Factor Market Imperfections and the Land Rental Market in the Highlands of Eritrea: Theory and Evidence*

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ABSTRACT. *This paper uses data from rural Eritrea to assess the effect of endowments in non-land factors of production on land-renting behavior of farm households and to test for transaction costs of adjustment in the land rental market. A two-stage approach for participation in the market as landlords or tenants is used for analysis. Results show the importance of the land rental market for adjustment to non- or semi-tradable non-land household endowments. There were indications of significantly higher transaction costs faced by potential tenants than by potential landlords.*

JEL classification: Q12

Key words: Eritrea, land rental market, transaction costs, market imperfection, selection model.

I. INTRODUCTION

The choice of land tenure systems for development has been a controversial policy issue in many parts of the world (Otsuka and Hayami 1992; Binswanger, Deininger, and Feder 1995; Deininger 2003). Eritrea is no exception to this. The collective ownership of land in Eritrea included frequent land redistributions and contributed to an egalitarian land distribution and prevented the development of a landless class. Serious rethinking and research may be necessary to assess the impacts of frequent redistributions and the land rental market on tenure security, efficiency of land use and incentives to conserve and invest in land improvement. This study assesses the efficiency of the land rental market and other related factor markets that are important for efficiency of agricultural production and for development policy not only in Eritrea but also elsewhere in Africa and other parts of the world.

It is claimed that tenancy markets, by transferring land to more productive farmers, have the advantage of minimizing efficiency losses that may be created due to imperfections in other markets and the absence of private land markets (Bliss and Stern 1982; Binswanger and Rosenzweig 1984). However, the presence of tenancy markets does not guarantee efficiency unless they work reasonably well. Adjustment of cultivated land through the land rental market may be constrained by transaction costs, creating a price band[1], which may lead to non-participation or incomplete adjustment by some households. Bliss and Stern (1982) assessed the determinants of net land leased-in using OLS on data from the Indian village of Palanpur. They found clear signs of inefficiency in the land lease markets but they did not control for sample selection when analyzing land leased for households participating in the market. Skoufias (1995) used Censored Tobit models on data from six Indian villages to assess the existence of transaction costs on each side of the tenancy market. He found significant transaction costs associated with land-renting causing absence of trade for many households (57% of the sample) and incomplete adjustment of area cultivated for those trading. He also found statistically significant asymmetry between some coefficients on the opposing sides of the market. The reasons for this asymmetry could be the dominance of share tenancy causing the tenancy market not to clear like a normal market based on the land price, and threats of eviction and rationing to reduce the disincentive problems in the tenancy market causing tenants to face higher transaction costs than landlords (Bardhan 1984; Bell and Sussangkarn 1988; Dutta, Sen, and Sengupta. 1989). Kevane (1997) is the only study of this kind that we know of in Africa. His study from Western Sudan, using the Bliss and Stern approach, found land rental markets to function efficiently for those participating in them.

This paper uses sample farm household data from the highlands of Eritrea to analyze the land-renting behavior of households in terms of their position in the land rental market (as landlords, tenants or non-participants) and to assess the transaction costs faced (if any) related to the adjustment process in the tenancy market. We apply two-stage estimation methods that allow for separate analysis of the decisions of participation and degree of participation in the land rental market by testing and correcting for selection bias related to participation in the land rental market. The two-stage approach also provides an opportunity for separate testing of asymmetries in the participation and the degree of participation equations. This method is new to previous studies of land-renting behavior in developing countries. Our study is also the first study of its kind in Eritrea and one of the first in Africa. This type of analysis can give insight into the kinds of tenancy reforms that may be required to deal with the land tenure systems in Sub-Saharan Africa where land markets are claimed to be full of imperfections.

The rest of the paper is organized as follows. In section two, we review the relevant literature. In section three we describe the agricultural setting in the highlands of Eritrea. In section four we construct a land-renting model under imperfect markets for non-land factors and develop a set of testable hypotheses. Section five outlines the estimation methods and presents the data. In section six, we present and discuss the results. Section seven concludes.

II. LITERATURE REVIEW

The subject of land rental markets in the context of imperfect markets for factors was first observed by Bell (1976) in his study of the Purnea district of Bihar, India. Bell argued that the non-existence of a market for bullock hire services provides the rationale for land-renting markets with the result that households with surplus bullocks relative to their land assets would choose to rent-in land, while those with more land relative to their bullock capacity would rent-out their surplus land. Bliss and Stern (1982) later developed this into a model in the context of imperfect markets for bullock and labor services. They postulated that households have a 'Desired Cultivated Area (DCA)' that is determined by their endowment in labor $(\overline{H})$ and bullock capacity $(\overline{O})$.

$$DCA = f(\overline{H}, \overline{O}) \qquad [1]$$

Participation in the land rental market in this model is an attempt to make up the difference between DCA and land owned ($\overline{L}$). Bliss and Stern referred to this difference as net land leased-in (NLI), which they expressed as

$$NLI = k(f(\overline{H}, \overline{O}) - \overline{L}) \qquad [2]$$

where k is a factor adjusting for imperfection in the land rental market. If households do not face transaction costs and adjustment of land owned to DCA is done smoothly, we have actual area cultivated (ACA) equaling DCA in which case k=1.

$$NLI = DCA - \overline{L} \qquad [3]$$

A linear approximation of [2] yields

$$NLI = C + k^{'} f_1 \overline{H} + k^{'} f_2 \overline{O} - k^{'} \overline{L} \qquad [4]$$

where C = constant term, $k^{'} = \partial k / \partial (DCA - \bar{L})$, $f_1 = \partial f / \partial \overline{H}$, and $f_2 = \partial f / \partial \overline{O}$. In econometric terms, [4] can be expressed as

$$NLI = \beta_0 + \beta_1 \overline{H} + \beta_2 \overline{O} - \beta_3 \overline{L} + e \qquad [5]$$

where $\beta_0 = C$, $\beta_1 = k^{'} f_1$, $\beta_2 = k^{'} f_2$, $\beta_3 = k^{'}$, and *e* is the error term. We refer to [5] as the Bliss and Stern (BS) model, hereafter.[2] Since with perfect adjustment *k*=1, a statistically significant $\beta_3 = -1$ in [5] is evidence of a well functioning land rental market. Estimating the BS model using sample data from the Indian village of Palanpur, Bliss and Stern (1982) found that the markets for bullock and labor service were highly imperfect due to high transaction costs[3] and that households resorted to the land rental market to adjust area cultivated to their endowment in bullock and labor factors. They found $\beta_3 = -0.78$, which was significantly different from –1, suggesting that the land rental market was not working perfectly and that adjustment through the land rental market could not compensate fully for the imperfections in labor and bullock factor markets. Similar tests by Pant (1983), Nabi (1985) and Srivastava (1989) in other locations of India reported that land rental behavior was affected by imperfections in other markets, but adjustment through land rental market was also not smooth due to transaction costs. On the contrary, Kevane's (1997) study in western Sudan showed a well functioning land rental market, suggesting that the imperfections in the market for non-land factors were partly compensated by the land rental market.[4]

Following Nabi's (1985) critique that the BS model is basically a short-term model, Taslim and Ahmed (1992) postulated a gradual achievement of the desired-renting area as opposed to the instantaneous adjustment in the BS model.[5] A test of their model on sample data from two villages in Bangladesh showed that adjustment was complete in one village but the lease market in the other village appeared to be in disequilibrium, showing that a model of gradual adjustment was more appropriate for the latter village than for the former village.

There are some weaknesses of the BS model and its applications, however. First, empirical studies based on the BS model analyze household land-renting behavior without distinguishing and analyzing households in terms of their position in the land rental market. There may be a substantial proportion of non-participants in the land rental market due to transaction costs. In this respect, estimation of NLI using pooled data may test for the presence/absence of transaction costs in the land rental market as a whole, but it does not explain how transaction costs vary across participating and non-participating households and how costly adjustment is for households renting-in land as compared to households renting-out land (Bell and Sussangkarn 1988). Moreover, it may be the case that the same factors may affect households on either side of the tenancy market differently due to possible asymmetry in other markets (Skoufias 1995). Households may have been rationed-out of the rental market or they may have chosen to adjust through participation in other markets (Bardhan 1984; Bell and Sussangkarn 1988).

The land-renting behavior of tenants and landlords in the BS model was analyzed without correcting for sample selection in the dependent variable. Attempts to correct for such bias include Skoufias's (1995) analysis of land-renting behavior of tenants and landlords separately using Censored Tobit model. A limitation of Skoufias's approach was that Tobit models do not consider the possibility that factors may have different effects on the choice of land strategies than on the decision on how much to rent-in or rent-out. Selection may, therefore, cause censored Tobit results to be biased. Furthermore, Tobit estimates are based on Maximum Likelihood estimation approach, which depends strongly on normality and homoscedasticity assumptions. We address this issue in this paper by studying the land-renting behavior of households renting-in and renting-out land separately using two-stage selection models of Heckman (1979), Lee (1983), and Deaton (1997).[6] Two-stage method allows us to assess whether there are asymmetries in transaction costs on the two sides of the land-renting market in relation to both the choice of land strategies and the extent of land-renting after having decided to rent-in or rent-out land. Application of selection models also allows testing for and correction of selection bias that otherwise may lead to wrong conclusions about the size and significance of parameters. Deaton's selection model allows us to relax the normality assumptions and correct standard errors for hetroscedasticity in the data.

