Land rental in Ethiopia: Marshallian inefficiency or factor market imperfections and tenure insecurity as binding constraints?

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Abstract: Although a large theoretical literature discusses the possible inefficiency of sharecropping contracts, empirical evidence on this phenomenon has been ambiguous at best. Household level fixed-effect estimates from about 8,500 plots operated by households who own and sharecrop land in the Ethiopian highlands provide support for the hypothesis of Marshallian inefficiency. At the same time, a factor adjustment model suggests that the extent to which rental markets allow households to attain their desired operational holding size is extremely limited. Our analysis points towards factor market imperfections (no rental for oxen), lack of alternative employment opportunities, and tenure insecurity as possible reasons underlying such behavior, suggesting that, rather than worrying almost exclusively about Marshallian inefficiency, it is equally warranted to give due attention to the policy framework within which land rental markets operate.

1. Introduction

In situations where the distribution of land ownership is different from the optimal operational structure, mechanisms -in many cases rental markets- that transfer this factor to its most productive use will have a key role in increasing total production and ensuring economic efficiency. Historically, when most of the land was cultivated with traditional technology and non-agricultural labor markets were virtually non-existent, the majority of such land transactions occurred between large landlords, often absentees, and small tenants with few alternative opportunities, essentially compensating for a skewed distribution of land ownership. Increasing complexity of the agricultural production process implies that imperfections in other markets which are frequent in rural areas of developing countries will affect the nature and direction of rental contracts. Moreover, with economic development, a number of other disequilibrating factors such as changes in the demographic structure, non-agricultural demand for land, and an array of other reasons for land transactions -from producers' desire to take advantage of opportunities for off-farm employment and temporary migration to differential agricultural ability- have started to complement, and in many cases substitute for, the "traditional" model of land leasing from large to small landlords (Sadoulet *et al.* 2001). As a result, land lease markets have become quite active even in countries, such as China or Vietnam, where, in view of a highly egalitarian distribution of land ownership, the traditional model of land leasing would otherwise lead one to expect limited levels of land rental activity.

In many developing countries, as land is a key productive asset and source of income, it is not only the level of land rental activity but also the productive use of the land thus transferred that is of relevance. In fact, economists have long been concerned about the efficiency implications of rental market operations with a view towards identifying policy options that, by helping improve the efficiency of outcomes, have the potential to make everybody better off. A key motivation for doing so has been that, in addition to the limited investment incentives conveyed by short-term rental contracts, share tenants will, in any given season, receive only part of their marginal product and thus have limited incentives to supply effort. A

large number of theoretical and empirical studies have aimed to identify conditions -mainly in terms of other market imperfections- under which sharecropping may be a rational strategy and to quantify the productivity implications, in a given production period or in terms of longer-term investment, of such an arrangement as compared to owner-cultivation.

While such analysis can provide useful insights and has led to a number of policy interventions, it takes the renting decision as given and makes few predictions about the extent to which rental markets' response to exogenous changes is optimal in the sense that it fully utilizes available opportunities. Exploring this issue is of policy relevance because, as discussed earlier, the incidence of exogenous changes to which land markets need to respond has sharply increased and is likely to become of even greater importance with economic development. More importantly, the transaction costs to be incurred in renting out land may well affect land owners' decisions on whether to, e.g., adopt new technology or take up off-farm employment and could thus have implications for growth in the non-farm economy.

Given its scant land endowment that is under significant threat from degradation, making the most productive use of available land resources is important for Ethiopia to escape the threat of starvation and dependence on food-aid. Similarly, the population's continued high level of dependence on agriculture imply that well-functioning land rental markets that would allow those with little comparative advantage in agriculture to take up non-agricultural employment, will be critical to lay the basis for overall development and a more diversified rural economy. If the experience of other countries that followed similar strategies is anything to go by, land rental markets will have to assume a major role in allowing movement of labor out of agriculture, and transferring land to more productive producers. However, past studies of the extent efficiency of rental markets in Ethiopia yield contradictory results; while some are unable to reject the hypothesis of friction-less adjustment through rental markets (Pender and Fafchamps 2006), others provide strong evidence for land markets allowing at best partial adjustment (Teklu and Lemi 2004, Holden and Ghebru 2006, Ghebru and Holden 2006).

In this paper, we use a large panel data set from Ethiopia that contains a large number of households who cultivate owned and sharecropped land simultaneously, in addition to being more detailed and larger than what had been available in other studies. To assess the efficiency of sharecropping as a key contractual arrangement in land markets, we estimate a production function and input demand functions using household fixed effects. To explore the extent to which land markets help farmers capitalize on existing opportunities, we use a friction model (Rosett 1959, Skoufias 1995) to identify whether rental markets allow producers to attain their desired level of land holding irrespectively of their endowment, and also to provide an empirical estimate of the magnitude of friction in land rental markets.

Results suggest that input and output intensities are indeed statistically significantly lower on sharecropped as compared to owned plots, thus leading us to reject the hypothesis that tenure status does not affect producers' decisions and that sharecropping contracts are not affected by Marshallian inefficiency, though the level of inefficiency is much lower than that was found elsewhere in the literature. At the same time, we find evidence not only for large amounts of friction that prevents land owners to use rental markets to adjust to their optimum size but also for the fact that such friction reduces productivity by preventing productive producers from gaining access to additional land.

The paper is organized as follows. Section two discusses features of the rural economy in Ethiopia to motivate the study and provide the background for some of the analytical hypothesis. It also introduces the conceptual framework for testing the efficiency of sharecropping and the extent to which rental markets facilitate optimum adjustment. Section three describes the sample and uses descriptive statistics from our data to generate summary statistics at household and plot levels. Section four presents results from the econometric analysis and discuses potential implications. Section five concludes by relating our results to the literature and highlighting areas for future research.

2. Background and conceptual framework

To motivate our analysis, we highlight key features of land tenure in Ethiopia, in particular the relative scarcity of land and the high risk associated with agricultural production, and the fact that land is state owned and relatively equally distributed. Despite the recent efforts to increase tenure security by demarcating individual land holdings in a very participatory manner, land policy remains ambiguous, and thus show how this may limit individuals' and households' desire and ability to participate in non-agricultural activities. This is followed by a discussion of the conceptual framework.

2.1 Distinguishing features of Ethiopian land tenure

Prior to 1975, land in large parts of Ethiopia was concentrated in the hands of absentee landlords, tenure was highly insecure, arbitrary evictions posed a serious threat, and much land was severely underutilized. The then prevailing land tenure system was characterized by great inequality which, through its negative impact on production and investment, not only affected productivity but was also considered to have been the most important cause of political grievances that eventually led to the overthrow of the imperial regime. The Marxist government, soon after ousting the imperial regime, transferred ownership of all rural land to the state for distribution of use rights to cultivators through local peasant associations (PAs) and then embarked on massive collectivization of peasant agriculture. However, contrary to the case of China (Dong 1996), the collectivization program was not associated with high levels of infrastructure investment, and as a result, most of the agricultural land remained rainfed and subject to degradation and

soil erosion (Kebede 2002). Transferability of land through lease, sale, exchange or mortgage, and the use of hired labor were prohibited and inheritance was possible only within immediate family members. In spite of these restrictions, farm households were involved in informal rental arrangements in the form of share or fixed rent tenancy at the very risk of losing land allocated to them by the PAs. The ability to use land was contingent on proof of permanent physical residence, thereby preventing migration from rural areas. More importantly, tenure security was undermined by the PAs' and other authorities' ability to redistribute land, an ability that was in some cases used for political ends (Ege 1997).

