Mechanisms for Land Transfer in Ethiopia: Implications for Efficiency, Equity and Non-Farm Development

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Abstract

We use data from Ethiopia to empirically assess determinants of participation in land rental markets, compare these to those of administrative land reallocation, and make inferences on the likely impact of households' expectations regarding future redistribution. Results indicate that rental markets outperform administrative reallocation in terms of efficiency and poverty. Households who have part-time jobs in the off-farm sector are significantly more likely to expect land to be taken away from them through administrative means. Eliminating the scope for administrative land reallocation may thus a pre-condition for more vigorous development of the off-farm sector.

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1. Introduction

In poor agrarian economies, land is not only a key factor of production but also performs an essential role as an insurance device and a social safety net. Ownership of land can provide access to credit which will enable households to make indivisible investments they would otherwise have not been able to undertake (Galor and Zeira 1993, Banerjee and Newman 1993). Where markets for output or labor are imperfect, access to land, even if only through use rights, can help households make effective use of family labor, and improve their nutritional status (Burgess 2001). The social importance of land, together with the fact that patterns of land allocation will affect efficiency of agricultural production, have motivated governments in countries where, often for historical reasons, access to land was highly unequal, to intervene in the functioning of markets through land reforms that aimed to equalize the ownership distribution of land. While the impact did not always live up to original expectations, reforms that gave more secure rights to households have generally had a markedly positive impact on welfare, productivity, and social peace (King 1977, Lin 1992, Binswanger *et al.* 1995).

One issue that is not entirely clear in this context is whether, once an egalitarian ownership distribution has been attained, further intervention to maintain such equality will either be needed or even beneficial (Banerjee 2000). In fact, a number of arguments suggest that such intervention may be detrimental to growth and equity goals. Uncertainty about whether or not plots will be possessed in the future is likely to reduce investment incentives. Administrators may be unable to observe producers' agricultural ability and thus give land to households who are unable to make the best use of it. Moreover, the need to demonstrate a "need" for land or its "productive" use may in the longer term induce higher population growth and in a more immediate context, undermine incentives for migration and non-agricultural investment by households if they have to fear that, such activities will increase their risk of losing their land (Yang 1997).

This issue is of critical importance for Ethiopia where, a decade after the government has started to individualize land rights, allow land rental, and largely eliminate the scope for land redistribution, political pressure for renewed redistribution is building up in a number of regions (Ethiopian Economic Association 2002). To decide whether to continue pursuing an interventionist stance towards land rights and land markets or to move towards abandonment of administrative controls in favor of decentralized land allocation, it will be important to know how well markets function,

how they compare to administrative reallocation of land, and whether the threat of being subject to such intervention leads households to adjust their behavior. Few studies have tried to empirically explore this issue and this paper aims to contribute at filling this gap.

First, we are interested whether and to what extent land markets contribute to the dual goals of greater equity and efficiency in the rural economy. To assess whether concerns about a negative equity impact of land rental market functioning are justified, we explore whether such markets transfer land to households with lower land endowments and whether there is evidence of an "agricultural ladder" whereby it is possible for households to make the transition from sharecropping to fixed rent tenancy. To ascertain the impact on economic efficiency, we probe whether markets provide access to land for producers with higher levels of ability. We find that markets and administrative mechanisms tend to transfer land to more productive and poorer households. This would suggest that there is little reason to be concerned about potential negative effects of the emergence of rental markets as, with more and more off-farm migration and non-farm employment, the need for reallocation of land increases.

A second issue to be explored, based on the identification of factors contributing to land access via markets in contrast to other mechanisms, is to compare the historical performance of land markets to that of administrative land reallocation. In addition to descriptive evidence highlighting that rental markets have recently become more important than administrative land reallocation, we find that reallocation appears to have been undertaken largely on political grounds, contributing neither to higher levels of efficiency nor equity.

Finally, exploring factors that lead households to perceive a threat of future land loss (or gain) through administrative redistribution, we find that it is farmers who are more productive who have part-time jobs in the off-farm sector who perceive a threat of land redistribution whereas renting in land increases the expectation of gaining through land redistribution in the future. If, as is quite likely, households adjust their behavior to avoid actions that might increase the probability of them login their land, our findings suggest that the danger of land redistribution is likely to retard the growth of the off-farm economy and, if realized, will also hamper agricultural productivity. This, together with the fact that it may be difficult to satisfy the expectation of those who expect to gain from administrative redistribution, suggests that a clear policy statement to reduce the scope for of land redistribution, together with proper

measures to increase households' tenure security may have an important effect not only to increase tenure security and land-related investment but also to help jump-start off-farm investment and labor markets.

The paper is structured as follows: Section two reviews the literature and develops a model and an estimation strategy to analyze land rental market decisions in a framework with off-farm employment opportunities, unobserved agricultural ability and non-zero probability of losing land that is rented out. Section three discusses data sources and provides evidence on descriptive statistics as well as the distribution of agricultural ability across producers. Section four discusses econometric evidence by comparing the determinants of administrative and market-based land reallocations, assessing the factors underlying hypothetical market participation, and quantifying the gains from better functioning of land rental markets. Section five concludes with policy implications.

2. Background and Conceptual Model

In this section we first present the background on land policy issues facing Ethiopia, their historical context, and the way in which exploration of land markets as compared to administrative transfers of land can help to provide insights and policy recommendations. We use this as a basis for formulating a conceptual model that allows us to derive empirically testable hypotheses which are related to the empirical literature on the subject of land markets and land reallocation. Finally, we discuss the strategy for estimation and linking the hypotheses to the data.

2.1. Review of the Literature

In a world of perfect information and complete markets, with zero transaction costs, the ownership distribution of land ownership will affect households' welfare but will not matter for efficiency outcomes, and everybody will operate their optimum farm size (Feder 1985). Government involvement in land markets has often been justified as a means to counter imperfections in capital and labor markets that are widespread in rural areas and which would prevent markets from bringing about socially desirable outcomes. We argue that market failures are more likely to be of policy relevance in land sales rather than in rental markets where sharecropping provides an opportunity to adjust to credit market imperfections in a flexible way with at most moderate productivity losses.

Imperfections in rural labor markets are mainly due to the cost of supervision which arises from the fact that, except in very limited circumstances, a wage workers' true effort is not easily observable. This implies that wage workers will have limited incentives to exert effort and either need to be supervised at a cost[1] or be offered contracts that provide higher incentives. Family members have higher incentives to provide effort than hired labor, implying that it would be advantageous for those who do not have enough land to fully utilize their family labor endowment to rent in land or for those who are relatively land abundant to rent out, rather than engaging in labor market transactions that incur supervision costs. Land markets would thus have a positive impact on improving land access by land-poor households. As long as imperfections affect only one market, everybody would still cultivate the same amount of land per capita.

Credit market imperfections can offset or even eliminate supervision cost advantages of family farmers. For example, if there is a need for up-front working capital (e.g. to acquire inputs in addition to land and labor) and access to capital depends on initial wealth, the optimal size of the operational holding would vary systematically with the size of owned holdings even if land rental markets operate perfectly. Recognition of the limitations of land markets in an environment characterized by multiple imperfections in other factor markets has led policy makers to try and impose restrictions on their unhindered operation. However, while such capital constraints are likely to be of relevance, and might be used to make at least a case in principle for government involvement, a large literature has demonstrated that adjustment of the contract terms, in particular the adoption of share-cropping contracts, provides households with an opportunity to overcome the working capital shortage at a relatively small cost. At the same time, it is well known that the scope for government intervention in land markets may be associated with a number of undesirable side-effects.