III. THE SETTING IN THE HIGHLANDS OF ERITREA

A defining feature of the land tenure system in the highlands of Eritrea was the collective ownership of land by village communities (*Deissa* system) and low inequality in land holding (with *Gini coefficient* =0.35, based on consumer units from our sample data). User rights to land were periodically redistributed through a process called *Wareida* to respond to demographic changes and ensure equity among right holders within a village. The last redistribution occurred between the year 1998 and 2000. Landlessness was little known in the area, but with an average land holding per household of 0.80 hectare (see Table 1), land was clearly scarce. Production was dominantly subsistence-oriented, but small-scale irrigated production of vegetable crops for the market was also practiced in some localities in the dry season.

The distributions of the non-land productive assets were unequal (see Table 1). If the markets for these were imperfect, this should create incentives for land-renting, which is allowed under the *Deissa* system of land ownership. Most of the tenancy arrangements in our study were pure sharecropping and cost and output sharing, with few cases of fixed-rent contracts.

Farming was labor intensive with animal traction used for plowing fields. Access to farm labor and particularly to male labor was binding during peak seasons. The traditional division of labor in agriculture in the highlands of Eritrea implied that only men carried out the plowing and thus there was limited substitutability between male and female labor. Access to off-farm work was generally uneven across households (see Tables 1 and 3), but households not participating in the land rental market appeared to be more active on the selling side of the off-farm wage labor market than the other groups of households. Better paying off-farm wage work opportunities were usually in relatively distant areas and, for cultural reasons, were generally accessible to men only (70 percent of the participants in off-farm wage labor in year 1999 and 2000 were men). Furthermore, agriculture is complex and requires entrepreneurial and managerial ability, but as is the case in most developing country agriculture, the market for such services was thin and thus farm skill was also generally non-tradable. Therefore, adjustment of labor services through hiring- in and hiring-out was generally costly. On the selling side, transaction costs in the labor market may include job search cost, time spent traveling, and seasonality and underemployment. On the buying side, it includes search and supervision costs.

The market for bullock power was nearly missing. The lumpiness of bullocks, also because they are operated in pairs, their vulnerability to mismanagement, and their highly seasonal demand in rain-fed agriculture may explain this (Binswanger and Rosenzweig 1986). One may argue for adjustment of bullock services to area cultivated through buying and selling of bullocks. However, this is difficult to achieve as the buying and selling involves transaction costs in terms of search cost and, more importantly, having (buying) bullocks and maintaining their capacity is an expensive task, which perhaps requires access to scarce capital, as well. Short-term adjustment in bullock capacity was, therefore, difficult.

Very few households reported having obtained informal credit in the study area. Only formal credit in kind was available through the government's integrated farming programs. Most farmers in the region participated in this program and got a limited access to fertilizer, seed, and sometimes tractor services to cultivate their land, and some extension services. However, the program appeared to be an *ad hoc* program rather than a sustained policy intervention.

IV. THEORETICAL FRAMEWORK

Transaction Costs and Land Rental Markets

Transaction costs include costs of searching for information, screening potential partners (to reduce adverse selection problems), negotiating contract terms, transportation costs, monitoring and enforcement costs (to reduce moral hazard problems) as are extensively explained in the transaction cost literature. Since land is an immobile resource in physical sense, other resources have to be brought to it for agricultural production. With perfect markets for other factors of production there would be no need for a land (rental) market to achieve efficiency (Bliss and Stern 1982; Binswanger and Rosenzweig 1984). Pervasive transaction costs in the markets for other factors of production as well as in the inter-temporal markets (for credit and insurance) create a rationale for markets for land. We assume that rural producers will maximize their utility by deciding how to combine their own resource endowments with resources obtained through the imperfect factor markets, possibly also selling or renting-out some of their resources. The effective prices they face as sellers or buyers of resources depend on the fixed and variable transaction costs they face in the different markets.

Contract choice in land rental markets is in itself complex and affects participation and the degree of participation. Output sharing (share-tenancy) causes the market for land leases not to clear in a normal sense. The share paid by the tenant to the landlord does not work the same way as a price. It creates an excess demand for land that implies rationing of potential tenants. Rationing makes it harder for potential tenants to find potential landlords to enter into contracts with. Potential tenants may, therefore, have to spend more resources initially to succeed in obtaining a contract and thus face higher transaction costs than potential landlords.

The possible disincentive effects that output-sharing may lead to may cause moral hazard problems that create a need for remedial actions that further may lead to asymmetries in transaction costs on the landlord vs. the tenant side of the market. Such transaction costs may become excessively high for absent landlords who, therefore, may prefer fixed-rent contracts to output sharing contracts. On the other hand, landlords may also impose threat of eviction (Bardhan 1984; Dutta, Ray, and Sengupta 1989) as a device to reduce monitoring costs and the disincentive effects. However, a credible threat requires rationing of tenants such that there are real costs of being evicted. There may be search costs related to finding another partner in relation to switching. It may be costly to collect information on relevant partners. Such costs would be smaller for landlords who may have the advantage of choosing among several willing tenants. This asymmetry in the land rental market would cause potential tenants to face higher transaction costs than do potential landlords.

The ability to enter the market from the tenant side may depend on the possession of non-land resources and the reputation of the tenant. This implies that transaction costs may be systematically different on the two sides of the market and may also vary among potential tenants and potential landlords. In a repeated game context like this it is also possible that potential tenants (non-participants or “outsiders”) face higher transaction costs than tenants (“insiders”).

Given participation as a tenant or landlord, it is still possible that there may be considerable variable transaction costs related to adjusting the cultivated area to the optimal level due to the spatial dispersion and lumpiness of plots of land and other factors of production, like bullock for plowing. There is likely to be economies of scale at small plot sizes (costs of fragmentation).[7] Such costs might be expected to be higher for tenants than for landlords in the case of pure share tenancy where landlords do not usually provide other inputs than the land. This is largely an empirical issue, however.

It is also assumed that market development costs of transactions are reduced as population density increases. Markets for land only develop after land has become scarce (Boserup 1965). Based on this, we may expect land rental markets to function better the scarcer land is. But how does this affect the land rental market when it does not clear in the Walrasian way. Does rationing become more severe as land scarcity increases?

A Simple Model

In this section, we write a simple model of participation in land rental market. In light of the above review of literature and the settings in the highlands of Eritrea, we postulate that participation in the land rental market is a result of imperfections in the services for non-land productive factors. Our model draws from Sadoulet, de Janvry, and Benjamin (1998) and builds on Holden, Shiferaw, and Pender (2001), which explicitly deals with and tests for imperfections in markets for land, bullock, and labor.[8]

Consider a farm household with initial endowments of land $\overline{L}$ and non-land $\overline{N}$ resources such as labor, bullock, and other productive farm assets. If the household has the possibility of adjusting its use of land and non-land through participation in the respective markets, we have

$$L = \overline{L} + L_b - L_s$$
$$N = \overline{N} + N_b - N_s \qquad [6]$$

where L and N are sizes of land cultivated and non-land resources used in production, respectively; L_b and L_s are the quantities of land rented-in and rented out in the land rental market, respectively; and N_b and N_s are the quantities of non-land resource hired-in and hired-out in the non-land market, respectively. We postulate that the household's crop output is given by

$$q = q(L, N) \qquad [7]$$

, where q is a twice-differentiable concave production function with positive and negative first q_L and second q_{LL} derivatives, respectively. We assume complementary relationship in production between land and non-land factors, i.e., $q_{LN} > 0$ and $q_{NL} > 0$. Assume that farm output can be sold at a market price of *p*, and land can be rented at effective "compensation" price, which depends on the given rental rate R and fixed (F^L) and variable (V^L) transaction costs that are faced in the land rental market.[9] We assume that transaction costs depend on land transacted. Non-land can be transacted at effective "compensation" price, which depends on the given price w and fixed (F^N) and variable (V^N) transaction costs that are faced in the non-land markets. We also assume that the transaction costs depend on quantity transacted in a non-decreasing fashion. The household's income y is given by

$$y = pq(L,N) - R(L_b - L_s) - F_b^L(L_b) - V_b^L(L_b) - F_s^L(L_s) - V_s^L(L_s) - w(N_b - N_s) - F_b^N(N_b) - V_b^N(N_b) - F_s^N(N_s) - V_s^N(N_s) \qquad [8]$$

with $$F_j^x(x_j) = \begin{cases} F_j^x \text{ if } x_j > 0 \\ 0 \text{ otherwise} \end{cases} \quad x = L, N \quad \text{j=s,b}$$

and $$V_j^x(x_j)\begin{cases} >0 \text{ if } \mathrm{x_j}>0 \\ =0 \text{ otherwise} \end{cases} \qquad x = L, N \quad \text{j=s,b}$$

The household's utility maximization problem can now be stated as

$$\begin{aligned} &\max_{L_b, L_s, N_b, N_s} = U(y) \\ &\text{s.t.} \quad L_s \le \overline{L} \\ &\qquad N_s \le \overline{N} \\ &\qquad L_s \ge 0,\ L_b \ge 0,\ N_s \ge 0,\ N_b \ge 0 \end{aligned} \qquad [9]$$

,where U is a strictly increasing twice-differentiable quasi-concave utility function. Using the above model, we may derive nine combinations of land and non-land strategies depending on the market status of the household in these factors. These combinations, labeled C1-C9 in Table 2, are results of variations in non-land to land ratios and variations in transaction costs of resource adjustment in land and non-land factor markets. Combinations C2, C5, and C8 show that the household has the possibilities of taking a seller, a buyer, or a non-participant position in the market for non-land factors while remaining to be non-participant in the land market. For C2 and C8, it can be that benefits from participation in land versus non-land markets are comparable, but the household is facing higher transaction costs in the land market than in the non-land market if it participates in the later market only. Similarly, households in C4 and C6 may face less transactions costs in the land rental market than in the non-land market.[10] If some households are rationed-out of the land market, they may sell their non-land resource instead of renting-in land.