Although it committed itself to a free-market philosophy and enacted a number of new pieces of legislation, the government that took power in 1991, did not fundamentally alter the ambiguity surrounding many aspects of land policy. For example, the right of every Ethiopian who wants to engage in agriculture to receive a piece of land for free is anchored in the 1995 Constitution. While it is recognized that this may conflict with other goals such as the desire for greater tenure security and well-functioning land rental markets, a 1997 federal proclamation, formulated to set out the overall legal framework, essentially transferred responsibility for enacting laws regarding the nature of land rights, their transferability, and matters of land taxation to regional governments (FDRE 1997).[1] As tenure insecurity could be decisive in preventing land owners from renting out, we briefly review regional policies on land redistribution and land rental.

Despite repeated public announcements against land redistribution, regional positions are not at all clear-cut even beyond the use of eminent domain for establishment of irrigation with due compensation for land and improvements which is clearly enunciated in the Southern Nation, Nationalities and Peoples Region (SNNPR) Amhara, and Oromia (ANRS 2000; ONRS 2002; SNNPR 2003). Proclamations in Amhara and SNNPR explicitly provide for other types of redistribution but make them the responsibility of local communities and require that they be supported by research that it will not lead to land fragmentation and does not adversely affect land productivity. No clear statement on redistribution is included in the Tigray proclamation (TNRS 1997). Proclamations in all regions highlight that the rights of persons who obtain a non-agricultural job or are absent from the village longer than a certain period will fall back to the village.

While households' use rights now include the rights to lease land to a third party, i.e. rental is officially allowed (Pender and Fafchamps 2006), regions impose various restrictions on the extent of land that can be leased or the duration of contacts (Nega *et al.* 2003, Beyene 2004). Oromia and SNNPR allow farmers to rent out up to 50% of their holding and stipulate maximum contract terms of 3 years for traditional and 15 years for modern technology (ONRS 2002; SNNPR 2003). Current policy in Amhara, the region

[1] A new federal rural land administration and use proclamation was enacted in 2005, partly to establish some consistency. Although its relevance for the analysis reported here is limited as our data were all collected before its enactment, it does not appear to clarify many of the provisions that had remained ambiguous in earlier legislation.

where our data was collected, is more progressive as a recently passed proclamation allows leasing of land for up to 25 years irrespective of the technology used (ANRS 2006). As all our data is from before 2005, it will not reflect changes brought about by this new development but suffice it to say that even after its passage, large amounts of uncertainty remain. For example, a clause that would have allowed mortgaging was removed from the draft proclamation before its enactment. More importantly, regulation is silent on whether long-term rental contracts entered into by a person who subsequently finds a non-farm job will have to be honored or not.

The notion that legal provisions lack clarity is supported by survey data. From our data, we note that, although the share of households who expect their land holding to be affected by administrative land redistribution or reallocation over the next five years has declined, on average it is still high with 47% over the three rounds. Such fears could reduce investment incentives (Deininger and Jin 2006b) as well as the propensity to rent out land which could be perceived as a signal that the land is no longer needed. Without judicial institutions to interpret regulations or adjudicate in case of dispute, it also implies that land conflicts are frequent and bureaucratic discretion in solving them pervasive (Rahmato 2003).

To reduce such conflicts and respond to widespread tenure insecurity, the government has recently launched an ambitious program of land certification.[2] This has made rapid progress, covering more than 6 million households by late 2005 in a highly participatory and low-cost process that includes delineation of borders and issuance of land use certificates in the names of husband and spouse. Evidence on farmers' willingness to pay for land registration, e.g. 84% in a sample from Amhara (Solomon 2004) suggests that such a program indeed responds to a strong demand from farmers. However, unless land ownership and the ways in which it can be exercised (including land transfers) are defined more clearly and the scope for interference is limited, the impact of such initiatives may well be significantly below their potential.

2.2. Testing the efficiency of sharecropping

In a world of perfect information, complete markets and zero transaction costs, the distribution of land ownership will affect welfare but will not matter for efficiency as everybody will operate their optimum farm size (Feder 1985). However, agricultural production is risky and outcomes depend on the level of technology and producers' ability. In addition to non-agricultural options which will affect potential tenants' reservation utility, labor and credit market imperfections as well as the transaction costs associated with transferring land will affect the outcomes that can be achieved in land rental markets. A key question is thus whether, taking the ownership distribution of land as given, rental markets will achieve socially optimal outcomes, and to identify the factors that will affect their ability to do so. By

[2] "In order to protect the user rights of farmers, their land holdings should be registered and provided with certificate of user rights. In this regard, a guarantee *may* be given to the effect that land will not be re-divided for a period ranging from 20-30 years. Some regional states have already started this aspect of the land use policy and it is a step in the right direction." (FDRE, 2002:p.53; italics added).

varying the share and a fixed payment to the tenant, land owners who wish to rent can achieve any combination of contractual forms from a wage labor over a share to a fixed rent contract. While all contracts will lead to equivalent outcomes if output is certain and tenants' effort can be enforced (Cheung 1969), relaxation of this assumption gives way to a number of scenarios.

If effort cannot be monitored and agents are risk neutral, only the fixed rent contract is optimal. The reason is that, in all other cases, equalizing the marginal disutility of effort to their marginal benefit will lead tenants to exert less than the socially optimal amount of effort, thus resulting in lower total production. The optimum outcome will require a trade-off between the risk-reducing properties of the fixed-wage contract, under which the tenant's residual risk is zero, and the incentive effects of the fixed-rent contract, which would result in optimal effort supply but no insurance. Second, limited tenant wealth has a similar effect because in case of a negative shock tenants with insufficient wealth are likely to default on rent payments. This implies that landlords will tend to enter into fixed-rent contracts only with tenants who are wealthy enough to pay the rent under all possible output realizations, implying that poorer tenants will be offered only a share contract (Shetty 1988). Finally, a dynamic setting opens up a number of additional perspectives, in addition to the scope for using the repeated game context and the threat of eviction to reduce the efficiency losses of sharecropping. A rental contract that provides tenants with adequate incentives to maximize production in any given time period may lead to overexploitation of the land if (dis)investment is considered, implying that a share contract with lower-powered incentives and possibly compensation may be more appropriate (Ray 2005).

