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Factors affecting renting in and renting out of land in a semi-arid economy of Tigrai, northern Ethiopia: a generalized random effect order probit model

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

Factors affecting renting in and renting out of land in a semi-arid economy of Tigrai, northern Ethiopia: a generalized random effect order probit model

Menasbo Tesfay^{1*}

Abstract: In the absence of land sale, the emerging of land rental market among smallholder farmers in developing countries has important implications on land use efficiency, productivity and poverty reduction. The purpose of this study is to analyze jointly the socio-economic factors undertaking decisions renting in and renting out of land in a land scarce and semi-arid economy of Tigrai, northern Ethiopia, using a generalized random effect order probit model. The model result reveals that decisions to rent in and/or rent out of land are significantly correlated, implying that standard order probit model analysis of such decisions are biased, thereby, justifying the use of a generalized random effect order probit approach. Model results show that some of the socio-economic factors affect farmers' renting in and renting out of land and work in the opposite directions. The likelihood of renting in land is high for farmers with better literacy rate and lived closer to the land. On the other hand, the likelihood of renting out of land is high among the illiterate farmers and lived far distant to their lands. Government policy has an important role to play in improving the factor equalization role of the land rental markets through investment in human capital and infrastructural development.

Subjects: Statistics for Social Sciences; Economics; Environmental Economics

Keywords: Land rental; generalized order probit; northern Ethiopia

JEL classification: D23; D61; Q15

1. Introduction

The emerging of land rental market in developing countries is an important attempt to address land use efficiency, equity and poverty reduction. In the absence of land sale as it is made in Ethiopia and factor market imperfection such as labor, oxen, and credit, the land rental market plays an important role in adjusting land to non-land resource endowment ratio. In the reverse share tenancy, where a tenant is relatively wealthier than a landlord, the land use right transfer from land rich, but poor in non-land resource to land poor, but rich in non-land resource, has generally been benefited the poor especially aged and female-headed households (Ghebru & Holden, 2015). Secured land use right encourages poor households to rent out their land to the efficient operator, and they get better income and reduce the severity of food deficiency (Holden et al., 2013).





After instituting the market-based economic system in Ethiopia in 1991, the government has lifted the restraint of land used transferred and land leased that was practiced during the command economy. Waiving this restriction has created a favorable condition for the emerging and facilitation of the land rental market process among smallholder farmers (Gebregziabher & Holden, 2011). The institutionalization and endorsement of national rural land use proclamation in Ethiopia (proclamation no. 89/1997) have also confirmed a solid ground for the formalization of land rental market process among smallholder farmers. Moreover, the implementation of land registration and land certification reform in 1998/99 at regional level enhanced tenure security of landholders and improved the land rental market participation process among smallholders in land scarce and semi arid region of Tigrai, northern Ethiopia (Holden & Ghebru, 2011).

There is a growing body of empirical literature on the development of land rental market in developing countries, particularly in sub-Saharan Africa (Chamberlin & Ricker-Gilbert, 2016; Deininger et al., 2008; Gebregziabher & Holden, 2011; Holden & Ghebru, 2013). Holden and Ghebru (2013) illustrate the basic thoughtful of land rental market in Africa and its multiple features such as the types of land rental market transactions, access to and extent of land rental market participation, and constraints. The authors also stated that land rental market plays an important role in land equity, land productivity and poverty reduction of smallholder farmers. Deininger et al. (2008) assess the impact of land registration and land certification reform on land rental market of the landlord households in northern Ethiopia. They found that participation in the land rental market has positive effect on land productivity and farm income, especially for femaleheaded households. The intuition is that land certification improves the land tenure security of landholders and more secured property right increases participation in the land rental market, and welfare of poor households. Chamberlin and Ricker-Gilbert (2016) found that secured property right explains positively land rental market participation among Malawian and Zambian farmers. Post weather shocks, landholders in northern Ethiopia have an experience of participation in the land rental market. This is a form of distress land rental as coping mechanism and landlords want to meet immediate needs in the fixed rental contract or to reduce future food purchase in the share cropping after such shocks (Gebregziabher & Holden, 2011). This may also enhance tenant households access to land through renting in the year after shocks.

In the study region, majority of farm households are smallholders Gebregziabher and Holden (2011), where production and consumption decisions are made simultaneously. A household would like to participate in the land rental markets (i.e., as landlord, self-operator or tenant) depends on the comparative advantage of participation and non-participation.¹ This typifies that farm households decide to cultivate their land by themselves, rent out, or seek extra unit of land depending on the expected benefit packages (Holden et al., 2007). Jin and Jayne (2013) on the other hand, use four rounds of panel data and apply the pooled order probit model to assess factors affecting renting in and renting out of land among Kenyan farmers. In their approach, they use household endowments as an independent variables and faced serious estimation problem. Infact, in the panel data set, households' endowment variables adjust themselves overtime and inhibited strict exogeneity nature of the variables and create bias estimates.

