} \quad (16).$$

The switching regression or ordered probit model defined by these equations is estimated by full information maximum likelihood. Households' endowments of land and labor are represented by the total amount of land to which they have use rights, the head's age, and the number of family members 14 to 60 years of age. *K* is represented by the value of assets at the beginning of the year. Village per capita income and the head's level of education are used to approximate *O*. [17]

The upper and lower threshold functions $r(TC^{in})$ and $r(TC^{out})$ will be affected by economic (***V***) and institutional factors (***S***). The former are approximated by the per capita land endowment in the village, the share of adults in the village who, had migrated out of the province in the 1999-2001 period. The latter include whether the village allows rentals with non-residents, whether there is a rule mandating that land left uncultivated for one season be taken back by authorities, and whether households have land use certificates to document their land rights.

The rationale for including these factors is intuitive: Out-migration increases supply of land available for rent, thereby reducing search costs for potential tenants. Higher village level land endowments will reduce transaction costs for renting-in but also reduce numbers of potential tenants. Limitations on renting to outsiders will increase the costs of renting out but, by forcing landlords to rent to locals instead, may make it easier to find land to rent in. While reducing tenure security, rules requiring non-cultivated land to be returned to the village may increase supply of land to rental. Land use certificates should reduce the risk that rented land is lost to village-wide redistribution and thus encourage potential landlords to rent out.

3.3 Econometric results

Appendix table 2 reports results from estimating the Cobb-Douglas production function, for OLS and fixed effects. Coefficients on key inputs (land, labor and material costs) are all positive and very significant, implying that land and purchased inputs including seed, fertilizer, pesticides, and irrigation are key determinants of output. Coefficients on year dummies (not reported) also point towards an increase in productivity of 12-14 percentage points over the 4-year period. After netting out village means, our estimate of agricultural ability is distributed between -2.0 and 2.10 with 90% of the households concentrated between -0.65 and 0.8. The implied differences in output are large; at the mean of all other variables, an exogenous increase of ability from the mean to the 90% point (i.e. from 0 to 0.8) would increase output by 122%. [18]

Table 5 displays results from the ordered probit model with coefficients from the marginal product equation in the top panel and the lower and upper bound equations to determine the cutoffs between

[17] Equation (13) implies that the probability of falling into any rental regime is jointly determined by the functions *g* and *r*. Together with the fact that variables can not appear in the threshold and the main equations, our main criterion for whether to include a variable in the main or the threshold equations is whether this variable is expected to affect lower and upper bounds differentially or not.

[18] The corresponding physical value is an increase of 590 Y/mu. In view of this, the increases in output for the same plot reported earlier do not seem implausibly large and could be due to differences in ability.

leasing out and autarky and autarky and leasing in, respectively, in the middle and bottom panels. We discuss evidence for factor equalization, transaction cost, and growth effects. In each case, we illustrate in table 6 the magnitude of the participation effect by reporting the change in the probability of a household falling into one of the three regimes due to a counterfactual exogenous shift of a given variable from the sample mean to the maximum.[19]

The large and significant coefficients on households' endowment with land (negative) and labor (positive) suggest a strong factor equalization effect whereby, by transferring land factor from land-abundant and labor poor households to those with little land and large amounts of labor, land rental helps equalize access to traditional factors of production. Inclusion of ability, while reducing sample size by about 1,000, does not affect significance or magnitude of these variables but highlights that non-traditional factors are of importance as more able producers are more likely to rent in land (col. 2). Also, negative coefficients on age squared and households' education and initial assets imply that, by shifting land to younger, less affluent, and less educated producers, the factor equalization effect of land rental extends to non-traditional factors. There is thus little reason for concern about land rental promoting undesirable land concentration or reducing land access by the poor.

Comparing the impact of an exogenous change in a given independent variable from the sample mean to its maximum on estimated probabilities for participation in different regimes provides additional insights, in addition to reinforcing the relevance of non-traditional factors. While increasing the land endowment would result in a 40% increase in the probability of renting out (but only a 12% reduction in the probability of renting in), a similar shift of ability would increase the probability of renting in by 27% while reducing that of renting out by 7 points. Assets are of lower importance -with a shift to the maximum predicted to result in only changes of some 2 percentage points in either direction.