A large literature has focused on testing the extent of inefficiency involved in sharecropping contracts, although with often mixed results (Otsuka and Hayami 1988). One of the key problems of cross-sectional estimates is that the estimated 'inefficiency' of sharecropping is due to unobserved household characteristics that affect contract choice rather than the contractual structure *per se* (Binswanger *et al.* 1995).[3] Use of within-household variation suggests that, in India, share tenancy is associated with a reduction in input use of 32% and an average loss of productivity of 16% (Shaban 1987) although part of the losses may have been policy-induced as in the study setting administrative measures outlawing fixed rent contracts were in effect. More recent studies using household fixed effects cast doubt on the inefficiency of sharecropping (Jacoby and Mansuri 2006), suggesting that agents' choice of contractual arrangements is rational given the constraints faced in a given situation and that the scope for government to bring about more effective outcomes may be limited.

[3] If households entering into sharecropping contracts are poorer or have less access to capital than own-cultivators or fixed renters, what shows up in a cross sectional regression as an "impact" of sharecropping may well be the result of these factors rather than the specific form of the contract.

Although possibly limited by a rather small number of observations, studies from Ethiopia do not lend strong support to the hypothesis of Marshallian inefficiency either but instead suggest that farmers apply the same amount of inputs on land under informal and less secure contracts (rented, sharecropped and borrowed) and on lands formally allocated by peasant associations (Gavian and Ehui 1999, Pender and Fafchamps 2006). In fact, recent evidence suggests that, possibly due to eviction threats, sharecropped plots may be more productive than owner operated ones (Kassie and Holden 2006). To control for household-specific characteristics that vary systematically across owned and sharecropped plots (Bell 1977, Shaban 1987), we use the presence of a large number of households who own and sharecrop land at the same time to apply a methodology that compares yields and input intensities on owned and sharecropped plots for the same household. Formally, we estimate

$$y_{hi} = \gamma s_{hi} + \beta' x_{hi} + V_{vt} + u_h + \nu_{hi} \quad (1)$$

where y_{hi} denotes the value of either crop output or of variable inputs (family labor use per hectare, pair of oxen days per hectare, or quantity of chemical fertilizer use) per hectare by household h on plot i, s_{hi} is a dummy variable that equals one if the plot is owner-cultivated and 0 if the plot is sharecropped, and x_{hi} is a vector of exogenous plot characteristics such as soil quality and topography (measured by several dummy variables), a dummy variable whether the plot is irrigated or not, and the number of years the plot has been possessed by the current user. V_{vt} is a vector of time-varying district dummies that capture season and community specific effects, u_h captures the impact of all observed and unobserved household specific variables such as managerial ability, credit market access, or risk aversion that affect production decisions on all plots cultivated by the household equally, and v_{hi} is plot specific unobserved error term assumed to be identically and independently distributed with mean zero and finite variance.

In addition to yields, the main variable of interest, our empirical analysis focuses on use of family labor, draft power, and chemical fertilizer as the three most important inputs. The fact that all households use family labor and draft power allows estimation of a fixed effects model for these inputs whereas presence of non-trivial fraction of zero observations leads us to choose a random effects tobit model for chemical fertilizer. In this framework, the key variable of interest is the estimated coefficient on the ownership dummy, γ, that measures differences in yield or input intensity between owner-cultivated and sharecropped plots. A positive and significant coefficient would point towards existence of Marshallian inefficiency, i.e. differences that are due to the form of contract.

2.3 Optimality of adjustment through rental markets

Irrespectively of whether the principal's inability to enforce the optimum level of effort by the agent will lead to sharecropping being inefficient, it will be important to explore whether land rental will allow

households to attain their desired or 'optimum' cultivated land size. This may be prevented by a number of factors including the fact that land rental incurs significant transaction costs (e.g. for search of partners and contract enforcement) or imperfections in other markets, e.g. those for labor and draught animals, (Bliss and Stern 1982, Bell and Sussangkarn 1988). Ethiopian studies take evidence on the failure of rental markets to equalize factor ratios as an indicator for rental markets allowing only partial adjustment (Teklu and Lemi 2004). Together with large rates of non-participation, this is often interpreted as an indication for presence of friction in land rental markets (Holden and Bezabih 2006, Ghebru and Holden 2006). However, the approach taken does not allow quantification of the underlying factors. The only study that formally tests factor adjustment, albeit for a small sample of households renting out land only, is unable to reject the hypothesis of land markets facilitating full and frictionless adjustment to the desired land size (Pender and Fafchamps 2006). Other empirical studies show that imperfection on land rental markets leads to gendered productivity differentials; more specifically, it results in lower productivity on owned-operated land of female headed households than male headed households (Holden *et al.* 2001), and that female headed households rent-out their land to less productive tenants than male headed households (Bezabih and Holden 2006, Holden and Bezabih 2006).

To test whether this is the case, let k be the amount of net land leased which is itself a function of the difference between desired cultivated area (*DCA*), defined as the amount of land that matches the household's resource endowment in the absence of friction in the tenancy market, and total owned area (K).[4] Letting h be an the adjustment function which depends on the size and type of transaction costs in the rental market (Skoufias 1995), this relationship can be written as

$$k = h(DCA - K) = h(f(O, L) - K), \tag{2}$$

where, by assumption, *DCA* is a function of the household's endowment with oxen power O and family labor L. With the adjustment function h being non-decreasing in ($DCA - K$) and $h(0)=0$, i.e., a household that owns its desired cultivated area will not participate in the tenancy market, and f non-decreasing in both of its arguments, a first-order Taylor series expansion of equation (2) yields

$$k = (h' f_O)O + (h' f_L)L - h'K + C, \tag{3}$$

where h' is the slope the adjustment function, i.e. the first derivative with respect to ($DCA - K$), f_O and f_L are partial derivatives of the desired cultivated area function with respect to oxen and family labor endowments of the household, respectively, and C is a constant term.[5] Distinguishing observations with

[4] For graphical exposition of some of the possible forms of the adjustment function, *h*, see Bliss and Stern (1982) and Skoufias (1985).

[5] Using this basic model, Bliss and Stern (1982) applied ordinary least-squares to obtain regression estimators by pooling participants and non-participants together. This approach has been criticized as it ignores the non-linear nature of the participation decision in the tenancy market due to the presence of transaction costs and the possibility of asymmetries across the two sides of the market (Bell and Sussangkarn 1988, Skoufias

positive, zero, and negative amounts of net land leasing, an econometric model that accounts for these three observations, and that allows for asymmetry is given by

$$k_i = \begin{cases} -\alpha_n + \beta_n' Z_i + \varepsilon_i & if\ \varepsilon_i < \alpha_n - \beta_n' Z_i \\ 0 & if\ \alpha_n - \beta_n' Z_i \le \varepsilon_i \le \alpha_p - \beta_p' Z_i \\ -\alpha_p + \beta_p' Z_i + \varepsilon_i & if\ \varepsilon_i > \alpha_p - \beta_p' Z_i \end{cases} \quad (4)$$

where subscripts *n* and *p* denote the rental market participation status of household *i* with negative net leased-in area and positive net leased-in area, respectively; the parameters α_n and α_p include the constant term in (3) and the unobserved transaction costs that relate the latent to the observed variable; Z_i is a vector of household level variables; β is a vector of coefficients that combine the slope the adjustment function and the marginal responses of desired cultivated area to the underlying input endowment; and ε_i is the unobserved household specific error term.