First, even if they achieve their short-term aims, such interventions are likely to reduce tenure security and impose disincentives for investment. In fact, a large literature on land tenure and investment demonstrates that higher levels of tenure security (though not necessarily formal title) will lead to greater investment by households. (Soule *et al.* 2000, Otsuka 2001, Place and Migot-Adholla 1998, Binswanger *et al.* 1995, Besley 1995, Migot-Adholla *et al.* 1994, Feder 1988). While

[1] In agricultural production, supervision is particularly difficult or costly due to the spatial dispersion of the production process and the vagaries of nature imply a need to constantly adjust to micro-variations of the natural environment.

much of this literature has focused on investment that is directly attached to land, insecure tenure, i.e. the risk of losing land if specific actions are undertaken, is also likely to lead households to avoid such actions. For example, if non-agricultural development does require discrete and risky investments (e.g. migration), the threat of land loss in case such land is rented out or if the household takes on an off-farm job is likely to lead to a less than optimal level of the activity of interest.

Second, experience all over the world helped policy-makers to recognize that the mere fact of markets not leading to optimum outcomes does not imply that other mechanisms will automatically be able to bring about a more desirable outcome. A key reason is that, even in a closely knit and purely agrarian economy, it is unlikely that village leaders will be able to observe cultivators' agricultural ability. Thus, especially where producers' ability varies a lot or where the high political and administrative cost of redistribution implies that such an action is undertaken only infrequently, administrative land reallocation can lead to large efficiency losses, compared to the operation of more decentralized rental markets. This has indeed been confirmed for China (Deininger and Jin 2002). The allocative inefficiencies inherent in administrative processes for land redistribution are likely to multiply if possible rent-seeking behavior by administrators is allowed for. For example, there are reports that bureaucrats may use the system for their own political goals both from China (Li 2002, Turner *et al.* 1998, Huang 1999, Chen and Davis 1998). In Mexico, long-standing restrictions on the functioning of rental markets converted the land reform sector into a refuge of poverty (Velez 1995) and political patronage (Gordillo *et al.* 1998, Zepeda 2000).

A third reason for reliance on administrative reallocation to be associated with potentially undesirable consequences is that such intervention may generate its own dynamics and associated (potentially perverse) incentives. The example of China demonstrates that a policy based on redistribution is feasible if it is combined with restrictions on population growth. Without such restrictions, the ability to obtain land will essentially be a function of household size, something that can lead to high rates of population growth as a strategy to obtain land. Although the long-run nature of the phenomena at stake makes it difficult to clearly disentangle cause and effect, a study from Mexico indeed finds rates of population growth to be significantly higher where population could be used as a means to access land than where this was not possible (De Vany and Sanchez 1979). Similarly, while greater involvement by households in the local or regional off-farm economy is widely recognized as a critical pre-condition for broad-based rural development, insecure land tenure can undermine

the ability to achieve this goal. While a number of studies draw this link at the conceptual level, e.g. for the case of China (Yang 1997, Murphy 2000) and there is weak empirical evidence pointing into the same direction for Ethiopia (Dessalegn 1997, Holden and Hailu 2001).

Even though there are few examples of reforms that aimed to liberalize land rental markets, existing evidence points towards a positive effect. In Mexico, abandonment of rental restrictions in the constitutional reform of 1992 had a positive impact on productivity, land market activity, and equity (World Bank 2002). In China, land use rights that had been given to individuals after the 1978 introduction of the Household Responsibility System were increasingly made more secure in a process that is still ongoing. Restrictions on the scope to exchange land which are imposed at the local level have been shown to reduce the scope for efficiency- and equity enhancing land transactions (Deininger and Jin 2003). Even though households' preferences over land rights are shaped by a complex set of factors (Kung 2000, Kung 2002), there is evidence that those who experienced more secure property rights and abandonment of administrative land reallocation approve of this measure by a wide margin (Deininger and Jin 2003). An impact of more secure land rights on greater rental market activity has also been confirmed in Nicaragua (Deininger and Chamorro 2002).

2.2. A Model of Agricultural Production and Land Market Participation

We formalize these ideas using a model with household-specific ability where those who rent out land stand a risk of losing their asset to redistribution. Let the representative household *i* be endowed with endowments of labor $\overline{L_i}$ and cultivable land $\overline{A_i}$, a given level of unobservable agricultural ability α_i, and a vector of household characteristics and endowments $\boldsymbol{X}$. Egalitarian distribution of land endowments, together with administrative restrictions imply that there is no market for (permanent) farm labor. Income can be derived from farming, off-farm employment, and land rental. Agricultural production follows a standard production function and is also affected by household-specific ability α_i so household *i's* agricultural production is given by $\alpha_i f(l_i^a, A_i)$ where l_i^a represents labor and A_i land used in agricultural production. And f satisfies standard assumptions: $f_{l^a} > 0$, $f_A > 0$, $f_{l^a l^a} < 0$, $f_{AA} < 0$, $f_{l^a A} > 0$ and $f_{l^a l^a} f_{AA} - f_{l^a A} > 0$. A second possibility to generate income

is to devote labor time $l^o = \overline{L}_i - l_i^a$ to off-farm employment at an exogenously given wage *w.* Finally, rather than self-cultivate, households can rent out part of their land endowment or rent in additional land for agricultural production $\overline{A}_i$ -A_i at the competitive rental rate *r.* In addition, there is a non-zero threat ρ that the household's land will be subject to administrative redistribution. Taking all of these elements together, we obtain the expected utility of household *i* who aims to maximize current income plus future land wealth *Y+V (A)* with *V(0)=0*, *V'(A)>0.* Suppose there exist an probability $\rho \in [0,1]$ that a household who rent out part or all of its land will loss the part or all of its land, but ρ is irrelevant to those who rent in land or stay autarky. With further assumption of linearity of future land wealth function (or *V''(A)=0*), expected future land wealth of household *i* can be expressed as $V[\overline{A}_i + I_{out}\rho(\overline{A}_i - A_i)]$, where $\overline{A}_i$ is the land endowment, and A_i is amount used for self-cultivation. While this expression is a constant for households who engage only in self-cultivation (or renting in of land), the ability of those who rent out land in the market to keep all of their endowment depends on ρ, households' security of tenure.

Household *i* will choose l^{a*}, l^{o*} as well as A_i^* by solving the income maximization problem: $\underset{l^a, A}{Max}\ pa_i f(l_i^a, A_i) + wl_i^o + (\overline{A}_i - A_i)r + V[\overline{A}_i - I_{out}\rho(\overline{A}_i - A_i)]$ (1)

Where I_{out} is a binary indicator equaling one if a household rents out land and zero otherwise, *p* is the price of agricultural goods, l^o is the amount of time allocated to off-farm labor (= $\overline{L}_i - l_i^a$), and all other variables are as defined above. Optimal choices l_i^{a*}, l_i^{o*} and A_i^* will solve the first order conditions (FOC)

$$p\alpha_i f_{l_i^a}(l_i^a, A_i) = w \qquad (2)$$

plus, for households who rent in or stay autarky

$$p\alpha_i f_{A_i}(l_i^a, A_i) = r \qquad (3)$$

or for households who rent out

$$p\alpha_i f_{A_i}(l_i^a, A_i) = r - \rho V'[\overline{A}_i - \rho(\overline{A}_i - A_i)] \qquad (4)$$

In the appendix, we derive the following propositions which form the basis for our empirical tests.