The variables in the lower and upper bound equations point towards significant transaction cost effects. We note that activity in land rental markets is higher in locations with higher levels of past migration, that greater tenure security will increase supply of land to rental markets but not demand, and that local regulations affecting the cost of transferring land will affect producers' entry into rental markets. As it reduces the amount of labor available, higher village level migration is estimated to increase supply of land to rental and the demand for such land.[20] As expected, overall availability of land in the village reduces the propensity to rent out and makes it easier to rent in land.

The significance of the coefficient on having a land certificate in the lower but not the upper bound equation is consistent with the notion that limited levels of tenure security constrain households from supplying land to rental markets and that issuance of an 'official' document codifying their use rights

[19] Using equations (13)-(15), it is straightforward to compute the changes in the probability of being in a specific regime due to exogenous changes in independent variables. For the rent in regime, $Prob(rent\text{-}in)=Prob(\varepsilon>\delta S-\beta X)=1-\Phi(\delta S-\beta X)$ where as defined above, S is the vector of transaction cost variables X contains variables affecting the marginal product of land (i.e. α, A, L, K, O), *and* Φ is the cumulative density of the standard normal distribution. Thus, $\partial Prob(rent\text{-}in)/\partial S= -\phi((\delta S-\beta X)\delta$ *and* $\partial Prob(rent\text{-}in)/\partial X= \phi((\delta S-\beta X)\beta$, where ϕ is the density of the standard normal distribution. Equivalent formuas can be applied to renting out.

[20] This is consistent with the notion that cash constraints, which remittances may alleviate, are not a key factor affecting rental participation.

may make them more confident. By the same token, village-level rules that limit rentals to outsiders are estimated to be a significant factor reducing households' propensity to supply land to rental markets although they have no discernible impact on participation on the demand side. Surprisingly, land use regulations that allow village leaders to confiscate land that has not been utilized for one season are estimated to have a very significant impact on the propensity for rental market participation on either the supply or the demand side.

Although policy-related variables in the upper and lower bound equations have the expected sign and are significant at conventional levels, the predicted impact on behavior is small; according to our simulations, a change the dummy from 0 to 1 will change the probability of renting out by about 1 percentage point for having a certificate as well as leasing restrictions and by about 3 points for taking back land left without cultivation. As expected, the impact on renting in is much lower and often insignificant. Comparison to the large increases in participation probabilities 18% and 16% for renting in and 6% and 4% for renting out- predicted due to changes in migration and availability in village land, respectively, implies that land rental is driven largely by outside opportunities and that local policies, albeit significant, are not a major constraint to better land market functioning and growth.

The notion that availability of other economic opportunities is the main driver of observed increases in supply of land to rental markets is supported by the highly significant migration effect whereby higher levels of out-migration increase activity in rental markets and households' propensity to rent out and rent in, thereby allowing those who participate in migration to rent out their land and at the same time for those who have comparative advantage and higher productivity in agriculture to obtain increased amounts of land. As indicated in table 6, shifting a household from a village with average share of migrants in village to villages with the highest share of migrants in village would increase the propensity to rent in and rent out by 18% and 6% respectively. To appreciate implied effects, note that the share of migrants in the labor force from less than 5% in 1988 to 10% in 1995 (Rozelle *et al.* 1999a) and about 17%, or a total of 124.6 million in 2000 (Taylor *et al.* 2003, Liang and Ma 2004). With an expected further increase in the flow of migrants to 200 million by 2020, most of which from in rural areas (Cai and Wang 2003), rental is likely to increase. Indeed, land rental appears to be a critical element of the "development ladder" by which occupational structure in a given location shifts from migration to micro- and large enterprises while simultaneously pushing out the frontier to start a similar cycle in more remote regions (Mohapatra *et al.* 2006).