Non-participation in both markets simultaneously (C5) might be understood as if the household has an optimal mix of complementary factors or a situation where, for given endowments in resources, it faces transaction costs in both the land and the non-land markets in such a way that total costs of participation in these markets are higher than total benefits. The extent of non-participation in a market may, therefore, indicate transaction costs in that market. Non-participants may include households that are completely rationed-out of the tenancy market (Bell and Sussangkarn 1988; Skoufias 1995) and rationing may be explained by other factors than those explaining the degree of market participation.

Combinations C1, C3, C7, and C9 show participation in both markets. C1 arises when the households face low transaction costs in selling non-land and land, which may indicate lack of or low level of a third resource, say bullock or farm management skills, that are costly or impossible to rent-in, or the households face high opportunity cost of labor in off-farm activity due to some particular skill or education. C9 is a situation where the household has a sufficiently large amount of non-land resource, say bullocks and farm skills, for which there are high transaction costs in relation to selling and it faces sufficiently low transaction costs to rent-in land and hire-in some non-land resource such as labor. A reputation as a good and reliable farmer may reduce transaction costs related to entering the land rental market. For C3 to arise the household should be rich in non-land assets, but poor in land, creating the adjustment situation that land is rented-in and some non-land such as labor is hired-out at the same time to adjust the factor mix in relation to other non-land non-tradable factors. C7 is a situation where the household rents-out part of its land and cultivates the rest with the help of hired non-land resource. This represents household that is poor in non-land and rich in land.

Grouping of households in a survey in the categories C1-C9 may, therefore, be a useful first assessment of the extent of transaction costs in these markets. Table 3 in the results section provides such assessment for land and labor markets.

For a given non-land resource (fixed or optimally chosen), our theory predicts that household position in the land rental market depends on the shadow value of land R_o relative to the effective price of renting-out land R_s and the effective price of renting-in land R_b.[11] Four land strategies are possible for households owning some land. These are pure landlord (PL), landlord-cultivator (LC), owner-tenant or simply tenant (T), and owner-cultivator or non-participant (NP). The rationing argument together with screening and selection of potential tenants by landlords implies that potential tenants face higher transaction costs to enter the land rental market than potential landlords. Both tenants and landlords may also face non-linear variable transaction costs after having entered the land rental market in which case adjustment to the desired cultivated area would be incomplete. Based on the above theory, we test the following hypotheses.

(a) Imperfections in markets for non-land factors create a need for adjustment through the land tenancy market.

(b) Adjustment through the land rental market leads to more unequal distribution of operated holdings. This is based on the initial egalitarian land distribution and non-existence of landlessness and on the expected unequal distribution of non-land resources that are less tradable than land.

(c) There are significant transaction costs in entering the land tenancy market. We base this hypothesis on the immobility and spatial dispersion of land, the lumpiness of parcels of land, the costs of obtaining information about land and contract partners, the dominance of output sharing in the study area causing the land rental market not to clear in a Walrasian way, and rationing due to moral hazard problems in sharecropping arrangements.

(d) Potential tenants face higher transaction costs than potential landlords to enter the tenancy market. This follows from the above argument on output sharing and the threat of eviction theory creating an additional rationale for rationing (Bardhan 1984; Dutta, Ray, and Sengupta 1989).

(e) Screening and selection of potential tenants by landlords in the tenancy market cause significant asymmetries on the two sides of the market, leading to selection bias on the tenant side of the market. This is due to the potential problems related to moral

hazard and adverse selection related to land tenancy contracts (Bell and Sussangkarn 1988).

(f) There are non-linear variable transaction costs in relation to adjusting operational land holding for those who operate in the market (See the appendix section for hypothesis development on this).

(g) Land scarcity (higher population pressure) leads to better functioning of the land rental market (lower transaction costs) (Boserup 1965), alternatively

(h) Land scarcity reduces the probability that potential tenants are able to participate in the land rental market (our hypothesis, building on Bardhan 1984; Dutta, Ray, and Sengupta 1989).

V. METHODS AND DATA

Method of Hypotheses Testing

The choice of land strategies can be estimated using a probability model. Consider the following random utility model for household *i* faced with *J* choices of land strategies

$$U_{ij} = \gamma_j' z_i + \varepsilon_{ij} \qquad j = 1....J \qquad [10]$$

where $\gamma_j' z_i$ and ε_{ij} are the deterministic and random components of the model, respectively. The utility variable is unobserved, but the household is assumed to choose the alternative with the highest utility. Thus, a land strategy *j* is selected when $U_{ij} > \max_{j \neq k} U_{ik}$. If the error terms ε_{ij} are independent and identically Gumbel $G(\varepsilon_{ij})$ distributed, equation [10] leads to simple Multinomial Logit (ML) model (McFadden 1973)[12] with:

$$prob[I = j] = \frac{e^{\gamma_j' z_i}}{\sum_{k=0}^{2} e^{\gamma_k' z_i}} \qquad [11]$$

where *I* is a variable that contains the possible land strategies of each decision maker. For empirical analysis, we limit the alternative land strategies to three by treating the PL and LC land strategies as landlord (L) strategy. The model is estimated by Maximum Likelihood estimation method. Non-participants are used as benchmark category to identify the parameters of the model. This is in line with our theory since the decision to rent-in land or rent-out land is considered vis-à-vis no land transaction. The z variables include household endowment in male (*malelland*) and female (*femalland*) labor, number of bullocks (*bullockland*) and land irrigated in the previous year (*irlandland*) all of which are normalized by the size of land owned (*landow*). It also includes gender(*hhsex*), age(*hhage*), education(*hhedu*), and farm experience(*hhfamex*) of the household head, participation in off-farm wage labor in previous year(*ofa99d*), availability of land at village level (*vlavland*), average distance of plots from homestead(*aavdist*), and distance to the nearest market town(*marketd*), and four location dummies for five sub-regions.[13]

A positive (negative) significant value of the endowment of non-land factor of production in the tenant (landlord) equations indicates that the market for this factor or resource does not work perfectly and, therefore, creates incentives for adjustment in the tenancy market. This tests hypothesis *(a),* which will also be further tested using model [13] below.

Model [11] will also be used to test hypotheses (*d)* and *(g) vs. (h).* Hypothesis *(d)* may be tested by assessing the effect of non-land factors on the choices of landlord and tenant strategies in equation [11]. To do this, we imposed symmetry of parameter estimates (pair-wise and joint) across the landlord and tenant equations in the ML model.[14] Higher transactions costs on the potential tenant side of the market should imply that probability responses are higher for fixed non-land factors on the potential landlord side than on the potential tenant side of the land rental market. Hypotheses *(g)* vs. *(h)* can simply be tested by assessing how land scarcity affects the choice of land strategies in the ML model and the magnitude of land rented-in equation after having controlled for other factors. Hypotheses *(g)* vs. *(h)* will also be tested further by assessing how the size of land rented-in is affected by land scarcity in model [13] below.

In consideration of possible existence of variable transaction costs that may also vary across household groups, we estimate the quantity of land transacted by tenants and landlords separately by correcting for potential bias in parameter estimates that may arise due to sample selection (Heckman 1979). This will test hypothesis *(e)* and *(f).* Consider the following model for household *i* that rents-in or rents-out land.

$$L_{ij} = \beta_j^{'} x_i + u_{ij} \qquad \text{j=b,s} \tag{12}$$

, where L_{ij} is land rented-in or land rented-out, and $\beta_j^{'} x_i$ and u_{ij} are the deterministic and random components of the model, respectively. Since the value taken by L_{ij} is conditional on land strategy *j* being chosen, we cannot rule out the possibility that $corr(\varepsilon_{ij}, u_{ij}) = \rho_{ij} \neq 0$, which results in correlation between the explanatory variables and the error terms in equation [12]. The problem is, therefore, to estimate β consistently by taking into account the correlation between ε_{ij} and u_{ij}. Least squares estimates of β would not be consistent if the two error terms are not independent. The implied censored regression equation based on Lee's (1983) generalization of the Heckman (1979) method of selection bias correction is given by[15]

$$L_{ij} = \beta_j^{'} x_{ij} - \rho_{ij} \sigma_{ij} \lambda_{ij} + e_{ij} \tag{13}$$

, where λ_{ij}[16] is the selection variable, which is different from the standard Heckman selection variable and e_{ij} is an independent random term. This method, which we refer to as Heckman-Lee (H-L), hereafter, is implemented by estimating $(\gamma_j)'s$ using equation [11] to form λ_{ij}.