Proposition 1. In an agrarian economy, the amount of land rented in is strictly increasing in α, and strictly decreasing in $\overline{A}$. On the other hand, the amount of land rented out is strictly decreasing in α, and strictly increasing in $\overline{A}$. In this setting, rental markets would transfer land to "poor but efficient" producers and overall product will be strictly higher than in an economy where rental markets do not exist. An empirically testable hypothesis emerging from this is that ability will affect outcomes in rental markets but not results from administrative land redistribution.

Proposition 2. Imposing restriction in rental, represented by a probability of losing land that is rented out will drive a wedge between the amount of land rent payment received by those renting out, therefore reducing the amount of land that is transferred through markets and overall economic welfare.

2.3. Estimation Strategy

Agricultural ability: To recover agricultural ability, we take advantage of the availability of plot level data on production to estimate a production function with household fixed effects.[2] We assume that households use the Cobb-Douglas technology:

$$Q_{jip} = \exp(\alpha_i + \alpha_j) A_{jip}^{\theta_1} L_{jip}^{\theta_2} K_{jip}^{\theta_3} \qquad (5)$$

where Q_{jip} is agricultural output produced by producer i in village j on p^{th} plot; A_{jip}, L_{jip} and K_{jip} are land, labor and capital used by producer i in village j on plot p to produce output Q_{jip}, and $exp(\alpha_i+\alpha_j)$, is the efficiency parameter which has a household- and a village-specific element.[3] θ_1, θ_2, and θ_3 are technology coefficients common to all producers. Taking logs of both sides of equation, adding an *iid* error term, and letting q be the log of output, a, l, and k be the log of the inputs, and $\alpha_{ji} = \alpha_j + \alpha_i$, we obtain an estimable equation for production by producer i in village j on plot p as follows.

$$q_{jip} = \alpha_{ji} + \theta_1 a_{jip} + \theta_2 l_{jip} + \theta_3 k_{jip} + \varepsilon_{jip} \qquad (6)$$

[2] This forces us to exclude the 142 households who reported to cultivate only one plot in 1999.

Availability of multiple observations per household allows to estimate this using household fixed effects.

$$q_{jip} - \bar{q}_{ji} = \alpha_{ji} - \bar{\alpha}_{ji} + \theta (\mathbf{Z}_{jip} - \bar{Z}_{ji}) + (\varepsilon_{ji\,p} - \bar{\varepsilon}_{ji}) \quad (7)$$

where Z is a vector consisting of a, l, k and θ is a coefficient vector including θ_1, θ_2, and θ_3. The composite efficiency parameter α_{ji} can then be recovered for each producer. Given the fixed location of land, it is unrealistic to expect trades beyond the village level and what is relevant is therefore a producer's relative efficiency within the village. To eliminate village effects, we us a similar procedure at the village level to obtain α_j which can be used to obtain an estimate of α_i (=α_{ij}-α_j) for each producer in the sample.

Land market participation: To identify determinants of land market participation as emerging from proposition 1, we specify a reduced form regression for transferring in or out land through land rental markets, including both cash rent and share cropping with a household's agricultural ability, its endowments of land, labor, other production factors, and available off-farm opportunities as right hand side variables. Signs on other covariates will provide evidence on the extent to which operation of markets also can satisfy equity concerns. Formally, we estimate

$$R_i = \beta_0 + \beta_1 \alpha_i + \eta \mathbf{X}_i + \delta O_i + \varepsilon_i \quad (8)$$

where R_i is a dummy for renting or the actual amount of area rented in or out, α_i is agricultural ability as defined above, $\mathbf{X}_i$ is the vector of other household characteristics that includes educational attainments, family composition, land endowments, and total asset values, and O_i proxies for off-farm opportunities by indicating whether the household has past "migration" experience.[4] We also estimate a separate set of regressions that distinguishes sharecropping and renting so as to check whether there is a progression from one to the other, possibly in the sense of an "agricultural ladder".

Since ability can not be transferred in markets, we expect that markets transfer land to producers with higher agricultural ability, i.e. $\beta_1 > 0$. Of the other variables included

[3] The latter is likely to be related to infrastructure and market, soil quality, climate, and other village level characteristics.

[4] As noted earlier, migration in Ethiopia is very limited, so the variable chosen is if the head of the household has ever worked outside the *woreda*.

in ***X*** the most important prediction is that the coefficient on land endowment be negative, in line with a redistributive function of land rental markets which would lead them to transfer land to producers with lower levels of endowments. Also, while the amount of agricultural asset ownership would be irrelevant if markets for such assets were perfect, imperfections in rental markets for productive assets, especially draft animals, as variously found in the literature (Rosenzweig and Wolpin 1993, Binswanger and Rosenzweig 1986) would lead to a positive coefficient on this variable. To the extent that rental markets help to bring about intergenerational land transfers, the age of the household head would be expected to be negative. Finally, past migration experience will increase the effective wage rate that can be earned, other things equal, make it more likely for households to join the off-farm labor market, thus leading to a positive expected sign for renting out and a negative one for renting in (Reardon *et al.* 2001).

Market vs. administrative reallocation: To compare determinants of market- as compared to non-market based land reallocation, we repeat estimation of equation (5) with the difference that R_i is now replaced by a dummy for whether the household has, during the last 5-year period received land through redistribution or through the market.[5] This allows direct comparison between the productivity and equity impact to be expected from land markets as compared to administrative reallocation. We note, however, that, especially if past redistribution is only poorly correlated to the scope for future land market intervention, something that seems to be the case in Ethiopia, exploring determinants of reallocations in the past will be of interest to compare between different types of allocation mechanisms but is unlikely to have a direct impact on current household behavior.

Determinants of future land redistribution: More direct inferences on potential behavioral adjustments by households in response to perceived threats of land reallocation are available from an analysis of the factors leading households to expect that they will lose land in the future. To conduct this analysis, we estimate a probit equation similar to the one discussed above where R_i is replaced by an indicator of whether a household expects to be subject to land loss or gain via administrative action in the future. Also, we include an indicator for whether or not the household head had taken on off-farm employment in 1999, a variable excluded from earlier

[5] The survey does not elicit the size of area transferred either in total or under different mechanisms and only provides space for the two most important reasons of a decrease or increase in land, respectively. As there are very few households (10% of those affected) who even give two reasons, it is justifiable to assume that households either participated in rental markets or were subject to government redistribution.

regressions because it is jointly determined with rental decisions and therefore endogenous to current household behavior but not to future expectations.