4. Conclusion and policy implications

With an increasing body of literature testifying to the importance of land rental in Africa (Benin *et al.* 2005, Chimhowu and Woodhouse 2006, Baland *et al.* 2007, Deininger *et al.* 2007a) but also in other regions (Deininger *et al.* 2003, Gine 2005, Vranken and Swinnen 2006, Marsh *et al.* 2006, Masterson

2007), few studies have analyzed its impact and whether it fully realizes existing potential. Doing so for China provides analytical and empirical insights.

Empirically, we find that gains in productivity of land use through land rental in a growing economy can be large, with estimated productivity increases of some 60%. These translate into improvements of 25% in tenants' welfare and, by facilitating occupational diversification, even larger increases in landlords' income.[21] There is no evidence that rental puts the poor at a disadvantage; to the contrary the factor equalization and growth effects found here imply that, as better educated individuals join the non-agricultural labor force, the poor and less educated can gain by renting in additional land. Supply of land to rental markets increases with households' wealth, their access to non-agricultural opportunities, and development. While transaction costs, some due to local restrictions, significantly reduce rental participation, the magnitudes involved are minuscule compared to broader structural factors. Higher non-agricultural wages and well-functioning rental markets thus create a pathway for development to complement traditional avenues of land-related investment and links to markets.

Comparing salient features of land distribution and agricultural productivity between China and other regions helps identify broader lessons and areas for follow-up research. In Africa, complex property rights and tenure insecurity often restrict land-related investment (Goldstein and Udry 2006) and limit the willingness to rent out, something also encountered in many Eastern European countries (Lerman *et al.* 2002). To ensure such incentives, ways to increase security of land ownership and institutional arrangements allowing (longer-term) land transfers will be needed. Although high inequality of the land ownership distribution, together with non-agricultural growth, imply that opportunities for land rental in South Asia and Latin America are higher than in China, explicit restrictions on land rental (Deininger *et al.* 2007b) or limited tenure security (Macours 2004) significantly reduce land rental. To quantify potential and actual impact of better land rental markets and their link to the emergence of non-agricultural employment, in these settings, it will be necessary to adopt a general equilibrium framework of growth in agriculture and non-agriculture and to complement data on rental partners and rental restrictions used here with measures of tenure security. This is a challenging research agenda.

[21] The magnitude of these impacts significantly exceeds those commonly estimated to arise from altering the bargaining power within a given contract, thus suggesting that studying determinants of rental market participation may usefully complement the large literature on contract choice.

Table 1: Descriptive statistics

	Entire	By Regions			
	Sample	**N&NE**	**Coastal**	**Centre**	**SW**
Household characteristics & rental participation					
Household size	3.94	3.89	3.69	4.14	4.03
Members aged 15-60 years	2.99	2.97	2.88	3.15	2.93
Head's age	46.56	46.85	46.34	46.59	46.25
Head with secondary education (%)	52.12	58.98	55.31	45.12	45.84
Head with high school education (%)	18.30	21.02	23.74	17.62	9.41
Households renting in (%)	13.49	10.72	8.43	20.50	14.55
Households renting out (%)	9.81	6.15	10.76	13.68	10.53
Assets and income					
Total owned land (mu)	6.24	8.41	5.29	5.51	4.31
Owned land per capita (mu)	1.68	2.30	1.49	1.42	1.13
Value of total assets (Y)	27166	29992	36183	24244	17404
Per capita income	2983	3022	4184	2677	2158
of which from agri. (%)	58.38	60.91	49.42	57.59	63.43
of which from wage (%)	15.00	18.32	22.88	7.96	10.43
of which from migration (%)	11.21	6.42	9.98	16.77	13.85
of which from non-farm self emp.(%)	10.92	10.8	13.11	12.03	7.73
of which from transfer (%)	4.49	3.55	4.61	5.65	4.57
Renting in					
Renting in from relative (%)	39.32	58.59	25.86	35.08	54.43
Share with contract, incl. oral ones (%)	59.44	37.84	57.08	66.50	55.70
Share of contracts, written	7.78	18.46	24.44	1.67	3.41
Share with fixed term (%)	24.15	30.61	29.20	21.08	22.78
if yes, length of term (years)	2.71	3.82	3.80	2.11	1.57
Renting out					
Renting out to relative (%)	31.04	55.81	24.29	23.18	64.58
Share with contract, incl. oral ones (%)	59.29	22.73	50.00	75.00	47.92
Share of contracts, written	8.63	0.00	13.89	6.55	13.04
Share with fixed term (%)	26.61	34.09	22.14	28.77	22.92
if yes, length of term (years)	2.92	1.60	3.06	3.19	2.73
Village characteristics & land policy					
Village per capita land endow. (mu)	1.33	1.84	1.30	1.02	0.88
Villager per capita income (Y)	2256.26	2306.15	3229.46	1930.47	1649.44
Share of members migrating (%)	17.83	10.05	17.07	24.85	22.03
Of which, % migrating out of province	39.61	27.27	17.60	61.08	51.03
Have land certificate (%)	81.16	73.92	83.05	81.33	92.02
Renting to outsiders not allowed (%)	13.53	16.60	25.74	6.90	4.83
Uncultivated land taken away (%)	9.74	9.08	15.72	10.22	4.09
No of observations	19570	6622	3533	5187	4228