The resulting λ_{ij} is then used as an additional regressor in equation [13] to estimate β and $\rho_{ij}\sigma_{ij}$ consistently using Least Squares (Greene 2002). The explanatory variables in [13] are the same as in equation [11] except that none of them is normalized by the land owned variable (*landow*), as this variable is needed in the model to test for variable transaction costs in the land rental market. The explanatory variables are also the same for both the landlord and the tenant models.[17] Standard errors are corrected using the Huber/White/Sandwich estimate of variance to fix Hetroscedasticity in the model (Wooldridge 2002).[18]

Application of the H-L method on our data showed that the hypothesis of no selection bias was rejected for the tenant model, but not for the landlord model. To assess the sensitivity of the H-L result to alternative specifications, we estimated equation [13] using Deaton's (1997) two-stage regression model, which relaxes the assumption of joint normality of the error terms. Deaton's model uses the predicted probability variables (obtained, in our case from the ML model) in polynomial form as an alternative approximation of the selection variable λ_{ij}. We kept the first and the third degree polynomial elements in the tenant model.[19] None of the polynomial selection variables were found to be significant in the landlord model. The landlord model was thus estimated using OLS without the selection variables. We present Tobit estimation of the landlord model (as in Skoufias 1995) as supplementary.

Hypothesis *(e)* can be tested by assessing whether the coefficients in the land rented-in model are significantly different from their counterparts in the land rented-out model. Asymmetry of coefficients is tested by imposing joint and pair-wise equality of coefficients on the two sides of equation [13]. Hypothesis *(f)* can be tested by assessing whether the coefficient for size of the land owned variable (*landow*) in equation [13] is significantly greater than –1(land rented-out is multiplied by -1 for ease of interpretation). A significant difference indicates that there are significant variable transaction costs in adjustment of land size for those participating in the market. We can also assess the significance of the endowments of non-land factors of production in equation [13] to test for hypothesis *(a)* further.

The remaining hypotheses, *(b)* and *(c)* are tested as follows. Hypothesis *(b)* can simply be tested by assessing whether the tenancy market leads to a more inegalitarian distribution of operational holdings than the distribution of owned holdings is. This implies that land "moves" in an economic sense to the other factors rather than the other way around even though land is "immobile" in a physical sense.[20] Hypothesis *(c)* can be tested by observing the degree of non-participation in the land rental market since zero transaction costs would lead to a knife-edge switch between being a tenant or a landlord in this market (Bell and Sussangkarn 1988).

The Data and Variables

The data that we used in this study is from a sample of 319 households in 32 villages located next to each other in the highlands of Eritrea.[21] The distribution of sample villages by region and sub-region is shown in Table 4. An overview of the variables used in the empirical analysis is presented in Table 1, with means and standard deviations for each of the household groups.

We see in Tables 1 that, of the total sampled households, 20 percent were landlords, 34 percent were tenants and the remaining 46 percent were non-participants in the land rental market. We see that landlords rented-out a large share of their own land (about two-thirds). Land rented-in formed 38 percent of tenant's operated holding (*fsize*). Tenants were richer than non-participants and landlords in male labor, bullocks and irrigated land (lagged variable), while most landlords were female-headed households with younger age and less farm experience. But these are just average observations, and we will see if they would hold after subjecting our data to more rigorous statistical analysis.

VI. RESULTS AND DISCUSSION

Estimation results for the above-discussed econometric models are given in Tables 5, 7, and 8. Tests of differences in mean sizes of land and factor ratios between household types are presented in Table 6. Results of tests of symmetry of parameter estimates across the tenant and the landlord models are given in Table 9. The overall result is that the markets for non-land factors were imperfect and that caused participation in the land rental market. Yet, the land rental market was characterized by transaction costs, which, among others, caused many households to adopt a strategy of non-participation. Landlord and tenant households faced little transaction costs in adjusting to the desired size of land cultivated.

We will now present the results and discuss our main hypotheses in relation to these. Our first hypothesis *(a)* stated that imperfections in non-land factors create a need for adjustment through the tenancy market. We have already seen some of these adjustments as they came out in Tables 1 and 3. A more rigorous test is provided in Tables 5, 7, and 8. We found that the probability of participation in the land rental market (Table 5) was affected significantly by relative endowments of the non-land factors - male labor force (*malelland*) and bullocks (*bullockland*), - and farm experience (*hhfamex*). Households that were poor in these factors tended to rent-out land while households rich in these factors tended to rent-in land. Endowments in bullocks (*bullocks*) and farm experience also affected significantly the degree of participation in the land rental market (Tables 7 and 8). These results indicate that adjustment in the land rental market was a response to imperfections in the markets for animal traction, male labor and farm skills.

Our hypothesis *(b)* stated that adjustment through the land rental market leads to more unequal distribution of operated holdings. As we have already stated, the frequent land redistributions in the *Deissa* system aimed at ensuring and maintaining an egalitarian distribution of land within villages, taking demographic changes into account. In table 1, we see that there was not much difference in the mean size of land owned (*landow*) among the household groups, but operational holdings (*fsize*) were much larger for tenants, i.e., about double of that of non-participants and five times that of landlords (see also Table 6 for test of equality of mean sizes of land between the household groups). In total, terms, the standard deviation for land owned was 1.4, giving a 44% coefficient of variation (CV), while for land operated the standard deviation was 2.58, giving a CV% of 84. The corresponding CV% for bullocks (*bullocks)* was 78 and for male labor (*malelab*) 86. The initial distribution of bullocks and male labor was, therefore, clearly more skewed than that of land and this may explain the more skewed distribution of operational holdings because land has "moved" to bullocks and male labor in an economic sense.

Our hypothesis *(c)* was that there are significant transaction costs in the land tenancy market. Bell and Sussangkarn (1988) demonstrated that transaction costs would drive a wedge between the costs and benefits of tenancy as a landlord and as a tenant. We see from Table 3 that 46% of the households did not participate in the land rental market. We claim that the high degree of non-participation of households in the land rental market is an indication of transaction costs in this market as it is highly unlikely that all non-participating households have a perfect mix of land to non-land factors. In deed, there was significant difference in pre-lease factor ratios among non-participant households themselves. This is shown in Table 6 where the pre-lease bullock/land and adult labor/land ratios among non-participating households were significantly higher for households that were predicted to be tenants (PT) than for those that were predicted to be non-participants (PNP).[22]

We have already demonstrated that the markets for some non-land factors were imperfect and this created a need for the land rental market for factor ratio adjustment. The existence of labor market, albeit imperfect, could in principle provide alternative adjustment mechanism especially for potential tenants (with excess labor) who could not succeed in renting-in land. Nonetheless, 42 percent of the total number of households that did not participate in the land rental market did not participate in the labor market, as well (see Table 3). This suggests that non-participation in land market was not entirely due to perfect adjustment or because households chose to adjust through the labor market. Furthermore, 44 percent of the landlord households did not cultivate any land at all. This might be a sign of a well functioning land rental market, but the fact that post-lease bullock/land ratio for landlords that farm some land was significantly lower than for non-participant and tenant households (see Table 6) indicate some constraints to adjustment of bullock land ratios.

Hypothesis *(d)* stated that potential tenants face higher transaction costs than potential landlords in the tenancy market. We think that potential tenants may have been rationed-out of the rental market while landlords were less constrained in accessing the market. We see in Table 5 that *malelland* and *bullockland* were highly significant in both the landlord and tenant models, but the marginal effects were considerably bigger in the former, indicating that potential tenants faced higher transaction costs than potential landlords. Tests of equality of the marginal effects on opposite side of the ML probability model are presented in Table 9. Only *bullockland* and *irlandland* were significantly different in the two models. However, we regard this to be sufficient evidence of potential tenants facing higher transaction costs in relation to entering the land rental market. We have already seen in relation to hypothesis *(c)* that there was significant difference in pre-lease factor ratios among non-participant households, which suggested that some households actually possessed the resources they needed to be tenants, although they did not succeed in being tenants. We also found no significant difference in pre-lease bullock/land and adult labor/land ratios between the PT households and households observed to be tenants (T).