Household level variables which we expect to determine a household's participation in the tenancy market and its desired amount of net leased-in area are included in Z_i. They encompass the demographic structure of the household (number of male adults, number of female adults, number of children, and age and sex of the head of the household), key assets (number of bulls and oxen and other livestock owned, number of rooms in dwellings), the area of land and its quality, and the literacy level of the head of the household as a proxy for human capital endowments. In addition, we also estimate a version of this equation that includes a measure of agricultural ability as well as social capital variables, in particular whether or not the household belongs to a village-level burial association, at the household-level. This formulation implicitly assumes that households' endowments with land, labor and oxen are exogenously determined, a reasonable assumption in our context as endowments of land use rights have been assigned by the village some time ago and land cannot be sold, oxen markets are highly imperfect, and instantaneous adjustments in family size are impossible. District dummies and a time trend are included to capture differences in social and infrastructure endowments that affect agricultural productivity, prices, access to markets, and time-varying factors of relevance for rental market functioning.

The parameters of the model are estimated using maximum likelihood (ML) under the assumption of an identically, independently, and normally distributed error term with mean zero and constant variance σ^2 (Skoufias 1995). The ML estimator is consistent and asymptotically efficient. However, as the model to be estimated is based on the first-order Taylor expansion, it is not possible to distinguish the threshold values related to transaction costs from the intercept terms and less weight should be given to the magnitude of the estimated intercept terms in interpreting results.

1995). Such asymmetries may arise from differences in the slope of the adjustment function and/or from differences in the marginal responses of desired cultivated area to the household's endowment of draft power and family labor as can be seen from equation (3).

The econometric model in (4) can be used to test a range of hypotheses concerning the role of transaction costs and market imperfections in explaining the performance of the land rental market. First, ascertaining that the coefficients of land area owned equals -1 would provide evidence for efficient and complete adjustment to the desired level of cultivated area through land rental markets. Rejection of this hypothesis would suggest that friction prevents full adjustment in this market (Skoufias 1995). Second, we can test the symmetry of the adjustment function for households who rent in land and rent out land through a straightforward test of the equality of the coefficients of land area owned across the two sides of the rental market as well as the symmetry of all or subset of the estimated coefficients of the two sides of the rental market. Finally, we can make inferences regarding non-tradability of other inputs by testing whether the estimated coefficients of these inputs are statistically different from zero.

While land rental may reduce productive efficiency through the choice of specific contractual forms adopted in rental markets, a potentially more important channel through which rental can enhance productivity is by transferring land from less to more productive producers. To test whether this is the case in our data, we exploit the fact that we have detailed information on production inputs and outputs for 3 years that differ from each other in terms of rainfall, prices, and other opportunities. Assuming that the key determinant of overall output is farmers' managerial ability, that differences in terms of soil quality are directly controlled for, and that other time invariant factors such as infrastructure and market access are accounted for by district dummies, household fixed effects from a panel production function regression reflect heterogeneity in farming skills (Lanjouw 1999, Deininger and Jin 2005). We thus run a household fixed effect Cobb-Douglas crop production function (see appendix table 1 for results) to recover a measure of households' ability and include it in the above adjustment cost regression.

The literature on institutional economics has long highlighted that social capital and associated networks can have an important role in reducing the cost associated with economically beneficial transactions. For example, the size of a person's network will make it easier to identify potential transaction partners[6] and being part of a network is likely to reduce the cost of enforcing contracts or monitoring other parties' performance (Sadoulet *et al.* 1997). Although this could be of great relevance in our case, the measure in our data that is closest to such a network variable is whether or not the household participated and had a relation in a village burial association *('iddir')*. Inclusion of this variable in the respective regression could provide a first opportunity to test for network effects.

[6] This can be beneficial economically in a number of settings, e.g. by improving the scope for co-insurance if agents are subject to random but uncorrelated shocks (Fafchamps and Lund 2003), if there are economies of scale in utilizing fixed investment as in marketing (Fafchamps and Minten 2002) or if, as in labor markets, the surplus from a particular transaction depends on the quality of the match between the two partners.

3. Data and descriptive statistics

Our panel data suggest a comparatively high level of land rental activity, with an almost exclusive reliance on sharecropping, and a prevalence of rental transactions between close kin. The supply of land to the rental market is concentrated among female-headed households who lack sufficient draught power, suggesting that, contrary to what is observed in other countries, land rental actually contributes towards concentration of operational holdings as compared to land ownership. Descriptive data also point towards lower rates of input application and output per area cultivated on sharecropped as compared to own land, implying that a formal econometric test of the inefficiency of sharecropping would be appropriate.

3.1 Data and household level evidence

We use data from three rounds of a longitudinal survey of rural households in the Amhara region of the Ethiopian highlands that comprise production information during the main agricultural season (*meher*, i.e. September-February) of the 1999, 2001, and 2004 agricultural years. In each of these periods, the survey, which was implemented by the Department of Economics of Addis Ababa University in collaboration with the Department of Economics of Gothenburg University, covers about 1520 randomly selected households from 12 villages (*kebeles*) in 6 districts (*woredas*) in South Wollo and East Gojam zones of the Amhara region. Among others, data for every year include detailed information on household resource endowments, crop production inputs and outputs at the plot level, demographic characteristics of households and their participation in land, labor and credit markets. In the last round, additional modules, including among others detailed information on household consumption were added.

Table 1 provides household level information for the whole sample and separately for those leasing out, leasing in, and remaining in autarky. A first observation of interest is that land markets are very active with almost half the households (46%) participating in rental markets either on the demand or the supply side and only 54% remaining in autarky. The fact that our sample is relatively balanced (20% leasing out and 26% leasing in) highlights that the vast majority of transactions is between households in the same village.[7] A second observation of interest is that, with 40%, a significant share of those renting out (compared to 12% among those in autarky and 3% among those renting in) are female headed. With more than 70% of all female headed households renting out land, a key function of land rental is to transfer land from resource poor female-headed households to resource rich male-headed ones. Exploring the equity impact of such transfers may be of interest.[8] Third, with few differences in area owned between the different groups (1.08, 1.08, and 1.12 hectares, respectively), operation of land markets leads to a slight

[7] Almost all the households involved in the land rental market participated in either renting-out or -in land with less then 1% of households reporting to simultaneously lease out and lease in land.
[8] Excluding female headed households from the analysis does not change the result that land is predominantly transferred from resource poor to relatively resource rich households.

concentration of operational land holdings compared to land ownership, different to what is observed in most other countries. In fact, the Gini coefficient is 0.40 for land ownership but 0.47 for operational holdings. While this is low compared to the high levels of land inequality found in Latin American countries, it is higher than in China where rental markets equalize the operational land distribution.[9] Finally, while one would expect those renting in to have better access to family labor, their higher endowments of human and physical capitals (literacy and education levels) suggests that, contrary to what is observed in most other countries, there may be significant barriers to entry into non-farm activities.