Source: Own computation from NBS/World Bank land market survey

Table 2: Main income source of households leasing out before and after land transfer

	Before			
After	Agric. production	Local non-farm	Migration	Total
Agric. production	15.91%	0.63%	0.18%	16.73%
Local non-farm	8.32%	19.80%	0.45%	28.57%
Migration	32.91%	2.62%	19.17%	54.70%
Total	57.14%	23.06%	19.80%	100.00%

Source: Own calculation based on NBS/World Bank survey (tenants' assessment for 1106 land rental contracts)

Table 3: Per capita income households leasing in and leasing out before and after transfer

Households leasing out					
			Before		
After	<1500 Y	1500-3000 Y	3000-5000 Y	>5000 Y	Total
<1500 Y	9.84%	0.63%	0.09%	0.00%	10.56%
1500-3000 Y	17.42%	24.82%	0.09%	0.00%	42.33%
3000-5000 Y	1.81%	15.97%	12.82%	0.09%	30.69%
>5000 Y	1.08%	1.99%	6.95%	6.41%	16.43%
Total	30.14%	43.41%	19.95%	6.50%	100.00%
Households leasing in					
			Before		
After	<1500 Y	1500-3000 Y	3000-5000 Y	>5000 Y	Total
<1500 Y	10.57%	0.00%	0.00%	0.00%	10.57%
1500-3000 Y	10.34%	36.78%	0.69%	0.00%	47.82%
3000-5000 Y	0.00%	15.17%	17.01%	0.69%	32.87%
>5000 Y	0.00%	0.00%	4.60%	4.14%	8.74%
Total	20.92%	51.95%	22.30%	4.83%	100.00%

Source: Own calculation based on NBS/World Bank survey (landlords' and tenants' assessments for 1106 contracts).

Table 4: Productivity gains from land rental

	Total Sample	Renting to	
		Relative	Non-relative
Tenants' assessment			
Profit before transfer (Y/mu)	317.65		
Profit after transfer (Y/mu)	584.74		
Productivity gain through rental (Y/mu)	267.09		
Productivity gain through rental (%)	84.08		
of which to tenant (%)	65.33		
of which to owner (%)	34.67		
Land owners' assessment			
Profit generated by owner before transfer (Y/mu)	340.93	326.25	347.60
Profit after transfer (Y/mu)	623.9	512.08	685.99
Productivity increase through rental (Y/mu)	282.97	185.83	339.39
Productivity gain through rental (%)	83.00	56.96	97.35
of which to tenant (%)	65.46	69.03	65.88
of which to owner (%)	34.47	30.97	34.12
Actual & perceived constraints to rental			
Tenants rationed in the past (%)	39.02		
Tenants thinking RLCL improved market functioning	81.34		
Owners rationed in the past (%)	12.24		
Owners thinking RLCL improved market functioning	81.44		
Tenants having doubts about future (%)	44.54		
Owners having doubts about future (%)	22.98		
No. of observations	1149	140	311