Hypothesis *(e)* stated that screening and selection of tenants by landlords in the tenancy market cause significant asymmetries on the two sides of the market both with respect to probability of participation and degree of participation. Clear asymmetries on the two sides of the market were found as we have already discussed in relation to hypothesis *(d)*. The marginal effects for *bullockland* and *irlandland* were significantly different in the two sides of the ML model. Joint symmetry of all coefficients was also rejected for the degree of participation models (Table 9). The results indicate that potential tenants faced more difficulties in entering the land rental market. This is in accordance with the theory on rationing and threat of eviction of tenants. Availability of bullocks and male labor per unit of land increased the probability of being able to rent-in land but did not guarantee that they succeeded in doing so. The significance of the selection bias on the tenant side of the market but not on the landlord side is also an indication of an asymmetry on the two sides of the market. The impact of land scarcity was also clearly different on the two sides of the market (more on this later). Moral hazard and adverse selection may cause rationing from the supply side in the land rental market. We may therefore not reject hypothesis *(e)*.

Hypothesis *(f)* stated that tenants and landlords face non-linear variable transaction costs in relation to adjustment of operational land holding such that the degree of adjustment is not linear in own land and with coefficient -1. When we tested separately for this for tenants (Table 7) and landlords (Table 8), we did not find that the coefficients for land owned (*landow*) were significantly different from –1 for both tenants and landlords, after correction for selection bias. This indicates that variable transaction costs were linear and we reject hypothesis *(f)*. We also see from Table 9 that the parameters for land owned in the tenant and the landlord models were not significantly different from each other. We, therefore, reject hypothesis *(f)*. The land rental market was efficient for those participating in it.

Hypothesis *(g)* stated that land scarcity or population pressure should lead to a better functioning of the land rental market. This hypothesis should also be seen in relation to the next hypothesis *(h),* which stated that land scarcity increases the probability that potential tenants are rationed-out of the tenancy market. Land scarcity should lead to increased demand for land and higher shadow value of land. We see from Table 5 that the land scarcity variable (inverse of *vlavland*) significantly reduced the probability that potential tenants participated in the land rental market. On the other hand, land scarcity increased the probability that potential landlords participated in the land rental market. Land scarcity also reduced the size of land rented-in significantly (Table 7), but it did not have a similar effect on the size of land rented-out (Table 8). We may, therefore, not reject hypothesis *(h)*. This implies rejection of hypothesis (*g*).

Some other interesting findings were that sex of household head affected participation on one side of the market. Male-headed households were significantly more likely to rent-in land (Table 5) after we have controlled for the differences in other resource endowments. Land rented-in was also significantly higher for male-headed households after having controlled for differences in other resource endowments (Table 7). This could be because of farm-skill advantages men have over women or because of cultural biases preventing women from being on the buying side of the market. Households with old age of the household head were significantly less likely to rent-in land and more likely to rent-out land (Table 5). Age of household head also had a significant negative impact on land rented-in by tenants (Table 7). This may be due to labor constraint caused by old age. Education (*hhedu*) of the household head reduced the probability that households rented-out land and increased the quantity of land rented-in. These findings put together can be taken as further evidences of market imperfections for human capital. We also see that land rented-in is negatively affected by female labor force, although we do not know why this is the case. The normalized quantity of land irrigated in previous year (*irlandland*) reduced the probability that land was rented-out (Table 5). Land irrigated in previous year (*irland*) also stimulated the extent of land being rented-in. This may indicate that incomes from irrigation, through their effect in relaxing financial constraints, may have affected land-renting decisions positively, suggesting imperfection in the capital market as well.

Finally, land rented-in was significantly lower in areas further from the nearest market towns (*marketd)*. Although not statistically significant, land rented-out tended to decrease with *marketd*. These results appear to suggest that land transactions were bigger and more active around market towns, which usually are important sources of non-farm work opportunities for farm households. Low availability of alternative employment in remote areas may force some potential landlords to keep some of their land under own-cultivation in order to provide themselves with some employment. This may indicate the potential role of alternative employment in enhancing land transactions by making land more available for potential tenants.

VII. CONCLUSIONS

This paper analyzed the effects of endowments in non-land factors of production on the choice of land strategy and the extent of land-renting by farm households in the highlands of Eritrea. It also assessed transaction costs associated with the process of adjustment via the land rental market. Results of our empirical analysis showed that land rental transactions were motivated by need to adjust land area cultivated to endowments in imperfectly traded factors like bullock, family male labor, and farm skills. Through the land rental market, land has moved from households that were land-rich but poorly endowed in other factors of production to households that were land-poor but rich in other production factors. In this respect, it can be said that the land rental market improved resource allocation. This is consistent with similar findings from other developing countries that land rental markets played a role in compensating for imperfections in the other markets. Our results also support the arguments by Kevane (1997) and Sadoulet, Murgai, and de Janvry (2001) that land rental markets may have the potential to provide alternative avenues in reforming traditional African tenure systems.

Substantial non-participation in the land rental market indicates that there were considerable transaction costs in this market. Non-participants had problems adjusting their land and other factors to an optimal mix. Our findings revealed that the variable transactions in the land rental market were fairly linear and we had to reject our hypothesis of nonlinear variable transaction costs. This is in line with the findings of Kevane (1997), but contrary to the findings of Skoufias (1995).

The fairly high degree of non-participation in the land rental market may indicate that there is room for policy intervention to improve efficiency of resource allocation. The land rental market was informal and had not been stimulated by past policies. It may be difficult to suggest how transaction costs can be reduced in this type of market[23], but policies that aim at improving the markets for non-land resources can provide alternative adjustment mechanisms for households that are not able to enter the land rental market due to high transaction costs. For instance, creation and expansion of alternative work opportunities provides an opportunity to sell excess labor in the labor market. Availability of alternative employment can also improve the working of the land-rental market by encouraging potential landlords to make more land available for rent-out.

This study has revealed the importance of the land rental market for efficiency of resource allocation in agriculture in Eritrea.[24] The *Deissa* and *Wareida* systems have created an egalitarian distribution of land and one may say that this has also served as a safety net or insurance to the poor.[25] Through the land rental market, households that were too poor in non-land factors of production to farm the land themselves earned an income by renting-out their land to households that were richer in non-land factors and that, therefore, were more efficient land users. Although the rental market for land caused a more inegalitarian distribution of operational land holdings, the impact on the incomes of the poor landlords may still have been positive. Greater participation in the land rental market would lead to even more skewed distribution of operational holdings but this could also improve incomes of the poor landlords.

APPENDIX

Choice of Land Strategies

The purpose of this section is to explain the choice of land strategies by households. For simplicity, we consider the case with no fixed costs in the factor markets.

Let μ_L and μ_N be the multipliers associated with the endowments of land and non-land factors, respectively, and let *G* denote the Lagrange function associated with the household's utility maximization problem, equation [9]. The Kuhn-Tucker conditions are:

$$\frac{\partial G}{\partial L_b} = U^{'}(\ )\left[p\frac{\partial q(L,N)}{\partial L} - R - \frac{dV_b^L}{dL_b}\right] \le 0, \qquad L_b \ge 0, \quad \frac{\partial G}{\partial L_b}L_b = 0 \qquad [A1]$$

$$\frac{\partial G}{\partial L_s} = U^{'}(\ )\left[p\frac{\partial q(L,N)}{\partial L} + R - \frac{dV_s^L}{dL_s}\right] - \mu_L \le 0, \quad L_s \ge 0, \quad \frac{\partial G}{\partial L_s}L_s = 0 \qquad [A2]$$

$$\frac{\partial G}{\partial L_s} = \overline{L} - L_s \ge 0 \qquad \mu_L \ge 0, \quad \mu_L(\overline{L} - L_s) = 0 \qquad [A3]$$

$$\frac{\partial G}{\partial N_b} = U^{'}(\ )\left[p\frac{\partial q(L,N)}{\partial N} + w - \frac{dV_b^N}{dN_b}\right] \le 0, \qquad N_b \ge 0, \quad \frac{\partial G}{\partial N_b}L_b = 0 \qquad [A4]$$

$$\frac{\partial G}{\partial N_s} = U^{'}(\ )\left[p\frac{\partial q(L,N)}{\partial N} + w - \frac{dV_s^N}{dN_s}\right] - \mu_N \le 0, \quad N_s \ge 0, \quad \frac{\partial G}{\partial N_s}L_s = 0 \qquad [A5]$$

$$\frac{\partial G}{\partial N_s} = \overline{N} - N_s \ge 0 \qquad \mu_N \ge 0, \quad \mu_N(\overline{N} - N_s) = 0 \qquad [A6]$$

Under the assumption of increasing variable transaction costs there are no arbitrage opportunities and the household is never renting in and renting out production factors at the same time. This follows, for the land market, by letting *Ls* > 0 and *Lb* > 0 in the above first-order conditions, and after collecting terms arriving at a contradiction.

Focusing the attention to the behavior in the land market, let the optimal amount of non-land factors be *N**. There are four distinct land strategies:

1. The pure *landlord* rents out all the land, i.e. $L_s = \overline{L}$. This is optimal if

$$p\frac{\partial q(0,N^*)}{\partial L} < R - \frac{dV_s^L(\bar{L})}{dL_s} \qquad [A7]$$

The net marginal land rent received in the market exceeds the value of the marginal product of land even at the point with no own land utilization where the marginal product is the highest.