3.2 Plot level characteristics

Table 2 presents information on output and input as well as source of traction and, for rented ones, the type of transaction partner for the 19,249 relevant plots under cereals, pulses, and oilseeds in the pooled sample. Plots cultivated with vegetables, fruits and other trees are excluded because of the nature of the survey villages all of which are predominantly cereal-producing areas in the highlands, in addition to a number of technical reasons, e.g. significant underreporting of output for continuously harvested fruits and vegetables and non-availability of price information for some tree crops such as eucalyptus.[10] Out of these, slightly more than one third (7,569 plots) belong to owner-cum-sharecroppers who own and lease in land at the same time and who will be of main interest for the household fixed-effect regressions.[11]

Comparison of the columns 1-4 and 5-7 corresponding to the whole sample and the sub-sample of owner-cum-sharecroppers, respectively, points towards few significant differences, suggesting that the latter are broadly representative of the overall population. The table illustrates that with more than 90% of rented plots transferred under sharecropping rather than fixed rent, sharecropping is the predominant contractual arrangement. Panel 1 also illustrates that most transfers were limited to close kin: 60% of plots were exchanged between relatives or in-laws, an additional 30% among neighbors or village association members,[12] and only 10% between unrelated individuals. About 21% of plots are transacted in rental markets, a share that is significantly lower than that of households involved in rental transactions due to the fact that rental transactions normally involve only part of a household's endowment. With close to 50%, the share of output accruing to landlords is comparatively high. Although detailed data was not collected on the nature and formality of contracts, the mean leased-in plot in the sample had been in the

[9] The Gini coefficient for the ownership distribution of land is 0.92 for Venezuela and 0.87 for Brazil (Deininger and Squire 1998) compared to a Gini of 0.36 for the distribution of use rights, which was further reduced through transfers, in three provinces of China (Deininger and Jin 2005).
[10] A total of 3966 plots in the pooled cross-section, time-series sample which were allotted for vegetables, fruits and tree crops are dropped from the analysis. Of which 993 were operated by owner-cum-sharecroppers, but only 112 of them were sharecropped plots over the three periods.
[11] Given the small number of plots transferred under fixed rent arrangements and the fact that these are not used in our subsequent plot-level analysis, descriptive statistics for these are not reported separately but can be obtained from the authors upon request.
[12] Village associations are self-help groups and informal networks such as agricultural mutual aid groups, rotating savings and credit associations, rotating feast groups, burial associations, etc. that are formed among persons of common kin, neighborhood or faith.

possession of the current tenant for about 4 years, consistent with an average duration of contracts of 3 years as reported in the third round data.

Noting that the stars in column 8 indicate statistical significance of the difference in means between owned and sharecropped plots, we can compare differences in output and input use for plots operated by owner-cum-sharecroppers. We note that output per hectare is significantly lower on sharecropped plots compared to the ones under owner-cultivation. For owner-cum-sharecroppers, the difference amounts to 15 percentage points, and it is statistically significant at the 1% level. Although multivariate analysis will be needed to quantify the effect and assess whether part of this could be due to the slightly lower soil quality of sharecropped plots, this provides *prima facie* evidence of Marshallian inefficiency. Marked differences in application of almost all inputs between owned and sharecropped plots further support this interpretation. While 43% use an average of 102 kg/ha of fertilizer on own plots only 36% do so on sharecropped ones, in addition to applying a much lower quantity (77 kg/ha). Differences in manure application are even more pronounced, compared to 29% applying it on own plots, only 6% apply it on sharecropped ones and the differences in quantities are dramatic. Use of family labor is more than 25% less on shared in (191 days/ha) compared to own plots (257 days/ha) and even though hired labor is applied on a slightly higher share of sharecropped as compared to owned plots (23% vs. 17%), there is no significant difference in the amounts applied. As all of these differences are observed within the same household, they provide strong support to the notion of inefficiency due to the nature of contractual arrangements. At the same time, the considerably higher share of shared-in plots cultivated with own oxen suggests that shortage of oxen may indeed be a key reason for households to engage in land rental activities. The lack of rental markets for oxen can be attributed to synchronic timing of activities and moral hazard that could lead renters to over-use and under-feed animals. Thus, the main source of traction power for about 30 percent of cultivated plots was either oxen-sharing (*mekenajo*) or exchange of labor for oxen services.

4. Econometric results

Results from econometric estimation demonstrate that, even in an environment where there are little observed outcomes from operation of rental markets that are fully efficient, significant barriers to entry or friction in their operation could imply that whatever adjustment is brought about through the operation of such markets falls short of the potential. The hypothesis of sharecropping leading to inefficient use of resources is not rejected. This adds to the magnitude of friction that would, according to our estimates, prevent rental markets from attaining a first best allocation of resources.

4.1 Evidence on the inefficiency of sharecropping

Table 3 reports results from the household fixed effect estimates of yield and input intensity equations at the plot level for the most common crops. As discussed earlier, we use semilog equations conditional on plot characteristics (soil quality, topography, years of possession and availability of irrigation) to allow interpretation of the coefficients on the ownership dummy as percentage deviations of output and input intensities of owner-cultivated relative to sharecropped plots. After controlling for the effects of soil and other plot level characteristics, the results in column 1 of table 3 show a statistically significant difference in yields between owned and sharecropped plots that can be attributed to the rental arrangement. The point estimate suggests that, after adjusting for other factors, yields are 7% higher on owned as compared to sharecropped plots for the same household. This provides support for the hypothesis of 'Marshallian inefficiency', i.e. lower efficiency on sharecropped as compared to owned plots. The estimated magnitude is slightly less than half of the yield differential estimated in semiarid Indian villages (Shaban 1987). It suggests that the fact that rental contracts are normally entered only between close relatives or neighbors does not allow the principal to monitor to an extent that would bring tenants' effort to the optimum.

To complement the above results, columns 2-6 of table 3 report results of the corresponding fixed effect regressions for intensity of input application on owned and sharecropped plots by the same household. Except for oxen power, where descriptive statistics already pointed little differences, we find statistically significant differences in input use between owned and sharecropped plots throughout. For example, we estimate that the intensity of family labor and total labor (including hired labor) are 17 and 16 percentage points less on sharecropped plots (columns 2 and 3), respectively. The fact that similar conclusions emerge from random effect tobit regressions for intensity of fertilizer application (columns 5 and 6) implies that, conditional on fertilizer being used, owned plots receive about 38% more fertilizer than sharecropped ones. Overall, these results are consistent with what was found for yields, pointing towards moral hazard in tenants' effort supply, and an inability to use purchased inputs such as fertilizers to substitute for labor. The willingness of both parties to enter into such contracts points towards existence of capital market imperfections, possibly together with social norms, precluding a wider use of fixed rent contracts which one would expect to be less affected by such inefficiency.[13]

[13] To test this notion more formally we use information on the 128 households in the sample who operate plots under ownership as well as fixed rental (a total of 1565 plots over the three periods). Results, which are available upon request, indicate that, with the exception of family labor which is 13% higher on plots cultivated under ownership as compared to fixed rental, there are no statistically significant differences in input and output intensities between the two types of plots. This could be a form of investment on owned plots, for example by removing stones or applying more intensive weeding to prevent accumulation of a stock of weed seed.