Similarly, Jin and Deininger (2009) use four rounds of panel data from China and assess the determinants of land renting in and renting out decisions. They used standard order probit model and results show that a given variable reveals the same effect for tenant as well as landlord households. Conversely, tenant and landlord households are different peoples with different motives and a given variable may not have the same causal effect on land renting in and renting out decision a point in time. Given these backgrounds, the aim of this paper is to address what factors influence the likelihood of decisions on renting in and renting out of land among smallholders in a semi arid economy of northern Ethiopia ? To answer this research question, the study used three round surveys covering a 10-year period panel data of 960 farm households and a generalized random effect order probit model. Although this is not the first study that deals with factors affecting renting in and renting out of land decisions in developing countries, it is among the very few studies that utilizes long

and rich farm household-level panel data and applied meticulous econometrics method of estimation and identification strategies that enriched the previous works.

Moreover, the current study contributes to the existing literature in the following ways: First, contextually. As the emerging of land rental markets in Ethiopia has short history (after the removal of command economy in 1991), little is known about the key factors that influence the decisions to rent in or to rent out the land among smallholders. In an environment of incomplete factor markets and constitutionally restricted land sales (Ethiopia), farmers' initial factor endowments, such as owned land, family labor, and other socio-economic characteristics influence decisions on renting in or renting out of land is new market version to the study area .

Second: data, the current study is among the very few studies that deploy long and rich farm household level panel data that enriches the previous empirics through fixing the individual unobservable heterogeneity effect. Moreover, most of previous land rental market studies in developing countries use rainfall data from district level weather station records that is in general sets to cover wider geographical areas and thus their use as climate shock variables at micro level could be less meaningful in this case. The current study deploys rainfall intensity and rainfall variability data computed at community level from monthly satellite record of African Rainfall Climatology Version 2 (ARC2) precipitation estimates.

Third, methodologically, of course the standard pooled order probit model is possible to assess factors affecting renting in and renting out of land decisions in a panel data set. But the estimation process is undertaken in a single estimation route and a given variable estimates the same causal effect for the likelihood of renting in and renting out decisions. This procedure usually assumes that the estimated coefficients (in sign and magnitude) of independent variables do not vary between the likelihood of renting in and renting out decisions (Bellemare, 2009; Jin & Deininger, 2009; Jin & Jayne, 2013).

Fourth, the standard pooled order probit and random effect probit models compromise the effect of unobservable individual heterogeneity effect for some time-invariant control variables. Thus, these models lack to use an appropriate identification strategies and the validity of the estimated results are less reliable. Therefore, the current study aims to fill the methodological gap of previous works using the recently evolved method of estimation i.e., a generalized random effect ordered probit model. The advantageous of this model enables us to examine the decision making process of a single farmer who engages with the land rental market both as a tenant and a landlord at the same time. This method is the first in its kind when applied in the land rental market specifications and the application of this method for the subject matter is considered as the novelty of the current study.

The output of this study may potentially become an important avenue for policy makers to outline appropriate interventions to reduce the pervasive transaction costs associated with land rental markets and to enhance the efficiency of the existing renting in and renting out of land decisions among smallholders in developing countries.

The rest of the paper is structured as follow: Section 2 deals with the review of empirical literature. Section 3 discussed about the conceptual framework of renting in and renting out decisions. In section 4, data source and variables of interest for the analysis are discussed. The second part of section 4 also deals with the econometric model specifications. The descriptive statistics and results of the regression analysis are presented in section 5, followed by conclusions and policy implications in section 6.