2. *Landlord-cultivator* strategy is adopted when the marginal product of land in the production function is sufficiently high, i.e.

$$p\frac{\partial q(\bar{L}-L_s^*,N^*)}{\partial L} = R - \frac{dV_s^L(L_s^*)}{dL_s} \qquad [A8]$$

Here $0 < L_s < \bar{L}$.

3. A household who is a *tenant* adjusts the land rented in, denoted L_b, such that

$$p\frac{\partial q(\bar{L}+L_b^*,N^*)}{\partial L} = R + \frac{dV_b^L(L_b^*)}{dL_b} \qquad [A9]$$

The value of the marginal product of land equates the rental price plus the marginal transaction cost. As the rental price (or marginal transaction costs) increases, the land rented is reduced.

4. There is thus a range of value for the marginal product of land is such that it is not rational to participate in the land market, i.e.

$$R - \frac{dV_s^L(0)}{dL_s} < p\frac{\partial q(\bar{L},N^*)}{\partial L} < R + \frac{dV_b^L(0)}{dL_b} \qquad [A10]$$

Non-linear variable transaction costs

Focusing on the tenant and totally differentiating the first order condition [A1] yields

$$p\frac{\partial^2 q(\ )}{(\partial L)^2}(d\bar{L}+dL_b^*) - \frac{d^2V_b^L(\ )}{(dL_b)^2} = 0 \qquad [A11]$$

Thus $\frac{dL_b}{d\bar{L}} = -1$ only in a situation where the variable transaction cost function is linear.

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ENDNOTES

[1]With zero transaction costs there would be a "knife-edge" switch between renting-in and out.

[2] See Bliss and Stern (1982) and Skoufias (1995) for graphical presentation of this model.

[3] Bliss and Stern (1982) did not use the term transaction costs specifically, but their reference to costs related to search for suitable landlord or tenant and negotiation could be termed as transaction costs.

[4] Pender and Fafchamps (2000) argued that area cultivated would be independent of area owned if land rental market works perfectly; testing for this on sample data from four villages in Ethiopia, they found that area cultivated was positively and significantly affected by land owned, perhaps indicating the presence of transaction cost in the land rental market.

[5] Nabi (1985) and Taslim and Ahmed (1992) argued that observed rental patterns could be the result of both short and long term adjustments in factor inputs in which case it may be useful to consider changes in household assets and cultivation over time. This may, however, be context specific; in some cases institutional limitations may limit land-renting to be a short-run phenomenon. The assumption of short-term adjustment may not be wrong in our setting since the duration for most contracts is one year.

[6] Kochar (1997) applied Heckman's two-stage method on sample data from Northern Indian State of Uttar Pradesh to estimate tenancy outcomes. Her results show an insignificant effect of land owned on land leased by tenant-cum households, but since the focus of the paper was the effect of credit on tenancy outcomes, she did not make any comment on the implication of this for the working of the lease market. The study showed significant positive effect of endowment in labor and draft animal on area leased-in.

[7] Fragmentation of plots causes increased transportation costs. The average cost of using lumpy inputs such as bullock and implements should, therefore, be lower for larger and more consolidated plots than for smaller and fragmented plots.

[8] Holden, Shiferaw, and Pender (2001) also recognize that different factors may influence the participation or non-participation in these markets than those affecting the degree of participation. The functional relationships may also be different for the two stages.

[9] In fixed-rent market, the rental fee may be considered as the price of land. In sharecropping context, the price of land is not clearly defined. It may be possible to consider the output share of the landlord, which is $1-\alpha$, where $0<\alpha<1$, as *de facto* price if the tenant covers all the costs of production and there are no transaction costs in the land rental market. In reality, things are more complicated than this. To simplify matters, we assume that there is some effective rental price that varies across household types depending also on transaction costs in the land rental market.

[10] This may imply that households implicitly aim to minimize their transaction costs as part of their utility maximizing objective.

[11] See the appendix and Table 2 for details.

[12] Application of ML is justified on the assumption of independence of irrelevant alternatives (IIA), which comes directly from the assumption of independent and identically distributed error terms. An alternative to multinomial Logit model is Multinomial probit (MP) model, which relaxes the assumption of IIA by allowing the response errors to correlate. However, the assumption of IIA could not be rejected on our data in both the landlord and the tenant equations (Hausman test results are given in Table 6). Moreover, the MP model is not estimable with a completely free correlation matrix (Greene 2002). One needs to constrain the correlation structure and standard deviation to some specified value the choice of which

involves not only judgment but also affects results in terms of precision and statistical significance.

[13] The variable *p* from the theoretical model is not included as explanatory variable due to limited variation in prices in the cross-section data that we used for the analysis. The variable *w* was not observed for large number of households hence excluded from the empirical models. The transaction costs variable is not directly observable.

[14] The ML model allows for comparison of coefficients (and marginal effects) across the tenant and landlord equations.

[15] See Lee's (1983) and Bourguignon, Fournier, and Gurgand (2002) for details.

[16] The selection variable $\lambda_{ij} = \phi(H_j(\gamma_j^{'} z_i) / F_j(\gamma_j^{'} z_i)$, where ϕ is the standard normal density function, $F_j(\gamma_j^{'} z_i)$ is the cumulative distribution of ε_{ij} , $H_j(\gamma_j^{'} z_i) = \Phi^{-1}(F_j(\varepsilon_{ij}))$, which is the transformed normally-distributed residuals proposed by Lee (1983), and Φ is the standard normal cumulative. The distribution of $H_j(\gamma_j^{'} z_i)$ and u_{ij} are assumed to be bivariate normal.

[17] It may be possible to consider the effect of such variables as rental rates on area rented. It is erroneous to treat rental or sharing rates in the land rental market as exogenous, but it may equally be inappropriate to think that rental patterns are not affected by rental/sharing arrangements. We run a regression of the censored model for tenant households with dummy variables for the specific tenancy arrangements as regressors and found that area rented-in increased with pure sharecropping and fixed-rent as compared to fifty-fifty cost and output sharing land contract. However, we do not know if these variables are capturing the effect of variation in land price or the choice of particular contract over the other. Because of potential endogeneity, therefore, we chose not to include them in the censored models.

[18] A test of homoscedasticity was performed using the Breusch and pagan (1979) and the Cook and Weisberg (1983) test.

[19] Multicolliniarity among the polynomial selection variables caused the need to eliminate some of them. The elements with the highest variance inflation factor (VIF) were eliminated when all were insignificant to assess whether the others become significant after elimination.

[20] Implicitly, this signals that transaction costs in the land market are lower than in the markets for other factors of production.

[21] The survey was conducted in the months of March-October, 2001. The data collected is for the year 2000 rain-fed production season.

[22] Estimation of a net land leased-in equation (on the total sample of households) along the ideas of the BS model in Equation 5 can also give some indication on the existence of transaction costs in the land rental market as a whole. We estimated the model and found indications of both fixed and variable transaction costs in the land rental market. The *landow* variable was significantly different from -1, indicating variable transaction costs of adjustment in the land rental market. The constant term was also negative and significant, indicating presence of fixed transaction costs of adjustment in the land rental market. Regression results on this can be obtained from authors upon request.

[23] At this point, it may be worth to consider alternative land tenure arrangements, say private land markets. The recent literature on rural land markets (Sadoulet, Murgai, and de Janvry 2001; Deininger 2003) claims that transaction costs of adjustment to imperfections in the markets for credit, labor, and insurance are lower under land rental markets than under land sales markets, although empirical evidences on variation of transaction costs are rather scant.

[24] In a separate paper that we are working on, we found that, controlling for land quality and village effects, land productivity was higher for owner-tenants followed by owner-cultivators (non-participants). We also found that sharecropped plots were no less productive than own-plots. Regression results for this can be obtained upon request.

[25] It may, however, be likely that this form of extensive and frequent land redistributions can undermine investment incentives and the administrative costs are also likely to be high and the poverty reduction effect is likely to be small when an egalitarian land distribution has already been achieved (Deininger et al. 2003).