4.2 Evidence on friction in land rental markets

The evidence of existing rental contracts not being fully efficient will be largely independent from whether or not such markets allow producers to participate in such markets to rent in an amount of land that would allow them to attain their optimum holding size. To explore whether this is the case, the parameters for intensity of participation in tenancy market (table 4) allow a number of insights.[14]

Most importantly, noting that the coefficient of owned land area corresponds to the slope of the adjustment function in (2), the positive (negative) and significant coefficients of owned area in the leasing out (in) equations suggest that, once households' endowments with fixed factors are accounted for, land markets facilitate an adjustment towards households' desired level of cultivated area. However, figures in table 4 illustrate that both the hypotheses of the symmetry of the coefficients on both sides of the market and, more importantly, full adjustment, i.e. the equality of these coefficients to 1 or -1 is strongly rejected. While suppliers appear to be slightly less constrained than those demanding land through the market, estimated coefficients suggest that, on average, farmers realize only about 25% of the desired amount of land leased, pointing towards the existence of large amounts of friction in the land lease market. This is in marked contrast to results by the only other study on this issue in Ethiopia which -albeit based on somewhat imperfect data[15]- were unable to reject the hypothesis of perfect adjustment (Pender and Fafchamps 2006).

To put this figure into perspective, note that in India where a large number of policies impose multiple *de jure* restrictions on land rental (Deininger *et al.* 2006), the corresponding coefficient was 78% (Skoufias 1995), suggesting that, despite rental restrictions, producers in India were able to use markets to come much closer to their desired operational land endowment. We return to a discussion of possible policy issues underlying this phenomenon. A second finding of interest relates to the signs and significance levels of the coefficients on other factors, all of which should equal zero under the assumption of perfect markets.[16] The coefficient on ownership of draft animals is highly significant and positive (negative) on the demand (supply) side of the market, suggesting that households with more (less) animals are likely to lease-in (out) more (less) land in line with the hypothesis that land leasing decisions help to improve utilization of households' imperfectly tradable endowment with oxen. The extent of land transactions is also significantly affected by female headship and the number of male adult members and dependents in the expected way, due in part to the fact that -even if females may participate in other activities such as

[14] The dependent variable is the amount of net land leased-in (i.e. leased in minus leased out) in hectares. To facilitate interpretation, estimated coefficients in the lease-out equation (except for the district dummies, the time trend and the intercept term) are multiplied by -1. A positive (negative) coefficient in the leasing-out column can thus be interpreted as an increase (decrease) in the amount of land leased-out in response to a positive change in a given explanatory variable.

[15] In addition to a much smaller sample (161 observations), only one side of the market (leasing in) was observed.

[16] Note that it is difficult to disentangle the effect of the adjustment function from the marginal responsiveness of the desired cultivated area to the key inputs.

weeding and harvesting- ox ploughing is a male task and that it will be difficult for females to obtain the necessary male labor (plus oxen) input through the market. The value of other livestock and number of rooms in the house, a proxy for wealth and access to credit and working capital, is positive (negative) in the lease in (out) equation, suggesting that credit market imperfections may be another factor preventing households from leasing in their desired amount of land.

While the regressions suggest that land markets transfer land from older to younger households and thus substitute for administrative redistribution of land, households' literacy level is not significant, in contrast to what is found in other countries where off-farm labor markets are often found to be a driving factor underlying land market activity (Deininger and Jin 2006a). The fact that higher levels of education do not increase the propensity of renting out land points towards limited opportunities in non-agricultural labor markets. Finally, intercept terms and the district dummies are significantly different from zero (table 5), suggesting clear differences in the extent of land rental market functioning across villages. Although the coefficient on our social capital variable -whether the household participated in a village burial association or the number of relationships maintained- is highly significant in the rent-out but not in the rent-in equation (not reported), its high correlation with woreda dummies implies that its significance disappears once these are suppressed. Although this is consistent with the notion that higher levels of social capital reduce the barriers to renting out land, we conclude that the quality of either of the variables is poor and that better data will be needed to draw more and far-reaching conclusions.

Results for the equation that includes farming ability are reported in the last two columns of table 4. Our failure to find a statistically significant effect of ability on leasing-out decisions is consistent with the descriptive evidence according to which imperfections in input markets, rather than ability, are a key factor prompting households to supply land to the rental market. At the same time, we note that, according to our results, households with higher levels of ability are likely to rent-in more land (significant at 10%), implying that by providing greater land access to those with higher levels of ability, rental markets make some contribution to enhancing productive efficiency.

5. Conclusion and implications for future research

Study of land rental markets in Ethiopia is of interest not only because of the relevance of such markets for non-agricultural development but also because the country is characterized by a relatively equal allocation of land but high levels of production risk that lead to sharecropping as the most prevalent contractual form. Our results suggest that rental markets are doubly inefficient. On the one hand, transaction costs of rental imply that a large number of households are rationed out from rental market participation or, even if they are able to participate, are not able to use rental markets to attain their optimum operational land holding. On the other hand, credit market imperfections, together with high

levels of risk, imply that even those able to overcome barriers to market entry are unable to choose contractual arrangements (or to supervise tenants sufficiently) that are fully efficient. These results are in marked contrast to what has been found in other contributions to the literature on Ethiopia.

To interpret these results note that, although the level of inefficiency associated with sharecropping found here is comparatively modest, the magnitude of friction estimated here is much larger than what has been found in other countries where similar studies have been undertaken. Even if this does not allow us to unambiguously identify the source of such friction, it is consistent with the notion that the negative impact of a policy environment that restricts operation of land rental markets could be a key factor. For example, lack of clarity in the policy as to whether land will be lost if the owner takes up non-agricultural employment may constitute a strong impediment to out-migration from rural areas (Rahmato 2003). This is of relevance because, in rural areas all over the world, land markets that can adjust flexibly to the changes brought about by new technology, greater integration with marketing and processing, and better off-farm opportunities, will be a pre-condition for rural producers' ability to take advantage of these new opportunities.

Given the magnitude of the friction observed, more detailed analysis to identify factors that may prevent adjustment to households' desired level of operated land through rental markets would be of great policy relevance. The fact that policies are formulated at the regional level and have, at least on paper, changed considerably over time, could help separate the impacts of policy from those of other factors. Combining 'objective' legislative provisions with households' subjective perceptions of their land rights in a national data set could provide insights on the extent to which producers are aware of new legislation and the way in which such awareness links to and interacts with other factors and affects socio-economic outcomes. Such analysis is left for future research.