Source: Own calculation based on NBS/World Bank survey

Table 5: Determinants of land rental market participation

	Specification		
	Without ability	**With ability**	**With ability[22][21]**
Agricultural ability		0.402***	0.310***
		(8.89)	(6.88)
Household land endowment (log)	-0.199***	-0.311***	-0.309***
	(24.24)	(27.44)	(27.32)
Number of members aged 15-60 (log)	0.071***	0.062***	0.154***
	(8.23)	(6.87)	(5.21)
Value of total assets (log)	-0.056***	-0.035**	-0.034**
	(4.27)	(2.58)	(2.40)
Head's age (log)	1.777**	0.934	1.715
	(2.31)	(1.60)	(1.36)
Head's age squared	-0.262**	-0.152*	-0.250
	(2.56)	(1.95)	(1.49)
Head completed secondary education	-0.010	0.001	0.000
	(0.42)	(0.05)	(0.02)
Head completed higher education	-0.050*	-0.043	-0.055*
	(1.71)	(1.40)	(1.80)
Village per capita income	-0.144***	-0.139***	-0.088***
	(5.50)	(5.20)	(3.22)
Lower bound equation (lease out to autarky)			
Share of village workers migrating out of province	0.367***	0.407***	0.619***
	(8.52)	(9.03)	(5.12)
Own land certificate	0.070**	0.079**	0.082**
	(1.98)	(2.11)	(2.18)
Rule: Renting to outsiders not allowed	-0.076**	-0.083**	-0.080**
	(1.96)	(2.06)	(1.96)
Rule: Village takes back non-cultivated land	0.261***	0.253***	0.247***
	(6.91)	(6.39)	(6.22)
Village per capita land	-0.044**	-0.049**	-0.069***
	(2.15)	(2.29)	(3.21)
Upper bound equation (autarky to lease-in)			
Share of village workers migrating out of province	-0.420***	-0.385***	-1.185***
	(10.49)	(9.34)	(10.86)
Own land certificate	-0.033	-0.011	0.030
	(1.06)	(0.35)	(0.92)
Rule: Renting to outsiders not allowed	-0.014	-0.030	-0.011
	(1.96)	(0.80)	(0.29)
Rule: Village takes back non-cultivated land	-0.131***	-0.137***	-0.129***
	(3.58)	(3.63)	(3.39)
Village per capita land	-0.095***	-0.117***	-0.130***
	(5.27)	(6.29)	(6.93)
Log-likelihood	-13032.05	-12070.83	-11754.68
No. of observations	19,570	18,390	17,969

Note: Dummies for time and provinces included but not reported. Adjusted for clustering at village level.
Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

[22] Using only ability estimate derived from household-year combinations that do not involve any rental to avoid bias.

Table 6. Effects of changes in independent variables on probability of renting in or out

Variable	Scenario	Change in probability of renting in	Change in probability of renting out
Main equation variables			
Farming ability	Mean to max	0.269	-0.07
Land endowment	Mean to max	-0.122	0.398
No. of members 15-60	Mean to max	0.035	-0.021
Total assets	Mean to max	-0.024	0.020
Village per capita income	Mean to max	-0.027	0.023
Threshold equation variables			
Migration share	Mean to max	0.176	0.061
Village land	Mean to max	0.159	-0.035
Share of households with certificate	0 to 1		0.0112
Renting to outsider restricted	0 to 1		-0.0130
Taking back uncultivated land	0 to 1	0.028	0.037

Note: Blanks imply that the coefficient is insignificant.