Table 1

Summary Statistics by Household Type

Variable			Mean and standard deviation							
name	Type[a]	definition	landlord (L)		non-participant (NP)		tenant (T)		all sample	
			mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
landow	C	Size of land owned [b]	3.28	1.38	3.00	1.39	3.47	1.40	3.22	1.40
Landleased	C	Size of land rented-in/rent-out	2.12	1.56	0.00	0.00	2.09	2.04	0.28	2.05
fsize	C	Size of land operated [c]	0.95	1.35	3.00	1.30	5.11	3.00	3.06	2.58
malelabor	C	Number of adult Males	0.27	0.51	1.09	0.92	1.64	0.83	1.11	0.95
malelland	C	Number of adult males per unit of land owned	0.08	0.17	0.44	0.47	0.59	0.46	0.42	0.46
malelfsize	C	Number of adult males per unit of land operated	0.33	0.80	0.44	0.47	0.45	0.41	0.50	0.61
femallabor	C	Number of adult females	1.23	0.61	1.42	0.75	1.47	0.70	1.40	0.71
femalland	C	Number of adult females per unit of land owned	0.46	0.31	0.59	0.45	0.53	0.44	0.54	0.43
femalfsize	C	Number of adult females per unit of land operated	1.58	1.77	0.59	0.45	0.41	0.36	0.71	0.81
bullocks	C	Number of bullocks	0.30	0.61	1.14	0.76	1.82	0.84	1.20	0.93
bullockland	C	Number of bullocks per unit of land owned	0.09	0.20	0.47	0.46	0.61	0.36	0.44	0.43
bullockfsize	C	Number of bullocks per unit of land operated [d]	0.20	0.30	0.47	0.46	0.47	0.36	0.49	0.48
landlabor	C	Size of land owned per *adult labor* [e]	3.10	1.77	1.76	1.30	1.49	1.03	1.94	1.45
fsizelabor	C	Size of land operated per *adult labor*	0.72	1.06	1.76	1.30	2.15	1.82	1.53	1.48
landcons	C	Size of land owned per *consumer unit* [f]	1.83	1.39	0.95	0.58	0.84	0.58	1.09	0.87
fsizecons	C	Size of land operated per *consumer unit*	0.40	0.58	0.95	0.58	1.23	0.89	.85	0.83
irland	C	Size of land irrigated in previous year [g]	0.13	0.33	0.73	1.63	1.38	2.21	0.83	1.76
irlandland	C	Size of land irrigated (*irland*) per unit of land owned	0.04	0.09	0.23	0.52	0.42	0.75	0.26	0.58
vlavland	C.	Land availability at village level [h]	1.06	0.38	0.92	0.39	1.08	0.42	1.00	0.41
hhsex	D	Gender of household head: 1=male, 0=female	0.23	0.43	0.66	0.48	0.84	0.37	0.64	0.48
hhage	C	Age of household head in years	44	18	52	16	54	12	52	15
hhfamex	C	Farm experience of household head in years [i]	21	18	31	17	34	14	30	17

hhedu	C	Education level of household head in years	1.59	2.27	2.34	2.89	2.70	3.12	2.31	2.88
Ofa99d	D	Participation in Off-farm work: 1=yes, 0=no [j]	0.25	0.44	0.36	0.48	0.26	0.44	0.30	0.46
marketd	C	Village distance from nearest town in kilometer	7.88	4.69	7.17	4.87	7.52	4.58	7.43	4.73
aavdist	C	Average distance of land owned from homestead	22	9	20	10	22	12	21	10
sr	D	Four dummies for five sub-regions								
No. of observations			64		147		108		319	

[a] C = Continuous, D = Dummy. [b] Land is measured in *Tsimdi,* a traditional unit, which is equivalent to a quarter of a hectare. [c] Land operated is defined to include land fallowed in order to compare factor ratio results. [d] *bullockfsize* for landlord households was calculated for 36 (out of 64) households since land operated was zero for the remaining households. [e] *adult labor* = *malelabor* + (*femallabor**0.8). [f] *consumer units* = *adult labor* + (number of children under 15 * 0.5). The conversion factors of 0.8 and 0.5 are adopted from Bliss and Stern (1982). [g] *irland* measures the size of land the household irrigated in the year preceding the land-renting decision (it is a lagged variable). [h] *Vlavland* is obtained by normalizing average land owned at village level by average land owned for the total sample of households. [i] Farm experience measures the number of years the household head spent farming. [j] *ofa99d* indicates household participation in off-farm wage work during the year preceding the land-renting decision.

Table 2

Household Status in Land and Non-Land Markets

Status in non-land market	Status in land rental market: renting-out	non-participant	renting-in	price of non-land
buyer	$C1:\begin{cases} pq_L = R_s \\ pq_N = w_b \end{cases}$	$C2:\begin{cases} pq_L = R_o \\ pq_N = w_b \end{cases}$	$C3:\begin{cases} pq_L = R_b \\ pq_N = w_b \end{cases}$	$w_b = w + \frac{dV_b^N}{dN_b}$
non-participant	$C4:\begin{cases} pq_L = R_s \\ pq_N = w_o \end{cases}$	$C5:\begin{cases} pq_L = R_o \\ pq_N = w_o \end{cases}$	$C6:\begin{cases} pq_L = R_b \\ pq_N = w_o \end{cases}$	$w_o = p\frac{\partial q(L,\overline{N})}{\partial N}$
seller	$C7:\begin{cases} pq_L = R_s \\ pq_N = w_s \end{cases}$	$C8:\begin{cases} pq_L = R_o \\ pq_N = w_s \end{cases}$	$C9:\begin{cases} pq_L = R_b \\ pq_N = w_s \end{cases}$	$w_s = w - \frac{dV_s^N}{dN_s}$
price of land	$R_s = R - \frac{dV_b^L}{dL_s}$	$R_o = \frac{\partial q(\overline{L},N)}{\partial L}$	$R_b = R + \frac{dV_b^L}{dL_b}$	

The expressions after the parentheses are the marginal conditions for using land and non-land factors in production for the corresponding position in the respective markets. R_o and w_o are the shadow rental rate of land and shadow price of non-land factors, respectively.

Table 3

Number (%) of Households by Participation in Land and Labor Markets

	Land rental market [a]			
	landlord	non-participant	tenant	Total
Labor market	(R%, C%) [b]	(R%, C %)	(R%, C%)	(C %)
hire-out	18 (19, 28)	49(54, 33)	25(27, 23)	92(29)
non-participant	39 (28, 61)	61(45, 42)	37(27, 34)	137(43)
hire-in	12 (10,18)	51(44, 35)	54(46, 50)	118(37)
hire-in and hire-out [c]	5 (18, 8)	14(50, 10)	9(32, 8)	28(9)
Total (R %)	64 (20)	147(46)	108(34)	319(100)

[a] Participation in the land rental market is in net terms. [b] R% stands for row percentage and C% for column percentage. [c] hire-in and hire-out indicates the number of households who participated in both the selling and buying side of the labor market.

Table 4

Distribution of Sample Villages by Region and Sub-Region

region	sub-region	sample size: village	sample size: household	distance and location [a]	Elevation (in m)[b]	Rainfall(in mm)[c]	population density [d]
Debub	*Mendefera*	8	84	50-60Km. South	1500-2000	630	96
Debub	*Dibarwa*	8	88	30-51Km. South	1500-2000	560	63
Maekel	*Berik*	6	62	7-12Km. Northwest	>2000	486	120
Maekel	*Serejeka*	8	69	11-29 Km. North	>2000	537	107
Maekel	*Gala-Nefhi*	2	16	13-20 Km. North	>2000	387	148
Total		32	319			515	107

[a] Distance and location are stated vis-à-vis Asmara, the capital of Eritrea. [b] Elevation is in meters above sea level. [c] Rainfall level is an eight-year average in millimeter. [d] Population density is number of persons per KM^2 as reported in sub-regional land use documents of the Ministry of Agriculture (2000).

Table 5

The Choice of Land Strategies: Equation [11]

Variables	Prob.(I = T)			Prob.(I = L)		
	coefficients	robust se	marginal effects	coefficients	robust se	marginal effects
constant	γ_{T0} = -2.502**	1.287		λ_{L0} = 4.217**	2.085	
malelland	γ_{T1} =1.555***	0.521	γ'_{T1} =0.388	γ_{L1} =-3.116*	1.791	γ'_{L1} =-0.699
femalland	γ_{T2} = -0.346	0.389	γ'_{T2} =-0.086	γ_{L2} =0.864	1.489	γ'_{L2} =0.191
bullockland	γ_{T3} = 1.368***	0.580	γ'_{T3} =0.343	γ_{L3} =-5.36***	1.268	γ'_{L3} =-1.163
vlavland	γ_{T4} =1.975***	0.759	γ'_{T4} =0.491	γ_{L4} =-2.507*	1.374	γ'_{L4} =-0.584
irlandland	γ_{T5} =0.339	0.240	γ'_{T5} =0.087	γ_{L5} =-3.373*	1.759	γ'_{L5} =-0.716
hhsex	γ_{T6} =0.906*	0.510	γ'_{T6} =0.223	γ_{L6} =-0.960	0.674	γ'_{L6} =-0.255
hhage	γ_{T7} =-0.043**	0.021	γ'_{T7} =-0.011	γ_{L7} =0.046*	0.025	γ'_{L7} =0.011
hhfamex	γ_{T8} =0.016	0.017	γ'_{T8} =0.004	γ_{L8} =-0.036*	0.020	γ'_{L8} =-0.008
hhedu	γ_{T9} =0.004	0.057	γ'_{T9} =0.001	γ_{L9} =-0.140*	0.075	γ'_{L9} =-0.029
ofa99d	γ_{T10} =-0.350	0.348	γ'_{T10} =-0.087	γ_{L10} =-0.425	0.487	γ'_{L10} =-0.082
marketd	γ_{T11} =-0.025	0.034	γ'_{T11} =-0.006	γ_{L11} =-0.029	0.055	γ'_{L11} =-0.005
aavdist	γ_{T12} =0.011	0.016	γ'_{T12} =0.003	γ_{L12} =0.036	0.026	γ'_{L12} =0.007
sr2	γ_{T13} =0.007	0.413	γ'_{T13} =0.002	γ_{L13} =-0.523	0.584	γ'_{L13} =-0.113
sr3	γ_{T14} =0.389	0.691	γ'_{T14} =0.094	γ_{L14} =-3.655**	1.631	γ'_{L14} =-0.665
sr4	γ_{T15} =-0.200	0.632	γ'_{T15} =-0.048	γ_{L15} =-3.933*	1.118	γ'_{L15} =-0.722
sr5	γ_{T16} =-0.373	0.703	γ'_{T6} =-0.091	γ_{L16} =-3.394*	1.112	γ'_{L16} =-0.679