2. Review of empirical literature

Understanding the factors affecting participation in the land rental market in a semi-arid economy of developing countries like Ethiopia is important for (a) the high population growth of the country leads to lower per-capita land holdings, (b) the prevalence of agricultural risk

expressed interms of weather shock, encountered shortfall on agricultural production and food security of the rural society, (c) the underdevelopment of social and economic infrastructure and the prevsasive high cost of information, (d) concerns about the unequal distributions of landholdings due to some legal restirctions like prohibition of farm land sale, and (e) the presence of incomplete factor markets (Holden & Otsuka, 2014). Earlier studies of decisions on participation in the land rental market have aimed to assess the efficiency and effectiveness of land use among smallholders farmers through adjusting the cultivable farm size to their intended optimal farm size (Bliss & Stern, 1982; Skoufias, 1995). This has been supported more by the recent study of Ghebru and Holden (2015) in semi-arid regions of developing countries that participation in renting in and renting out of land is increasingly evolved through transferring of land use right from land rich but poor in non-land resources to land poor but rich in nonland resource farmers. Consistent to this, the study of Chamberlin and Ricker-Gilbert (2016) in Malawi and Zambia revealed that participation in the land rental market contributes for efficiency gains within the smallholder sector by facilitating the transfer of land from less-able to more-able producers, on average. However, due to the pervasive transaction costs and prevalence of imperfect factor markets, in developing countries, allocative inefficiency of the land rental market process is dominant characteristic of smallholder agriculture (Holden et al., 2009).

The analytical portion of this paper, however, primarily focuses on examining potential determinants of land renting in and renting out decisions in developing countries (Ethiopia). This is because land lease is one means of livelihood of smallholder farmers in the study area. There are many factors possibly affect decisions of renting in and renting out of land among smallholders in developing countries such as family labor endowment, infrastructure, and institutional services. But, the size—ratio of land to non-land resources takes the greater share (Chamberlin & Ricker-Gilbert, 2016). In recent years, governments of developing countries including Ethiopia give high attention to secure land tenure of smallholders through provision of land registration and land certification reform. This in turn improves the participation of land rental market among smallholders especially the poor and female headed households (Menasbo et al., 2019).

Different studies have analyzed determinants of decisions on land rental market participation from the demand and supply sides. For instance, Chamberlin and Ricker-Gilbert (2016) using panel data from Malawi and Zambia notified that household endowment proxy by agricultural inputs strongly and positively affect the probability of renting in land while return from agricultural activities influences positively the likelihood of renting out of land. The intuition is that wealthier farmers have relatively better potential of neutralizing risk effects associated with agriculture and pursue to cultivate extra unit of land through renting in. On the other hand, better agricultural return makes powerful to poor households economically and motivated to rent out their land. Feng and Heerink (2008) using cross-sectional data from rural China assessed factors that influence the likelihood of renting in land. They used institutional factors such as social network in the right hand side of renting in land model specification and found a positive and significant effect. The idea is that a farmer with better social network enables to reduce the transaction costs of searching potential partner and improves the likelihood of renting in land compared to farmers with limited social network. However, there is a specification problem. Institutional variables are possibly endogenous variables and treated as a control variables lead to bias estimates. In addition, the study fails to take any attempt to fix the endogeneity problem using any of the appropriate remedies.

Using four rounds of panel data and standard order probit model, the study of Jin and Deininger (2009) assesses factors affecting the probability of renting in and renting out of land in rural China. In their estimation process, asset values are treated as an exogenous regressor and results revealed positive and significant effect on the likelihood of renting out land while negative and significant effect on the likelihood of renting in land. However, their findings has faced an identification strategy problem. First, asset values are naturally endogenous variables and treated these as a control variables create biased estimates. Second, asset values are endowments(wealth), and in the panel data set, they adjust themselves over time and loss their exogeneity. Third, standard order probit estimation method disregards to control the possible biases from the unobservable individual heterogeneity effect of some

time- invariant control variables. Consistent to this, Deininger and Jin (2005) use three rounds of panel data and random effect probit model to assess factors influencing participation of renting in and renting out of land in rural China. They found that non farm assets affect the probability of renting out of land positively at high level of significance.

On the other hand, Sanzidur (2010) using cros- sectional data from Bangladesh, and probit model results, show that capital assets affect positively and significantly the likelihood of renting in land while non -agricultural income affects negatively and significantly the probability of renting out of land. But, none of these studies attempt to fix the problem of endogeneity and unobservable individual hetero-geneity effect as capital assets and non -farm income are likely endogenous variables.

In a perfect factor market, access to credit influences participation in the land rental market. While in developing countries credit market is missing or incomplete, farm households unable to take a loan and rented in land against future profits. The general idea is that financial institutions decline to provide loan for farmers, especially smallholders. This is because the collateral endowment is agricultural land which is exposed for various types of risks and financial sectors become risk averse on default loans (Liesbet & Johan, 2006). The review of empirical literature for this study reveals that though previous works have invested much effort on the determinants of participation decisions in the land rental market from the tenant and landlord households, there are no comprehensive studies that have systematically addressed the problem of observable and unobservable heterogeneity effects and the corresponding remedies as well. To fill this methodological gap, this study attempts to deploy the recently evolved method of analysing renting in and renting out of land simultaneously.