Table 1: Household level descriptive statistics

Variable	Total	By land market participation status				
		Leased-out		Autarky	Leased-in	
Household characteristics						
Female head dummy (%)	15.37	39.95	***	11.82	3.29	***
Head literate (%)	41.31	29.05	***	41.27	51.14	***
Age of head in years	48.38	51.61	***	48.71	45.11	***
No. of rooms in dwellings	1.95	1.74	***	1.95	2.13	***
Owned area in ha	1.10	1.08		1.12	1.08	
Number of adult males	1.49	1.04	***	1.57	1.70	***
Number of adult females	1.46	1.33	***	1.52	1.46	*
No. of dependents (<15 or >60)	2.72	2.26	***	2.74	3.05	***
Agricultural production						
Net land leased-in	0.01	-0.71	***	0.00	0.61	***
Cultivates any land (%)		63.2				
Owned cultivated area in ha	0.95	0.37	***	1.12	1.07	
Total cultivated area in ha	1.11	0.37	***	1.12	1.69	***
Share of good quality land (%)	38.42	36.68	*	39.42	37.70	
Owns bulls or oxen (%)	67.31	23.65	***	72.42	91.32	***
No. of bulls/oxen (for owners)	1.19	0.39	***	1.21	1.79	***
Value of other livestock in ('000) Birr	1.20	0.57	***	1.20	1.69	***
Distribution over districts (*Woredas*)						
Woreda1 (Machakel), East Gojam (%)	15.44	13.09		12.55	23.38	
Woreda2 (Gozamin), East Gojam (%)	15.91	16.88		16.64	13.61	
Woreda3 (Enemay), East Gojam (%)	15.98	21.35		12.25	19.54	
Woreda4 (Tehuledere), South Wollo (%)	20.57	18.94		23.20	16.35	
Woreda5 (Tenta), South Wollo (%)	15.96	13.55		20.03	9.32	
Woreda6 (Habu), South Wollo (%)	16.14	16.19		15.33	17.81	
Number of observations	4268	871		2302	1095	

Source: Own computation from AAU/UG Amhara Panel Survey

Note: Unit of observation is a household in a given year. Except for negligible attrition (less than 3% between rounds), this implies that the same household contributes three observations.

Stars indicate that means for the lease-out and lease in group, respectively, are significantly different from those for the group remaining in autarky. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: Plot characteristics for different samples (only cereals, oilseeds and pulses plots)

	Total sample				Owner-cum-sharecroppers			
	All	**Own cult.**	**Shared in**	**Shared out**	**All**	**Own cult.**	**Shared in**	
Relation w. partner (TP)								
TP relative (%)	48.16		48.55	49.83	48.95		48.95	
TP in-law (%)	10.68		11.13	11.22	10.61		10.61	
TP neighbor (%)	17.53		15.62	18.52	15.34		15.34	
TP member of VA (%)	12.74		13.83	10.79	14.38		14.38	
TP unrelated (%)	10.90		10.87	9.64	10.72		10.72	
Harvest share received (%)	51.08		53.10	49.18	53.39		53.39	
Output & plot characteristics								
Crop output/ha (Birr)[1]	2753.71	2788.92	2579.31		2868.60	2973.47	2480.64	
Crop output/ha (Birr)	2087.78	2086.07	2147.79		2043.36	2106.22	1827.98	***
Plot size in ha	0.26	0.26	0.29	0.28	0.26	0.26	0.28	***
Years of possession	15.99	17.43	3.91	17.85	13.79	16.70	3.81	***
Good soil quality (%)	36.94	37.81	34.92	33.27	36.08	36.43	34.88	
Medium soil quality (%)	41.76	41.72	40.59	43.31	40.93	41.22	39.93	
Poor soil quality (%)	21.16	20.33	24.49	23.28	22.88	22.21	25.19	***
Flat land (%)	3.84	3.83	2.98	4.74	68.48	67.09	73.21	***
Gently sloped (%)	3.45	3.41	2.80	4.42	27.51	28.58	23.86	***
Steeply sloped (%)	0.42	0.45	0.20	0.36	4.00	4.32	2.92	***
Irrigated (%)	2.47	2.67	1.39	2.26	2.42	2.75	1.29	***
Variable input use								
Used fertilizer (%)	36.95	36.99	34.33		41.88	43.45	36.49	***
Fertilizer used per ha (kg)	90.05	91.54	78.22		96.29	102.30	76.76	***
Used manure (%)	25.84	28.91	6.31		23.65	28.84	5.85	***
Manure used per ha (kg)	2953.28	3284.99	414.29		3079.62	3803.08	294.78	***
Used improved seed (%)	3.83	4.08	2.14		3.88	4.45	1.93	***
Male family labor/ha (d)	178.11	185.15	136.30		162.86	171.84	132.09	***
Fem. family labor/ha (d)	92.03	97.20	60.51		79.57	85.64	58.74	***
Total family labor/ha (d)	270.15	282.35	196.81		242.43	257.49	190.83	***
Used hired labor (%)	17.13	16.16	21.91		18.43	17.24	22.51	***
Hired labor/ha (d)	72.96	79.81	45.39		46.97	48.90	41.90	
Source of traction								
Own pair of oxen (%)	58.47	56.46	70.30		67.00	66.22	69.65	***
Oxen exchange for labor (%)	15.87	17.17	7.34		11.12	12.37	6.84	***
Oxen sharing (%)	19.28	19.39	19.80		19.39	18.98	20.82	*
Gift/support (oxen party) (%)	5.03	5.49	2.06		1.96	1.88	2.22	
Oxen rental (%)[1]	1.12	1.20	0.50		0.54	0.56	0.47	
Hoe and other (%)	0.40	0.48	0.00					
Pair of oxen days per ha	50.38	49.74	54.36		52.27	51.83	53.79	
Number of observations	19249	14668	2013	2217	7569	5859	1710	

Source: Own computation from AAU/UG Amhara Panel Survey

Note: Unit of observation is a plot in a given year. Thus the same plot could provide multiple observations.

Significance levels reported for t-tests of the equality of the means between owned and shared-in plots for the sub-sample of owner-cum-sharecroppers. * significant at 10%; ** significant at 5%; *** significant at 1%

[1] Value of crop output per ha (Birr) using all the plots (including plots covered by vegetables and perennial crops).

[2] Rental includes provision of animals by the sharecropping partner or other arrangements.