Appendix table 1: Household and village characteristics by rental status

	Type of household		
	Rent-in	**Autarkic**	**Rent-out**
Household characteristics			
Owned land (mu)	5.60***	6.18	7.65***
Owned land per capita (mu)	1.47***	1.67	2.10***
Household size	4.02*	3.94	3.87*
Members 15-60 years old	3.06*	2.99	2.90*
Head's age	45.82**	46.62	47.11**
Head with secondary education. (%)	50.09**	52.88	48.62***
Head with high school education. (%)	16.47*	18.74	17.21***
Assets and income			
Value of total assets (Y)	24,039***	27,417	29,467***
Per capital net income (Y)	2734.14***	3003.06	3168.60***
Share of income from agriculture (%)	64.73***	61.00	53.06***
Share of inc. from wage (%)	7.31***	11.85	12.29***
Share of inc. from migration (%)	18.78*	17.98	23.65***
Share of inc. non-farm self emp.(%)	9.17	9.17	11.01**
Agricultural Ability	0.049	-0.016	-0.007

Source: Own computation from NBS/World Bank land market survey.
t-test compares means between sub-group and autarky; *, **, *** imply significance at 10%, 5% and 1% respectively

Appendix table 2: Coefficients from Cobb-Douglas Crop Production Function (OLS and panel)

	OLS	Fixed-effect
Total Expenditure on crop production (log)	0.376***	0.151***
	(35.43)	(22.65)
Total area cultivated (log)	0.243***	0.400***
	(14.43)	(28.75)
Total labor days on crop production (log)	0.179***	0.048***
	(18.79)	(6.86)
Total value of agricultural assets (log)	0.025***	0.006**
	(10.44)	(2.51)
Head's age (log)	1.635***	0.449
	(4.29)	(1.11)
Head's age (log) squared	-0.229***	-0.065
	(4.49)	(1.18)
Share of village irrigated	0.125***	-0.013
	(5.49)	(0.76)
Head with secondary education or higher	0.019**	0.028***
	(2.19)	(3.06)
Household-year observations	50234	50234
Households		13125
R-squared	0.60	0.32

Year dummies included but nore reported. Robust t statistics in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Annex 1: Proofs for main propositions

Proposition 1: The amount of land rented in (out) is strictly increasing (decreasing) in households' agricultural ability, α_i, and strictly decreasing (increasing) in the land endowment $\overline{A}_i$. Rental markets will transfer land to efficient, but land-poor producers, thereby contributing to higher levels of productivity and more efficient factor use in the overall economy.

Totally differentiating both sides of (2) with respect to α (ignoring the subscript to keep notation simple), yields:

$$pf_{l_a\alpha}(\alpha, l_a, A) + p(f_{l_a l_a}\frac{\partial l_a}{\partial \alpha} + f_{l_a A}\frac{\partial A}{\partial \alpha}) = 0 \qquad \text{(A1)}$$

Total differentiation of both sides of (3) or (4) with respect to α, yields:

$$pf_{A\alpha}(\alpha, l_a, A) + p(f_{AA}\frac{\partial A}{\partial \alpha} + f_{Al_a}\frac{\partial l_a}{\partial \alpha}) = 0 \qquad \text{(A2)}$$

From (A1), we obtain $\partial l_a / \partial \alpha$; substituting this into the (A2), with some manipulation of terms, gives:

$$\frac{\partial A^*}{\partial \alpha} = \frac{f_{Al_a} f_{l_a\alpha} - f_A f_{l_a l_a}}{(f_{AA} f_{l_a l_a} - f_{Al_a} f_{l_a A})} = \frac{f_{Al_a} f_{l_a\alpha} - f_{A\alpha} f_{l_a l_a}}{[f_{AA} f_{l_a l_a} - (f_{Al_a})^2]} > 0 \qquad \text{(A3)}$$

Thus, for all households participating in rental markets (on either side), area operated increases with ability. The amount of land rented in (or out) is the difference between operational land size and the land endowment, i.e.

$a^{in} = A^* - \overline{A}$ and $a^{out} = \overline{A} - A^*$ (A4)

Total differentiation of both sides of (A4) with respect to α, yields $\frac{\partial a^{in}}{\partial \alpha} = \frac{\partial A^*}{\partial \alpha} > 0$ and $\frac{\partial a^{out}}{\partial \alpha} = -\frac{\partial A^*}{\partial \alpha} < 0$, implying that amount of land rented in (or out) is increasing (deceasing) in agricultural ability.

Total differentiation of both sides of (A4) with respect to $\overline{A}$, yields $\frac{\partial a^{in}}{\partial \overline{A}} = -1 < 0$ and $\frac{\partial a^{out}}{\partial \overline{A}} = 1 > 0$, implying the amount of land rented in (or out) is strictly decreasing (or increasing) in land endowment.