3. Conceptual framework

The conceptual framework for the land rental market participation and factors affecting it builds on Jin and Deininger (2009). In a unitary household model, a farmer experiences a utility maximization problem with U = u(y, l), where y is income and l is leisure. U is strictly concave in y and l and twice differentiable (i.e., U' > 0. and U'' < 0). Households' income is captured from three sources: (a) from agricultural production, (b) from off- farm employment, and (c) from participation in land rental market.² Farm household allocates its family labor endowment into own farm activities (L_A) and supply the remaining for labor market (L_w) at an exogenous wage. The land rental market process is managed with transaction cost (Jin & Deininger, 2009; Jin & Jayne, 2013). This cost includes the collection of land rental market information, searching and screening of potential partner (lender or borrower), and enforcing the rental contract. Transaction cost negatively affects the livelihood of both landlord and tenant households, but in different ways. For a landlord household, cost of renting out extra unit of land is (α -TC^{out}). Where α the fixed land rental market benefit or share of output expected to gain from share cropping and TC is transaction cost accounted from renting out one extra unit of land. On the other hand, tenants' cost of renting in extra unit of land is $(1 - \alpha) + TC^{in}$. To acquire $(1 - \alpha)$ share of output, tenant household has incurred actual investment cost on the rented in land and TC is the transaction cost accounted from renting in one extra unit of land. The nature of transaction cost is deduction(minus) cost from the benefit of output share to the landlord households, while it is an added(plus) cost to the rented in land investment of tenant households. Given share cropping is the dominant land rental contract arrangement in the study region Ghebru and Holden (2015), and proportional transaction cost increases with the extent of rented in and rented out of land, households' decision problem of renting in or renting out extra unit of land is formulated as follows:

$$\mathsf{Max} \ \mathbf{U} = (\mathbf{y}.\mathbf{I}) \tag{1}$$

Subjected to:

$$y = PQ(Z_{A,L_{A}}) + I^{out}(\alpha - TC^{out})Z_{1} - I^{in}((1-\alpha) + TC^{in})Z_{2} + wL_{w}$$

$$\tag{2}$$

$$\bar{Z} = Z_A + Z_1 - Z_2 \tag{3}$$

$$\overline{L} = L_A + L_W + l \tag{4}$$

Where y is full income. P is output price, and Q is crop production and it is a function of cultivable land size (Z_A) , and extent of agricultural labor $(L_A).\overline{Z}, Z_A, Z_1 and Z_2$ are the pre-rental land endowment of household, cultivable land size, extent of area rented out and extent of area rented in, respectively. Likewise, \overline{L}, L_A, L_W and l denote farm households' labor endowment, labor allocated to own farm activities, household labor supply to labor market, and leisure, respectively. W is an exogenous labor wage rate. I^{in} and I^{out} are renting in and renting out of land decision participation identifiers, respectively. Assuming equation (3) above holds, the optimum choice of Z_A solves the First Order Condition (FOC):

$$U_{y}pQ'Z_{A} - U_{y}I^{out}(\alpha - TC^{out})Z_{1} - I^{in}((1 - \alpha) + TC^{in})Z_{2} \le 0$$
(5)

Which gives us:

$$pQ'Z_{A} = I^{out} \left(\alpha - TC^{out} \right) Z_{1} - I^{in} \left((1 - \alpha) + TC^{in} \right) Z_{2}$$
(6)

In a perfect land rental market, the land rental fee is shared output (α) exclusively decided per unit of land renting in or renting out. This shared output is often equal to the marginal product of the land under transaction. But, in developing countries, land rental market is imperfect, the land rental process accompanies with high transaction costs as discussed in equation (6), and the firstorder condition of land for Z₁ and Z₂ are derived as follows:

3.1. Z₁(rented out.I^{out} = 1, 0 otherwise)

$$-pQ'Z_{A} + (\alpha - TC^{out}) \le 0. \& Z_{1}(-pQ'Z_{A} + (\alpha - TC^{out}) = 0$$
(7)

Where P is output price, and $Q'Z_A$ is marginal product of cultivable land. Household chooses to participate in land rental market as a landlord when the transaction cost adjusted expected benefit ($\alpha - TC^{out}$) is higher than the marginal product of self-operated land ($Q'Z_A$). Equate both sides of equation (7) gives:

$$Q'Z_A \le (\alpha - TC^{out})$$
. Then $Z_1 > 0$. (8)

As far as the marginal product of self-operated land is less than or equal to the transaction cost adjusted benefit a household is expected to receive, household decides to rent out and the extent of renting out of land is positive. However, if

$$Q'Z_A > (\alpha - TC^{out})$$
. and then $Z_1 = 0$. (9)

The marginal product of self-operated land is greater than the transaction cost adjusted benefit, household decides not to rent out and amount of rented out of land is zero.