3. Background, Data, and Descriptive Statistics

The data used for this study is from the fifth round of the Ethiopia Rural Household Survey, conducted in 1999 by the Economics Department of Addis Ababa University. It covers 1680 households in 4 of the country's major regions, Tigray, Amhara, Oromia and SNNP. In addition to standard characteristics routinely included in household surveys, this survey provides information on output as well as inputs of labor, seed, purchased inputs (fertilizer, pesticide, etc.), and cultivation techniques (eg. double cropping) at the plot-level. This allows us to estimate a production function with household fixed effects to recover households' agricultural ability as discussed above. Moreover, information on past involvement in administrative reallocation or rental markets and on whether specific households expect to gain or lose through administrative reallocations in the future is included.

3.1. Land Policy in Ethiopia

Ethiopia has not only a very eventful recent history in which land issues have played an important role but, more importantly, also faces crucial decisions in the area of land policy and especially land markets. Historically, land tenure in Ethiopia falls into three broad periods. Before 1975, land was concentrated in the hands of absentee landlords, tenure was highly insecure, arbitrary evictions posed a serious threat, and many lands were severely underutilized. The land tenure system was characterized by great inequality which, through its 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 regime (Adal 2001).

Following the overthrow of the imperial regime in 1975, the Marxist government (the *Derg*) transferred ownership of all rural land to the state for distribution of use rights to cultivators through local peasant associations (PAs). The transferability of rights received was highly restricted; transfer through lease sale, exchange, or mortgage, among others, was prohibited and inheritance allowed only to immediate family members. The ability to use land was contingent on proof of permanent physical residence, thereby for example preventing migration. More importantly, tenure security was undermined by the PAs' and other authorities' ability to redistribute land,

often for political reasons, something that is well documented for the case of Amhara (Ege 1997).

The government taking power in 1991, though committed to a free-market philosophy, has, with three notable exceptions, made few substantive changes to Ethiopian farmers' land rights which are therefore still considered to be quite inadequate (Hoben 2000). First, land was made a regional responsibility, implying that regional governments can enact laws relating to the nature of land rights and their transferability as well as land taxation. Second, the frequency of land redistribution was to be reduced; in fact Tigray declared an end to administrative land redistribution while Oromia restricted the scope for redistribution to irrigated land. Finally, rentals have been officially allowed (Pender and Fafchamps 2000) although local leaders and governments seem to have great discretion to impose restrictions on land transfers. For example, the region of Oromia allows farmers to rent out only up to 50% of their holding and stipulates maximum contract terms of 3 years for traditional and 15 years for modern technologies.

The Government's Poverty Reduction Strategy espouses the guiding principle that every farmer who wants to make a livelihood from farming is entitled to have a plot of land free of charge (Republic of Ethiopia 2002). Even though it may conflict with this goal, the strategy also mentions a need for greater tenure security and better functioning of land rental markets. Responsibility for implementation is left with regional states which have adopted very different implementation strategies.[6] Whether the lack of a national policy on the issue is a cause for concern is very much an empirical issue of great relevance which we pursue in more detail below.

3.2 Household Characteristics

Table 1 provides key household characteristics and details on income and crop production. The average household is composed of 5 people, among which about 2 are aged less than 14 and 2.7 between 14 and 60. The average age of the head is around 50 and 77% of households are male headed. Levels of education are very low; only 40% of heads in the sample are literate, with an average of 1.35 years of formal education. However, the fact that the maximum level of formal education in any given household is 3.2 years suggests that levels of education are improving

[6] "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

among the younger generation. All of the descriptive statistics point to large differences between regions, with Tigray being by far the worst in terms of most social indicators.

These regional differences are more pronounced for total household income which, with an average of B 2280, varies between B 981 in Tigray and B 3116 in Oromia, implying not only a relatively high level but also large regional differences in poverty. Using the national poverty line, 36% of the households are classified as being poor, but 75% are so in Tigray. Agriculture remains the mainstay of the rural economy, accounting for about 70% of total income. While 29% of households complemented their agricultural income with some receipts from non-agricultural self employment, only 4% had their primary job in the non-farm sector, 6% received wage income from off-farm work, and 9% worked in other woreda including those who sent home remittance and those worked off-farm in other woredas. Within the agricultural sector, income from crop production is clearly the most important, accounting for 66% of total income, although with considerable inter-regional variation (from 46% in Tigray to 75% in Oromia). The endowment of arable land held by households, excluding grazing and garden land, is very small, 1.22 ha per household or 0.29 ha per capita. Per capita land holdings are larger in Amhara and Oromia (0.45 and 0.34 ha respectively) and very low in Tigray and SNNP (0.12 ha), in line with income levels. In addition to limits on land endowments, use of modern technology remains low. While 73% of households use fertilizer which is highly subsidized, only 19% used improved seed and 31% chemicals, suggesting that fertilizer may not always be used optimally. Regional differences (only 6% and 4% of households use seeds and fertilizer, respectively, in Amhara) further exacerbate these differences.

3.3. Land Market Participation

Past and current participation in market-based or administrative land transactions, as well as expectations for the future, are summarized in table 2. We find that, with the exception of Amhara where 19% of households lost land and 11% increased their endowment through land redistribution over the last 5 years, the extent of administrative reallocation of land during this period has been quite limited – only few households in Oromia and SNNP received or lost land through the same means, bringing the total of households affected to 4% and 6%, respectively. The share of households who, over the last 5 years, increased or decreased their cultivated land

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." (Republic of Ethiopia, 2002:p.53; italics added).

area by renting in, a lower bound for activity in land rental markets,[7] was above the share of those who received land through redistribution, with 11% of households reporting to have received land and 9% that they supplied land through either rental or sharecropping.

Current (i.e. 1999) participation in rental markets is even higher. Taking fixed rental and sharecropping together, 24% of households report to currently use somebody else's land through markets (7% through rental and 17% through sharecropping). The fact that this percentage is almost equal to the share of households (20%) who report to have supplied land to the market (6% for rental; 14% for sharecropping) suggests that migration remains extremely limited and that absentee landlords are virtually non-existent.[8] With the exception of Oromia, sharecropping is more important than fixed rental, something that can be explained by the fact that agricultural production in Ethiopia, largely rainfed, is risky. The importance of sharecropping is reinforced by the fact that the area involved is much larger than for the case of rental, amounting to about half of the average per capita endowment.

Data on future expectations reveal two observations of interest. First, there is a resurgence of expectations of land reallocation through administrative means; 10% of survey respondents expect to lose land to administrative reallocation within five years. This is surprising given that land redistribution in the past decade was essentially limited to Amhara. Large inter-regional differences in the expectation of future redistribution (ranging from 20% in Amhara to 2% in Tigray) suggest that policy decisions affecting these issues are indeed taken at the regional rather than the national level. A second finding of at least equal interest is the large discrepancy between those who expect to receive additional land and those who expect to lose land from redistribution.

With the exception of Oromia, the share of producers who expect to gain from administrative land reallocation everywhere is at least double the share of those expecting to have to cede land in such a process. Since reallocation of land is a zero-sum game, i.e. it is impossible to give out more than what is taken away from others, this implies that any redistribution that will try to satisfy expectations will lead to

[7] The survey asked whether the household's land size increased or decreased during the last 5 years and for the main reason for such a change. This implies that households who already rented in land but did not increase the amount rented would have answered negatively to this question.