Proposition 2: The presence of transaction costs defines two critical ability levels $\alpha_l(TC^{out}, ..)$ and $\alpha_u(TC^{in}, ..)$ such that households with ability $\alpha_i \in [\alpha_l, \alpha_u]$ will remain in autarky. Any increase in TC^{in} or TC^{out} will expand the autarky range, thus reducing the number of producers participating in rental markets and thus the number of efficiency-enhancing land transactions. Compared to a situation with no transaction cost, this will decrease productivity and social welfare.

Using the functional form $f(\alpha, l_a, A) = \alpha^{1-\beta_1-\beta_2} l_a^{\beta_1} A^{\beta_2}$ for the production function, FOC (2-4) can be rewritten as:

$$p\beta_1 \alpha^{1-\beta_1-\beta_2} l_a^{\beta_1 - 1} A^{\beta_2} = w \qquad \text{(A5)}$$

and for households who rented in: $p\beta_2 \alpha^{1-\beta_1-\beta_2} l_a^{\beta_1} A^{\beta_2 - 1} = r + TC^{in}$ (A6)

for households who rented out: $p\beta_2\alpha^{1-\beta_1-\beta_2}l_a^{\beta_1}A^{\beta_2-1} = r - TC^{in}$ (A7)

Plugging $A = \overline{A}$ into (A5) allows us to obtain $l_a^* = (\frac{w}{p\beta_1\alpha^{1-\beta_1-\beta_2}\overline{A}^{\beta_2-1}})^{\frac{1}{\beta_1-1}}$ (A8)

Plugging $l_a = l_a^*$ and $A = \overline{A}$ into (A7) allow us to derive $\alpha_l = \left(\frac{r - TC^{out}}{\beta_2(l_a^*)^{\beta_1}\overline{A}^{\beta_2-1}}\right)^{\frac{1}{1-\beta_1-\beta_2}}$ (A9)

Similarly, plugging $l_a = l_a^*$ and $A = \overline{A}$ into (A6) yields $\alpha_u = \left(\frac{r + TC^{in}}{\beta_2(l_a^*)^{\beta_1}\overline{A}^{\beta_2-1}}\right)^{\frac{1}{1-\beta 1-\beta 2}}$ (A10)

This allows to show that $\partial\alpha_l/\partial TC^{out}<0$ and $\partial\alpha_u/\partial TC^{in}>0$, suggesting that increase in transaction costs reduces the number of producers participating in rental markets.

Proposition 3: Increases of the exogenously given wage for off-farm employment will increase the amount of land transacted in rental markets by increasing the amount rented out by households with low agricultural ability (who will join the off-farm labor force) and the amount rented in by those with high-ability (who specialize in agricultural production). This will be associated with a decrease in the equilibrium rental rate which, in a risk-free environment, will make everybody better off.

First, we consider the case where there is no minimum labor (l_a^c) below which households quit farming.

Obtaining $l_a = r^{(\frac{1}{\beta_2})}\beta_1^{(-\frac{1}{\beta_2})}\alpha^{(\frac{1-\beta_1-\beta_2}{-\beta_2})}A^{(\frac{1-\beta_1}{\beta_2})}$ from (7) and substituting it into (6), with some manipulation, yields:

$A^* = \alpha w^{(\frac{\beta_2}{\beta_1+\beta_2-1})}\beta_2^{(\frac{\beta_2}{1-\beta_1-\beta_2})}\beta_1^{(\frac{\beta_2-1}{\beta_1+\beta_2-1})}r^{(\frac{1-\beta_2}{\beta_1+\beta_2-1})}$ (A11),

suggesting that optimal operational land size is proportional to farming ability. Denoting by Δ all the right hand side terms except α, we can rewrite: $A^* = \alpha\Delta$ (A12)

With total land in the economy being $n\overline{A}$, the land market clearing condition is $\int_{\underline{\alpha}}^{\overline{\alpha}}\alpha\Delta d\alpha = n\overline{A}$. This allows us to solve for $\Delta = \frac{2n\overline{A}}{\overline{\alpha}^2 - \underline{\alpha}^2}$. Substituting this into (A12) allows to solve for A^*, and consequently for l_a^*, and r^*.