Table 3: Determinants of output and input intensity per ha for owner-cum-sharecroppers (household fixed effects estimates)

	Value of output per hectare (log)	Family labor per ha (log)	Total labor per ha (log)	Pair of oxen days per ha (log)	Quantity of fertilizer per ha – Random effect tobit	
					Coef.	Marginal effect (dlny/dx)
Ownership dummy	0.071**	0.171***	0.163***	0.014	59.804***	0.380***
	(2.48)	(6.55)	(6.25)	(0.49)	(6.17)	(6.16)
Number of years possessed	-0.002	-0.002*	-0.003**	-0.001	-0.752*	-0.005*
	(1.32)	(1.89)	(2.12)	(0.81)	(1.86)	(1.86)
Good soil quality	0.107***	0.034	0.030	-0.010	-20.215**	-0.129**
	(3.66)	(1.30)	(1.14)	(0.34)	(2.15)	(2.14)
Medium soil quality	0.091***	0.024	0.019	0.015	-12.818	-0.082
	(3.32)	(0.98)	(0.76)	(0.59)	(1.45)	(1.45)
Flat land	0.064	0.049	0.026	0.046	-8.880	-0.056
	(1.22)	(1.03)	(0.56)	(0.91)	(0.52)	(0.52)
Gently sloped land	0.085	0.035	0.021	0.058	-18.830	-0.120
	(1.61)	(0.73)	(0.44)	(1.15)	(1.09)	(1.09)
Irrigated land	-0.055	-0.040	-0.056	-0.046	-28.103	-0.179
	(0.83)	(0.66)	(0.93)	(0.72)	(1.09)	(1.09)
Constant	7.143***	4.663***	4.736***	3.480***	-81.877***	
	(124.51)	(89.34)	(90.85)	(63.18)	(4.20)	
Observations	7569	7569	7569	7569	7569	
Number of household	591	591	591	591	591	
R-squared	0.25	0.12	0.13	0.15		

*Note:*Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
The reported marginal effects for the fertilizer regression are provided in the form of *dlny/dx* such that we can interpret the coefficient of the ownership dummy similar to that of the labor intensity regressions as the percentage deviations of input intensities on owner-cultivated plots relative to sharecropped plots. Time-varying district (*woreda*) dummies are included, but not reported.

Table 4: Determinants of net land leased-in: Maximum likelihood estimates

	Simple friction model		Ability included	
Variable	**Leased-out**	**Leased-in**	**Leased-out**	**Leased-in**
Owned area (ha)	0.305***	-0.208***	0.303***	-0.208***
	(5.14)	(3.84)	(4.95)	(3.75)
Proportion of good soil quality	-0.052	-0.007	-0.058	-0.011
	(0.83)	(0.11)	(0.83)	(0.18)
Number of dependents	-0.057***	0.067***	-0.044**	0.066***
	(2.79)	(3.56)	(2.03)	(3.40)
Number of adult male	-0.090***	0.071**	-0.091***	0.070**
	(2.76)	(2.40)	(2.59)	(2.32)
Number of adult female	-0.004	-0.039	0.009	-0.043
	(0.13)	(1.11)	(0.25)	(1.19)
Number of bulls and oxen	-0.641***	0.292***	-0.629***	0.286***
	(9.36)	(4.32)	(8.91)	(4.25)
Value of other livestock owned × 10^{-3} (Birr)	-0.096***	0.036**	-0.083**	0.035**
	(3.00)	(1.99)	(2.57)	(1.98)
Number of rooms of the household	-0.030	0.079***	-0.043	0.084***
	(1.03)	(2.79)	(1.30)	(2.90)
Age of household head (years)	0.011***	-0.011***	0.012***	-0.011***
	(5.93)	(5.26)	(5.52)	(5.04)
Female headed household	0.619***	-0.654***	0.611***	-0.634***
	(7.41)	(5.85)	(6.81)	(5.48)
Household head can read and write	0.021	-0.000	0.008	-0.000
	(0.35)	(0.01)	(0.12)	(0.01)
Farm ability			-0.058	0.111*
			(0.94)	(1.68)
Threshold effect and constant parameters				
Woreda2	-0.270**	0.222**	-0.294***	0.232**
	(2.50)	(2.41)	(2.62)	(2.44)
Woreda3	-0.265**	-0.186*	-0.253**	-0.139
	(2.53)	(1.89)	(2.16)	(1.29)
Woreda4	-0.762***	0.340***	-0.840***	0.334***
	(5.93)	(2.79)	(5.98)	(2.66)
Woreda5	-0.958***	0.333***	-1.026***	0.355***
	(7.30)	(2.87)	(7.19)	(2.98)
Woreda6	-0.439***	-0.053	-0.436***	-0.003
	(3.76)	(0.48)	(3.44)	(0.03)
Time trend	0.101***	0.138***	0.097***	0.142***
	(3.50)	(4.58)	(3.03)	(4.58)
Constant	-0.630***	0.369***	-0.735***	0.360**
	(3.60)	(2.58)	(3.81)	(2.43)
σ	1.025***		1.058***	
	(9.78)		(9.58)	
Log likelihood	-4680.15		-4466.07	
Wald chi2(23)	156.65***		140.08***	
Observations	4268		4106	

Note: Robust z statistics adjusted for clustering in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1% Coefficients for leasing-out (except constant and dummies) are multiplied by -1 for ease of interpretation. The discrepancy in the total number of observations is mainly because about 137 households leasing-out land were pure landlords over the three periods, and the rest is due to missing values in the value of crop output or its determinants. This leads to some missing values in the household fixed effects (a proxy variable for farming ability) obtained from the regression estimates given in appendix table 1.

Table 5: Wald tests of Equality of coefficients on opposite sides of the land lease market

Hypothesis tested (using estimated coefficients given in the first two columns of table 5)	Wald statistic chi2(r)
Symmetry of all coefficients (except woreda dummies), r=11	37.20***
Symmetry of subset coefficients (resource endowment: labor, land, oxen, assets), r=8	36.60***
Owned area	11.2***
Owned area=-1, r=2	218.64***
Good soil quality	0.57
Dependants	0.16
Male adult	0.21
Female adult	0.99
Oxen	22.68***
Other livestock	3.08*
Rooms	1.94
Age	0.06
Female headship	0.1
Literacy	0.08
Equality of intercept terms	
Woreda1[a]	1.13
Woreda2	1.72
Woreda3	9.31***
Woreda4	6.32***
Woreda5	14.66***
Woreda6	9.49***

Note: * significant at 10%; ** significant at 5%; *** significant at 1%

[a] Woreda1 is the district included in the constant term (the reference category). The intercept term for the other districts is, therefore, the sum of the coefficients of the respective district dummy and the constant term.

Appendix table 1: Determinants of value of crop output for all plots: Household fixed effects estimates

	Value of crop output (log)
Plot size (log)	0.219***
	(21.86)
Male family labor (log)	0.320***
	(24.35)
Female family labor (log)	0.010
	(0.96)
Hired labor (log)	0.039**
	(2.33)
Pair of oxen days (log)	0.158***
	(15.31)
Chemical fertilizer kg (log)	0.164***
	(13.73)
Manure in kg (log)	0.019
	(1.64)
Dummy female family labor[a]	-0.057*
	(1.82)
Dummy hired labor[a]	-0.116***
	(3.42)
Dummy oxen labor[a]	0.125**
	(2.51)
Dummy chemical fertilizer[a]	0.212***
	(5.28)
Dummy manure[a]	0.142**
	(2.09)
Number of years possessed	0.000
	(0.10)
Good soil quality	0.129***
	(6.52)
Medium soil quality	0.112***
	(6.10)
Flat land	0.016
	(0.47)
Gently sloped land	0.039
	(1.12)
Irrigated land	0.056
	(1.27)
Constant	4.192***
	(42.50)
No. of observations	15935
No of households	1504
R-squared	0.44

Note: Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%
[a]The value of the dummy is 1 if the input is not used, and the value is 0 if the input is used.
Time-varying district (woreda) dummies included throughout but not reported.

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