[8] The only exception is Tigray where the share of households reporting to rent out is much lower than the ones renting in. Given the small sample size we can not determine whether this is a significant deviation from national trends. Further examination of this issue with a different data set would be of interest.

significant further fragmentation of holding sizes in a situation where, with given technology, the amount of land available to households is often already too small to produce enough for subsistence (Ethiopian Economic Association 2002).

4. Econometric Evidence

We find that both the plot level production function as well as the participation equations provide results that are not only highly significant statistically but also in line with our predictions. Markets seem to transfer land from large and less efficient to small and relatively more efficient producers as predicted by the model and there is some indication of producers' progressing from sharecropping to cash rental with increased age and wealth that would be worth exploring further. By comparison to administrative reallocation which seems to have been driven mainly by political, rather than economic, concerns, land markets appear to have clear equity and efficiency advantages.

Exploration of the factors leading a surprisingly large number of individuals to expect losing or gaining land through redistribution in the future highlights that households who work in off-farm jobs for part of the time and more productive producers are significantly more likely to be concerned about losing land to redistribution. As they would adjust their behavior so as to minimize the danger of land loss, this would be expected to lead to delayed and stunted development of the non-farm economy and, to the extent that it reduces the extent of land transfers, possibly a reduction in agricultural productivity.

4.1. Market-based Land Transfers

Before discussing evidence regarding determinants of market participation, we review results from the plot-level production function with household or *woreda* fixed effects for the 1334 households who have on average 4.4 plots each (see appendix table 1). Crop dummies are included to control yield differences among crops. The parameters on main inputs are consistent with expectations. Application of modern seed, fertilizer, and chemicals all are estimated to significantly increase the value of production. Indicators for land quality are significant and of the expected sign; output from plots with "secondary" and "tertiary" land quality is about 8 % and 11% lower, respectively, than for plots with good soil quality, the default subsumed in the intercept. Plots used for two seasons produce slightly lower output for each individual season. We also note that α_i , the deviation of household *i*'s agricultural ability from

the village mean, ranges between –2.27 and 2.12, pointing towards considerable scope for improvements in productivity through reallocation of land between producers.

To assess whether markets or administrative mechanisms contribute to such reallocation, table 3 reports results from probit (columns 1 and 2) and tobit (columns 3 and 4) equations for market land transfers where rental and sharecropping are lumped together. Results strongly support the hypothesis that markets transfer land from households with low agricultural ability and relatively abundant land endowments to those with high agricultural ability and scarce endowments. We also find a pronounced endowment effect whereby households who have little land available per capita use rental markets to gain access to more land and vice versa; notably the coefficients are significant at the 1% level throughout. This clearly counters fears that liberalization of land rental markets would cause land concentration that would leave the poor without land access.

Similarly strong effects are found for ability the coefficient of which is always very positive and highly significant in the renting in equation. It is always negative for renting out, although significant only at 10% in the tobit equation. This implies that productivity is not the only factor leading households to supply land to the rental market but that it is clearly the more productive ones who obtain land through rental. To illustrate the magnitude of the estimated coefficients, we note that, compared to the household with the lowest agricultural ability in the sample, the one with the highest ability is 23% more likely to obtain land through the rental market. Similarly, a household with per capita land one standard deviation above or below the mean is 15% and 8% more (or less) likely to rent in (or out) land, respectively, than the average household.

In addition to these coefficients, factors related to households' endowment with other factors and their composition are largely as expected. The coefficient on draft animals, which is positive for renting in (together with other assets) and negative for renting out implies that, due to imperfections in rental markets for animals, it is easier to transfer land than animals or associated capital equipment. Having one more draft animal will increase the probability of a household to receive in land by 8%. Male headed households are more likely to rent in land while female headed ones are more likely to rent out. Younger households are more likely to participate on the demand side of rental markets; the coefficients from the probit regression suggest that the probability to rent in land increases up to 26 years and slowly declines

thereafter. Once these factors are accounted for, a higher number of children below 14 years reduces the probability of renting in and increases the probability of renting out.

4.2. Administrative Land Reallocation

Table 5 allows us to compare the performance of administrative reallocation to land transfers through the market, something that is of particular interest with respect to the extent to which land was transferred to households with high agricultural ability and limited land endowments. We find that administrative land reallocation did not transfer land to more efficient or poorer producers but also that very few variables predict households' past receipt or loss of land through redistribution. In fact, the only variable significant at the 5% level, the number of draft animals, goes in a direction opposite from what one would expect from a measure that is supposed to equalize land access among households. Ability is insignificant, supporting the notion that this variable either can not be observed by community leaders or that increasing efficiency has not figured high as a goal of activities and policies aimed at land redistribution. Comparing this evidence to determinants of land rental (column 2) suggests that, even though the recall data are slightly less precise, the latter shifted land to those with lower endowments and higher levels of productivity, and was thus arguable more redistributive than administrative reallocation as noted before.

Similarly, the only variable that is highly significant for loss of land through redistribution is the household's educational level and the number of draft animals, supporting the notion that redistribution is motivated more by political than economic considerations. While low ability is not estimated to have been a driving factor behind supply of land to rental markets, the positive and significant coefficient on households' land endowment, the negative coefficient on male headship, and the negative coefficient on the number of draft animals owned in the renting out equation all suggest that, historically, land markets have performed much better than administrative means in benefiting the poor and increasing overall productivity. The above findings are not too surprising, given that it is widely acknowledged that land redistribution was largely a political exercise. Still, if the past is any guide to the future, we would not expect administrative land reallocation to have a positive impact on productivity or increased land access by the poor. To assess whether the scope of such redistribution may have a negative impact on household behavior through other channels, we turn to the analysis of factors affecting households' expectation regarding land redistribution in the future.

4.3. Future Land Redistribution

Factors that systematically increase households' expectation of experiencing an increase or a decrease in their land endowment through administrative measures are, to the extent that they affect household behavior, arguably important from a policy perspective Results from regressions with regional and *woreda* dummies, respectively, are presented in table 6.

The most significant determinant that leads households to believe that land will be taken away from them is whether or not the head has a part-time, though by no means primary, job in the off-farm sector. According to our estimates, off-farm employment increases the subjective probability of future land loss by between 10% and 15%. To the extent that households base future actions on such beliefs, the fear of losing land is likely to lead to a considerable reduction in their willingness to take on off-farm employment which could have far-reaching implications for the emergence of the non-farm economy, a factor which, all observers agree, will be of critical importance for future development in Ethiopia.

It is also worth noting that contrary to what was found in China where administrative land redistribution clearly targeted larger farmers and had a negligible productivity impact (Deininger and Jin 2002d), the regressions suggest that it is not large but more productive farmers who feel most threatened by future land redistribution. The positive and highly significant coefficient on ability implies that, even though this would directly decrease overall productivity, productive farmers are most threatened by land being taken away from them. By comparison, farm size, as measured by the per capita land endowment, remains insignificant. In addition, higher levels of education and a lower number of members between the age of 14 and 60, is also found to have a significant effect on the probability of land loss.