Observations=318

Wald $\chi^2(32)$ =120.59

Prob> χ^2 =0.00

log- pseudolikelihood =-220.10

Test for IIA excluding tenant group: χ^2 = 16.21 and p = 0.50

Test for IIA excluding landlord group: χ^2 = 7.06 and p = 0.98

Frequencies of actual & predicted outcomes

	Predicted			
Actual	Tenant (PT)	Landlord (PL)	Non-participant (PNP)	Total
tenant (T)	65	0	43	108
landlord (L)	3	45	15	63
non-participant (NP)	32	13	102	147
Total	100	58	160	318
% of correct prediction	65	77.5	63.5	66.67

* Significant at 10%; ** significant at 5%; *** significant at 1%. One observation was dropped from the analysis due to missing data for one variable.

Table 6

T-Test of Equality of Means of Land and Factor Ratios between Household Types

Variable	P-value				
	L and NP	L and T	NP and T	PT and PNP [b]	PT and T
Land owned (*landow*)	0.17	0.39	0.001	na[c]	na
Land operated (*fsize*)	0.00	0.00	0.00	na	na
land owned per adult labor	0.00	0.00	0.07	0.04	0.50
land operated per adult labor (post-lease)	0.00	0.00	0.00	na	na
number of bullocks per unit of land owned (pre-lease)[a]	0.00	0.00	0.02	0.01	0.58
number of bullocks owned per unit of land operated(post-lease) [a]	0.00	0.00	0.16	na	na

[a] Bullock/land ratio for landlord households was calculated for 36 (out of 64) households since land cultivated was zero for the remaining households. [b] PT refers to non-participant households that were predicted to be tenants (32 in total) and PNP refers to non-participant households that were predicted to be non-participants (102 in total). The distinction is based on the frequencies of actual and predicted outcomes given at the bottom of Table 5. [c] na = not applicable.

Table 7

Determinants of Land Rented-in: Equation [13] [a]

Variables	H-L model		Deaton model	
	coefficients	robust se.	coefficients	robust se.
constant	β_{T0}=-1.548	1.504	3.260**	1.548
malelabor	β_{T1}=0.514	0.326	0.508	0.330
femallabor	β_{T2} = -0.593***	0.247	-0.625***	0.250
bullocks	β_{T3} = 1.157***	0.329	1.111***	0.298
vlavland	β_{T4} = 4.113***	1.067	4.023***	1.253
irland	β_{T5} = 0.391***	0.120	0.383***	0.139
hhsex	β_{T6} = 1.833***	0.648	1.841***	0.709
hhage	β_{T7} = -0.078**	0.033	-0.081***	0.035
hhfamex	β_{T8} = .0460 **	0.024	0.050**	0.024
hhedu	β_{T9} = .119**	0.062	0.126**	0.063
Ofa99d	β_{T10} = -0.442*	0.308	-0.434	0.311
marketd	β_{T11} = -.080**	0.035	-0.080**	0.039
aavdist	β_{T12} = -0.012	0.012	-0.012	0.011
sr2	β_{T13} = -1.136***	0.347	-1.153**	0.337
sr3	β_{T14} = -0.244	0.611	-0.240	0.615
sr4	β_{T15} = 0.953	0.843	0.849	0.874
sr5	β_{T16} = -0.330	0.622	-0.416	0.685
landow [a]	β_{T17} = -0.916***	0.288	-0.895**	0.313
lambda	λ_T = 2.271**	1.027		
Prob.(I =T)			-6.422***	2.835
[Prob.(I = T)]^3			2.782	2.759
Observations	318		318	
Percent censored	66		66	
F(18, 89)	5.47		F(19, 88)	5.84
Prob > F	0.00			0.00
R^2	0.56			0.56

[a] The null hypothesis of *landow* = -1 could not be rejected with F (1, 89) = 0.08 and Prob > F = 0.78 for H-L model and F (1, 88) = 0.36 and Prob > F = 0.55 for Deaton model.

Table 8

Determinants of Land Rented-out: Equation [13][a]

Variables	OLS		Tobit: Interval regression	
	coefficients	robust se.	coefficients	robust se.
constant	β_{L0} = -1.581	1.261	-1.909	1.243
malelabor	β_{L1} = 0.132	0.605	1.009***	0.403
femallabor	β_{L2} = 0.320	0.326	0.033	0.311
bullocks	β_{L3} = 0.755***	0.288	1.724***	0.311
vlavland	β_{L4} = 0.683	0.742	2.099	1.458
irland	β_{L5} = 0.210	1.183	1.136**	0.509
hhsex	β_{L6} = 0.141	0.896	0.720	0.614
hhage	β_{L7} = -0.011	0.014	-0.037**	0.019
hhfamex	β_{L8} = 0.031**	0.014	0.039	0.016
hhedu	β_{L9} =0.065	0.106	0.141	0.077
Ofa99d	β_{L10} = -0.099	0.438	0.271	0.397
marketd	β_{L11} = 0.050	0.036	0.078**	0.038
aavdist	β_{L12} = 0.022	0.019	-0.010	0.024
sr2	β_{L13} = -0.447	0.512	-0.119	0.469
sr3	β_{L14} = 0.373	0.529	2.269**	1.106
sr4	β_{L15} = 0.587	0.602	2.631***	0.722
sr5	β_{L16} = -0.176	0.788	2.034***	0.800
landow[b]	β_{L17} = -0.780***	0.288	-0.933***	0.331
sigma			1.671	0.144
Observations	63		observations [b]	210
F(17,45)	7.04		Wald $\chi^2(17)$	168.82
Prob > F	0.00		Prob > χ^2	0.00
R^2	0.58		Log pseudolikelihood	-160.11

[a] test of the null hypothesis that *landow*= -1 could not be rejected with F (1, 45) =0.58 and Prob > F = 0.45 for the OLS model and $\chi^2(1)$ = 0.04 and Prob > χ^2 = 0.84 for the Tobit model. [b] The number of observations for Tobit model is the sum of non-participant and landlord households.

Table 9

Test of Equality of Marginal Effects on Opposite Sides of the Land Rental Market

Prob.(I = T) vs. Prob.(I = L)		Land rented-in vs. land rented-out [b]	
Hypothesis tested	Wald statistic: $\chi^2(r)$ [a]	Hypothesis tested	$\chi^2(r)$
		$\beta_{T0} = \beta_{L0}$	0.01(1)
$\gamma'_{T1} = \gamma'_{L1}$	1,50(1)	$\beta_{T3} = \beta_{L3}$	1.59(1)
$\gamma'_{T2} = \gamma'_{L2}$	0.17(1)	$\beta_{T8} = \beta_{L8}$	0.20(1)
$\gamma'_{T3} = \gamma'_{L3}$	11.03(1)***	$\beta_{T17} = \beta_{L17}$	0.00(1)
$\gamma'_{T4} = \gamma'_{L4}$	0.09(1)		
$\gamma'_{T5} = \gamma'_{L5}$	2.79(1)*		
$\gamma'_{T6} = \gamma'_{L6}$	0.02(1)		
$\gamma'_{T7} = \gamma'_{L7}$	0.00(1)		
$\gamma'_{T8} = \gamma'_{L8}$	0.42(1)		
$\gamma'_{T9} = \gamma'_{L9}$	1.62(1)		
$\gamma'_{T10} = \gamma'_{L10}$	0.00(1)		
$\gamma'_{T11} = \gamma'_{L11}$	0.01(1)		
$\gamma'_{T12} = \gamma'_{L12}$	0.00(1)		
$\gamma'_{T13} = \gamma'_{L13}$	0.36(1)		
$\gamma'_{T14} = \gamma'_{L14}$	7.89(1)***		
$\gamma'_{T15} = \gamma'_{L15}$	13.85(1)***		
$\gamma'_{T16} = \gamma'_{L16}$	6.76(1)***		
		Joint [c]	158(18)***

* Significant at 10%, ** significant at 5%, *** significant at 1%.

[a] r = number of restrictions. [b] The pair-wise test is only for variables that were found to be significant on both sides of equation [13]. [c]The joint test is for equality of all the coefficients on both sides of the market