Specifically, $A^* = \alpha\frac{2n\overline{A}}{(\overline{\alpha}^2 - \underline{\alpha}^2)}$, $l_a^* = \alpha\left(\frac{\overline{\alpha}^2 - \underline{\alpha}^2}{2n\overline{A}}\right)^{(\frac{\beta_1}{\beta_2-1})}w^{(\frac{1}{\beta_2-1})}\beta_2^{(\frac{1}{1-\beta_2})}$ and $r^* = \left(\frac{\overline{\alpha}^2 - \underline{\alpha}^2}{2n\overline{A}}\right)^{(\frac{\beta_1+\beta_2-1}{\beta_2-1})}w^{(\frac{1}{\beta_2-1})}\beta_2^{(\frac{1}{1-\beta_2})}\beta_1$.

The assumption of a minimum level of farm labor (l_a^c) implies that households who would optimally supply less than l_a^c to agriculture will move out of farming and rent out all their land. The key to solve this problem, is to find the critical farming ability (α_c), i.e., any households with $\alpha < \alpha_c$ will have $l_a^* < l_a^c$ (for $\partial l_a^*/\partial\alpha > 0$) and therefore rent out all their land. Setting $l_a^* = l_a^c$ allows us to solve for α_c, With some manipulation, we obtain:

$\alpha_c = \left(\frac{\overline{\alpha}^2 - \underline{\alpha}^2}{2n\overline{A}}\right)^{(\frac{\beta_1}{1-\beta_2})}w^{(\frac{1}{1-\beta_2})}\beta_2^{(\frac{1}{\beta_2-1})}l_a^c$ (A13)

Since now only households with $\alpha \in [\alpha_c, \bar{\alpha}]$ will cultivate, the new market clearing condition is $\int_{\alpha_c}^{\bar{\alpha}} \alpha \Delta d\alpha = n\bar{A}$, plugging a_c from (A13) into the market clearing condition allows us to obtain new Δ and consequently new optimal operational land size A^{**}:

$$A^{**} = \alpha \frac{2n\bar{A}}{\bar{\alpha}^2 - \left(\frac{\bar{\alpha}^2 - \underline{\alpha}^2}{2n\bar{A}}\right)^{\left(\frac{2\beta_1}{1-\beta_2}\right)} w^{\left(\frac{2}{1-\beta_2}\right)} \beta_2^{\left(\frac{2}{\beta_2 - 1}\right)} l_a^c} \tag{A14}$$

Setting $A^{**} = \bar{A}$ also allows us to solve for another critical farming ability α_{au}, which divides households between rent-in (for $\alpha_i > \alpha_{au}$) and rent-out ($\alpha_i < \alpha_{au}$), specifically, we can have:

$$\alpha_{au} = \frac{\bar{\alpha}^2 - \left(\frac{\bar{\alpha}^2 - \underline{\alpha}^2}{2n\bar{A}}\right)^{\left(\frac{2\beta_1}{1-\beta_2}\right)} w^{\left(\frac{2}{1-\beta_2}\right)} \beta_2^{\left(\frac{2}{\beta_2 - 1}\right)} l_a^c}{2n} \tag{A15}$$

Finally, equalizing both the right hand sides of equation (A11) and (A14) allow us to solve for the new equilibrium rental rate r^{**}. With some manipulations, we can obtain an explicit solution for r^{**} (not reported).

We can also show that $\frac{\partial A^{**}}{\partial w} > 0$, $\frac{\partial \alpha_{au}}{\partial w} < 0$, $\frac{\partial \alpha_c}{\partial w} > 0$ and $\frac{\partial r^{**}}{\partial w} < 0$, which suggests that, as off-farm opportunities increase a larger number of households will drop farm production and rent out all their endowment, the equilibrium rental rate will decrease, households who remain in agricultural production cultivate more land, and more households will rent in land.

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