While the fact that the dependent variable is a dummy precludes us from making inferences on the possible impact of such redistribution on production, we note that the increase in the probability of suffering a land loss that is associated with higher ability is quantitatively large; compared to the least productive producer in the sample, the most productive one is almost 20% more likely to lose land to reallocation. To the extent that fears of land expropriation by authorities lead households with comparative advantage in non-farm jobs to reduce their participation in non-farm employment, one would clearly expect reduced growth of the off-farm sector as a result of such high levels of tenure insecurity. Eliminating such fears

would, by increasing the scope for off-farm employment, result in a Pareto improvement.

Turning to determinants of households' belief in whether or not they will receive (rather than lose) land through administrative means, there is some indication that, within any given *woreda* it is indeed producers with less land who expect to gain in a future redistribution (column 4 of table 6). However, the fact that the number of household members between 14 and 60 years is negative suggests that these may not have the labor force to make use of the land. Also, households renting in land think they will be able to benefit from land redistribution in the future. Even though the link is less direct than for of off-farm employment, this could contribute to undermining the future functioning of rental markets in the future. From all perspectives then, the prospect of future redistribution appears to be conducive neither to a more egalitarian distribution of land nor to higher levels of rural productivity.

5. Conclusion and Policy Implications

This study contributes to the literature in two ways. First, we demonstrate empirically that land rental markets in Ethiopia work better than administrative mechanisms to reallocate land among producers. Second, we document a link between higher levels of off-farm employment and lower levels of tenure insecurity in the form of a (individual) fear of being affected by land redistribution. To the extent that, for agrarian countries like Ethiopia, development of economic opportunities in the non-farm sector will be a critical element of any strategy aiming at higher economic growth, this suggests that land tenure could have implications that go beyond mere land-related investment.

We find that, despite some restrictions on their functioning, land rental markets did help to further equity and efficiency objectives in ways that are much superior to what has been accomplished by administrative reallocation of land. Contrary to fears that land markets might lead to accumulation of land in the hands of the rich and powerful, greater emphasis on rental markets as compared to administrative reallocation of land is shown to provide greater benefits to poor but efficient producers who have few alternative opportunities of using their labor endowment. Land transfers in rental markets were shown to provide greater land access to producers with higher levels of ability and lower endowments while administrative land reallocation was largely a political exercise that contributed to neither of these objectives.

Despite limited success of this measure in the past, support for administrative reallocation of land appears on the increase. In addition to the scant empirical basis to expect such allocations to contribute to either higher levels of efficiency or poverty reduction, this is of concern for two reasons: First, even in the best of cases, and assuming considerably improved mechanisms, Ethiopia's narrow land base will limit the scope for such a measure to lead to significantly improve the welfare of the large majority of producers. Second, unrealistic expectations about the potential impact of redistribution can easily lead to an inflation of expectations that might be problematic. Finally, and most importantly, our regressions show that the scope for administrative land redistribution will affect household behavior in ways that can undermine precisely the non-farm activities on which further development of Ethiopia's rural areas depends.

From a policy perspective, the economically and socially positive role of land rental markets suggests that taking further steps to eliminate obstacles to the functioning of such markets would be beneficial to broader rural development in Ethiopia. Also, irrespectively of a possible need for transitory arrangements, abandoning the scope for future land reallocation could have considerable economic benefits while losses associated with such a measure appear to be mostly of a political nature. A policy statement highlighting that there will be no land distributions in the future could thus actually benefit the poor.

There are three areas where future research may be of interest. First and most obviously, it would be desirable to confirm or refute the evidence on a potential link between land tenure security and off-farm participation for other settings. Second, it would be of interest to explore welfare implications of land rental markets in a dynamic context, specifically with regard to the existence or not of an "agricultural ladder" whereby households could proceed over time from being sharecroppers to cash rental and possibly towards land ownership. Third, recent evidence suggests that allowing transferability of land in sales markets is likely to be associated with considerable investment benefits. In view of high risk of agriculture and the fact that sales markets are more likely to be affected by credit market imperfections than those for rental, an extension to sales markets, linked to the effectiveness of existing safety nets and implications for household welfare, would be of interest. Our results suggest that it would be useful to focus policy discussion on these issues, rather than a model of redistribution which had very limited success in the past and may negatively affect the off-farm economy.

Table 1. Basic Characteristics of the Sample

		Region			
	National	**Tigray**	**Amhara**	**Oromia**	**SNNP**
Household characteristics					
Household size	5.04	4.72	4.31	5.11	5.81
No. of people less than 14	1.93	2.04	1.60	1.97	2.17
No. of people between 14 and 60	2.75	2.19	2.32	2.82	3.31
No. of people older than 60	0.36	0.49	0.40	0.31	0.33
Has male household head	0.77	0.51	0.73	0.81	0.85
Age of household head	49.26	51.53	50.28	48.38	48.52
Illiteracy rate	59%	77%	63%	53%	58%
Year of education of household head	1.35	0.43	0.88	1.38	2.11
Max. years of education of household	3.21	2.45	2.39	3.08	4.51
Income and its composition					
Total household income (Birr)	2280.26	980.93	2446.17	3116.25	1360.01
Share of poor[1]	36%	75%	30%	21%	52%
Share of agricultural income in total	80%	67%	78%	86%	78%
Value of total household assets	486.05	275.62	375.10	639.05	457.96
Household head with non-ag. primary job	4%	2%	5%	3%	5%
Household head worked off-farm	6%	7%	9%	4%	6%
Share with self-employment	29%	12%	25%	28%	40%
Household head migrated	9%	11%	7%	9%	10%
Crop production Characteristics					
Share of crop income in total	66%	46%	55%	75%	72%
Own cultivable land holding[2]	1.22	0.44	1.49	1.67	0.58
Per capita own arable land holding[2]	0.29	0.12	0.45	0.34	0.12
Share of households used improved seed	19%	10%	6%	24%	28%
Share of households using fertilizer	73%	74%	64%	90%	55%
Share of households using pesticides,	31%	1%	4%	62%	22%
Share of households with draft animals	85%	94%	98%	92%	57%
Number of draft animals owned	3.87	4.63	6.52	3.61	1.45

[1]Total household income less than national poverty line (1075 Br per household)
[2]Excludes grazing and garden land

Table 2: Past, current, and future changes in land holdings

	Regions				
	Average	**Tigray**	**Amhara**	**Oromia**	**SNNP**
Changes in land holding last 5 years					
Increased land through reallocation	4%	0%	11%	1%	1%
Increased land through rental/sharecropping	11%	1%	14%	12%	9%
Lost land through reallocation	6%	0%	19%	1%	2%
Rented/sharecropped out land	9%	4%	5%	12%	9%
Market participation					
Rented in land	7%	1%	5%	13%	4%
Area rented in (ha)	0.05	0.00	0.03	0.12	0.01
Sharecropped in land	17%	3%	35%	10%	12%
Area sharecropped in (ha)	0.12	0.01	0.30	0.07	0.04
Rented out land	6%	1%	3%	12%	4%
Area rented out (ha)	0.04	0.00	0.03	0.08	0.01
Sharecropped out land	14%	15%	24%	12%	8%
Area sharecropped out (ha)	0.12	0.06	0.24	0.10	0.04
Expectation regarding land changes					
Expects increase through redistribution	11%	13%	14%	11%	5%
Expects decrease through redistribution	10%	2%	7%	20%	3%

Table 3. Determinants of Participation in Market-based land transfer

	Probit Results		Tobit Results	
Agricultural ability	0.051**	-0.025	0.251***	-0.170*
	(1.99)	(1.53)	(2.81)	(1.87)
Per capita land holding	-0.430***	0.236***	-1.578***	1.423***
	(5.34)	(6.92)	(5.67)	(7.86)
Head's age (log)	1.983*	0.399	5.838	2.110
	(1.80)	(0.54)	(1.52)	(0.53)
Head's age (log) squared	-0.289*	-0.049	-0.851*	-0.253
	(1.95)	(0.50)	(1.65)	(0.48)
No of people < 14a	-0.029***	0.020***	-0.096***	0.116***
	(3.10)	(3.26)	(2.96)	(3.56)
No. of people 14 – 60a	-0.003	0.001	-0.012	0.015
	(0.32)	(0.13)	(0.34)	(0.42)
No of people < 60a	-0.007	-0.002	-0.065	0.023
	(0.22)	(0.09)	(0.55)	(0.18)
Max years of education	0.009*	0.002	0.039**	0.017
	(1.78)	(0.64)	(2.31)	(0.96)
Male headed	0.134***	-0.080***	0.524***	-0.370***
	(3.76)	(2.96)	(3.48)	(2.96)
Migration	0.037	0.139***	0.052	0.537***
	(0.73)	(3.61)	(0.30)	(3.42)
Value of assets	0.000***	-0.000	0.000***	-0.000
	(2.87)	(1.21)	(3.28)	(0.87)
Number of draft animals	0.022***	-0.014***	0.097***	-0.087***
	(3.49)	(3.59)	(4.53)	(4.18)
Constant	-13.812*	-5.985	-11.900*	-5.999
	(1.90)	(0.79)	(1.67)	(0.81)
No. of observations	1236	1236	1236	1236
Log-likelihood	-537.73	-418.61	-755.46	-485.52

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Regional dummies included throughout but not reported

Table 4. Determinants of area rented in/out or sharecropped in/out

	Area rented in	Area sharecropped in	Area rented out	Area sharecropped out
Agricultural ability	0.204**	0.188**	0.070	-0.275*
	(1.97)	(2.08)	(0.63)	(1.92)
Per capita land holding	-1.520***	-1.592***	1.042***	1.170***
	(2.83)	(5.49)	(4.07)	(4.35)
Head's age (log)	0.096	6.090	1.231	0.075
	(0.01)	(1.56)	(0.23)	(0.01)
Head's age (log) squared	-0.024	-0.895*	-0.112	0.066
	(0.03)	(1.71)	(0.16)	(0.09)
No. of people<14	-0.023	-0.108***	0.095**	0.111**
	(0.44)	(3.29)	(2.03)	(2.50)
No. of people between 14 and 60	-0.007	0.026	-0.029	0.010
	(0.14)	(0.76)	(0.58)	(0.20)
No. of people >60	-0.307	0.082	-0.055	-0.039
	(1.50)	(0.70)	(0.32)	(0.23)
Max. years of education of household	0.029	0.025	-0.018	0.010
	(1.00)	(1.47)	(0.66)	(0.41)
Headed by male	0.268	0.531***	-0.137	-0.406**
	(1.10)	(3.31)	(0.78)	(2.42)
Household head migrated	-0.049	0.105	0.467**	0.531**
	(0.16)	(0.59)	(2.17)	(2.52)
Value of assets	0.000***	0.000	-0.000	0.000
	(3.43)	(0.99)	(1.26)	(0.28)
Number of draft animals	0.076**	0.091***	-0.120***	-0.062*
	(2.23)	(4.21)	(3.21)	(1.94)
Constant	-2.861	-12.200*	-4.884	-2.994
	(0.24)	(1.68)	(0.50)	(0.28)
Observations	1236	1236	1236	1236
Log-likelihood	-616.83	-301.17	-245.10	-313.76

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Regional dummies included throughout but not reported

Table 5. Determinants of past changes in land holding

	Gained land through...		Lost land through...	
	Redistribution	**rental**	**redistribution**	**rental**
Agric. ability	0.002	0.035*	-0.003	-0.002
	(0.44)	(1.94)	(0.60)	(0.14)
Per capita land	0.005	-0.068*	0.012	0.105***
	(0.66)	(1.70)	(1.62)	(4.20)
Head's age (log)	-0.088	0.707	0.214	-0.034
	(0.66)	(0.86)	(1.05)	(0.06)
Head age square	0.010	-0.099	-0.027	0.008
	(0.55)	(0.91)	(0.99)	(0.11)
No of people < 14a	0.000	-0.006	-0.002	0.008*
	(0.35)	(1.00)	(0.93)	(1.91)
No. of people 14 – 60a	0.002*	0.008	-0.000	-0.002
	(1.92)	(1.35)	(0.18)	(0.40)
No of people < 60a	0.006	-0.035	0.006	-0.025
	(1.43)	(1.36)	(1.09)	(1.28)
Max years of education	-0.000	0.003	0.002***	0.002
	(0.06)	(1.17)	(3.30)	(0.77)
Male headed	-0.010	0.081***	0.000	-0.050**
	(1.61)	(3.16)	(0.08)	(2.35)
Head migrated	-0.002	-0.006	-0.004	0.042
	(0.27)	(0.18)	(0.48)	(1.49)
Value of assets	0.000	0.000	-0.000	-0.000
	(0.10)	(0.94)	(0.08)	(0.04)
Number of draft animals	0.002**	0.001	0.003***	-0.008***
	(2.30)	(0.32)	(3.37)	(2.58)
Observations	1236	1236	1236	1236
Log-likelihood	-160.79	-437.45	-219.68	-307.68

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Regional dummies included throughout but not reported

Table 6. Determinants of household's expectations regarding future redistribution

	Expects to			
	Lose land		Gain land	
Agricultural ability	0.021**	0.044***	-0.024*	-0.019
	(2.04)	(2.60)	(1.81)	(1.52)
Per capita land holding	0.032	0.028	-0.004	-0.106***
	(1.13)	(0.61)	(0.15)	(2.74)
Head's age (log)	0.022	-0.011	-0.012	-0.009
	(0.04)	(0.01)	(0.02)	(0.02)
No. of people<14	-0.005	-0.004	-0.005	-0.006
	(0.94)	(0.45)	(0.94)	(1.12)
No. of people between 14 & 60	-0.015**	-0.021**	-0.012**	-0.018***
	(2.52)	(2.47)	(2.02)	(3.04)
No. of people >60	-0.011	-0.011	0.005	0.001
	(0.62)	(0.42)	(0.28)	(0.04)
Maximum years of education of household	0.009***	0.005	0.001	-0.000
	(3.39)	(1.40)	(0.45)	(0.16)
Headed by male	0.008	-0.007	0.026	0.032*
	(0.42)	(0.23)	(1.31)	(1.72)
Value of assets	0.000	0.000	-0.000	-0.000
	(0.40)	(0.08)	(1.29)	(0.27)
Number of draft animals	-0.004	-0.002	-0.002	-0.003
	(1.20)	(0.45)	(0.63)	(0.89)
Head w off-farm experience	0.105***	0.152***	-0.036	-0.031
	(2.98)	(2.97)	(1.18)	(1.04)
Area rented out	-0.030	-0.020		
	(1.04)	(0.48)		
Area rented in			0.039***	0.029**
			(2.86)	(2.09)
Observations	1236	882	1236	1194
Log-likelihood	-350.91	-288.73	-342.05	-315.20
Dummy	Region	Woreda	Region	Woreda

Absolute value of t statistics in parentheses

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

Crop dummies is included to control the yield differences among crops but not reported

Appendix 1. Results of Fixed Effect Panel Estimation of Plot Level Production Function

	Household Fixed Effects	Woreda Fixed Effects
Log of labor usage	0.169***	0.158***
	(9.94)	(12.08)
Log of cultivated area	0.457***	0.439***
	(22.08)	(27.94)
Log of value of seed use	0.023***	0.034***
	(3.33)	(5.32)
Dummy modern seed use	0.404***	0.424***
	(6.95)	(7.99)
Land quality secondary	-0.079**	-0.052**
	(1.99)	(2.05)
Land quality tertiary	-0.110**	-0.136***
	(2.08)	(3.55)
Plot used for two seasons	-0.086	-0.026
	(1.64)	(0.69)
Fertilizer used	0.067*	0.067**
	(1.89)	(2.29)
Chemicals used	0.199***	0.239***
	(4.31)	(6.23)
Observations	5839	5839
No of households/woredas	1334	18
R-squared	0.37	0.36

Absolute value of t statistics in parentheses

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

Crop dummies is included to control the yield differences among crops but not reported

Appendix 2: Proofs for main propositions

Proposition 1. Among the households who rent out land, the higher their ability, α, the less likely they will rent out. Alternatively, among households who rent in land, the higher α, the more likely they are to rent in.

To show this, totally differentiate (1) and (2) with respect to α, then reorganize the two differential equations into a matrix form, yielding: $\begin{bmatrix} p\alpha f_{l^a l^a} & p\alpha f_{l^a A} \\ p\alpha f_{A l^a} & p\alpha f_{AA} \end{bmatrix}$

$$\begin{bmatrix} \partial l^a / \partial \alpha \\ \partial A_i / \partial \alpha \end{bmatrix} = \begin{bmatrix} -pf_{l^a} \\ -pf_A \end{bmatrix}$$

Solving for $\partial A_i / \partial \alpha$ by Cramer's rule, yields:

$$\partial A_i / \partial \alpha = \frac{\begin{vmatrix} p\alpha f_{l^a l^a} & -pf_{l^a} \\ p\alpha f_{A l^a} & -pf_A \end{vmatrix}}{|H|} = \frac{-p^2 \alpha f_A f_{l^a l^a} + p^2 \alpha f_{A l^a} f_{l^a}}{|H|} > 0 \qquad \text{(for} \quad f_A > 0,$$

$f_{l^a} > 0,\ f_{l^a l^a} < 0,$ and we know $|H|>0$ by the sufficient second order condition of maximization problem.

Similarly for household who rent out land, totally differentiating (1) and (2)' with respect to α, then reorganizing the two differential equations into a matrix form, yields: $\begin{bmatrix} p\alpha f_{l^a l^a} & p\alpha f_{l^a A} \\ p\alpha f_{A l^a} & p\alpha f_{AA} + \rho V''(.) \end{bmatrix} \begin{bmatrix} \partial l^a / \partial \alpha \\ \partial A_i / \partial \alpha \end{bmatrix} = \begin{bmatrix} -pf_{l^a} \\ -pf_A \end{bmatrix}$

Solving for $\partial A_i / \partial \alpha$ by Cramer's rule yields:

$$\partial A_i / \partial \alpha = \frac{\begin{vmatrix} p\alpha f_{l^a l^a} & -pf_{l^a} \\ p\alpha f_{A l^a} & -pf_A \end{vmatrix}}{|H|} = \frac{-p^2 \alpha f_A f_{l^a l^a} + p^2 \alpha f_{A l^a} f_{l^a}}{|H|} > 0$$

This implies that for all households that participate in rental markets (on either side), the amount of area operated will increase with ability.

For households renting in, the amount of land rented in is the difference between the amount of operational land and the land endowment, i.e. $A_{in} = A - \overline{A}$ (A1).

Total differentiation of both sides of (A1) with respect to α, yields $\frac{\partial A_{in}}{\partial \alpha} = \frac{\partial A}{\partial \alpha} > 0$, implying that for households who rent in land, the amount of land rented in is increasing in agricultural ability. Total differentiation of both sides of (A1) with respect to $\overline{A}$, yield $\frac{\partial A_{in}}{\partial \overline{A}} = -1 < 0$, implying that for the households that rent in land, the amount of land rented in is strictly decreasing in land endowment.

For those households that rent out land, the amount of land rented out is the difference between the land endowment and the land used for self-cultivation, or formally, $A_{out} = \overline{A} - A$ (A2). Total differentiation of both sides of (A2) with respect to α, yields $\frac{\partial A_{out}}{\partial \alpha} = -\frac{\partial A}{\partial \alpha} < 0$, which implies that for those households who rent out land, the amount of land rented out will decrease in agricultural ability. Total differentiation of both sides of (A2) with respect to $\overline{A}$, yields $\frac{\partial A_{out}}{\partial \overline{A}} = 1 > 0$ (for by assumption, individual household's operational land, A is not constrained by individual household's endowment), implying that for those households who rent out land, the amount rented out is strictly increasing in land endowment.

Proposition 2. Imposing restriction in rental, represented by a probability of losing land that is rented out, will cause households who would be better off in off-farm employment (e.g. due to low agricultural ability) to stay in farming, or $\partial A_{out} / \partial \rho > 0$ where ρ denotes the probability of losing land that is rented out.

Since this is only relevant for households who rent out land, we can prove the proposition by totally differentiating (1) and (2)' with respect to ρ, and then reorganizing the two differential equations into matrix form, which yields:

$$\begin{bmatrix} p\alpha f_{l^a l^a} & p\alpha f_{l^a A} \\ p\alpha f_{A l^a} & paf_{AA} + \rho V''(.) \end{bmatrix} \begin{bmatrix} \partial l^a / \partial \rho \\ \partial A / \partial \rho \end{bmatrix} = \begin{bmatrix} 0 \\ -V'[\overline{A}_i + \rho(\overline{A}_i - A_i)] \end{bmatrix},$$

The first matrix is H, as defined earlier, and the sufficient second order conditions of the household's maximization problem imply that it is negative.

Solving $\partial A/\partial \rho$ using Cramer's rule, yields:

$$\partial A_i / \partial \rho = \frac{\begin{vmatrix} p\alpha f_{l^a l^a} & 0 \\ p\alpha f_{Al^a} & -V'(.) \end{vmatrix}}{|H|} = \frac{-p\alpha f_{l^a l^a} V'(.) - 0}{|H|} > 0 .$$

Taking derivative of (A2) with respect to ρ yield $\partial A_{out} / \partial \rho = \partial \overline{A} / \partial \rho - \partial A / \partial \rho = -\partial A / \partial \rho < 0.$

Therefore households who would be better off renting out land will be forced to rent out less or even stay autarky due to the high restriction on land transfer (note that restriction increases as ρ is getting bigger).

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