3.2. Z_2 (rented in. $I^{in} = 1$, 0, otherwise)

$$-pQ'Z_{A} + \left((1-\alpha) + TC^{in}\right) \le 0.\& Z_{2}(pQ'Z_{A} - \left((1-\alpha) + TC^{in}\right) = 0$$
(10)

$$Q'Z_{A} > \left((1-\alpha) + TC^{in}\right) \text{ and } Z_{2} > 0$$
(11)

Similarly, tenant household is accessed to extra unit of land provided that the marginal product of renting in (evaluated at the level of own land endowment, $Q'Z_A$) is to be greater than the investment cost of collecting $(1 - \alpha)$ output share plus renting in transaction cost (TC^{in}). On the other hand,

$$Q'Z_A < ((1-\alpha) + TC^{in})$$
 and then $Z_2 = 0$ (12)

If the marginal product of extra unit of renting in land (evaluated at the level of own land endowment, $Q'Z_A$) is less than the corresponding land rental expenses $((1 - \alpha) + TC^{in})$, household decides not to rent in and the extent of renting in land is zero.

Finally, the self-operator household decides to remain independently to the land rental market, the marginal product of extra unit of self-operated land is greater than the transaction cost adjusted benefit received as a landlord and less than the transaction cost adjusted rental payment expect to pay as a tenant. Therefore, farm households' decision to participate in the land rental market ultimately depends on the relation between the marginal product of self-operated land and transaction cost adjusted rental payment or benefit under a set of constraints. Based on the FOCs above, farm household is summarized in one of the following three exclusive land rental market regimes:

Rent out (landlord)
$$(Z_1 > 0) = Q'Z_A \le (\alpha - TC^{out})$$
 (13)

Self-operated (Autarky)
$$(Z_1 = Z_2 = 0) = (\alpha - TC^{out}) < Q'Z_A < (\alpha + TC^{in})$$
 (14)

Rent in (tenant)
$$(Z_2 > 0) = Q' Z_A \ge \left(\alpha + TC^{in}\right)$$
 (15)

On the one hand, the higher transaction cost, the more self-operated households and demotivated to participate in the land rental market (Jin & Deininger, 2009). On the other hand, production risk, variations in human capital and non-land resource constraint, and households with relatively high per capita land participated in the land rental market as a landlord (Sanzidur, 2010). Based on the above discussion, the following hypotheses are formulated for empirical tests.

(H₁): Pre- rental owned farm size has a positive and significant effect on the likelihood of renting out of land, while it has a negative and significant effect on the likelihood of renting in land.

(H₂): Transaction cost proxy by distance to plot has a positive and significant effect on decision of renting out of land, while negative and significant effect on decision of renting in land.

(H₃): Rainfall has a lagged positive effect on land access to tenant households, while a lagged negative effect to landlord households in the land rental market.

4. Data and method of analysis

4.1. The data

The data used in this paper come from a balanced panel of 320 households surveyed in 2005/06, 2009/10 and 2014/15 production seasons from rural Tigrai, northern Ethiopia. All households in the sample were rural landholders with farming as the main source of livelihood (crop and livestock production). To get representative households, a two-stage sampling technique was applied. In the first stage, communities were stratified based on variations in agricultural production potential, access to irrigation and market, population density, and agroecology diversification. In the second stage, a random sample of 24 to 25 households were taken from the sampled communities for a detailed interview. In the subsequent surveys, there was no attrition except for some changes in the household headship that implied changes in the gender and/or age of some households' headship. Moreover, in a long panel data set, unit of analysis is the land. If the household head that was interviewed in the earlier survey died or migrated, the household remains in the sample as long as the household and its plots are still managed by an existing member of the household who steps into the headship either as a spouse or descendant family member (son/daughter).

The household-panel survey data consist of detailed questions of household composition and socio-economic characteristics, land rental market participation status. Sample household were categorized into three rental market regimes. First, landlord households those who either part or all of their plots rented out. Second, tenant households those who own land but seek extra land to adjust with their non-land resource endowments in the share tenancy market. Third, self-operated households who manage their land themselves independently to the land rental market. The main concern of this study focuses on landlord and tenant households who participate in renting out and renting in land, respectively. The household and farm plot survey was supplemented by community-level information such as access to the market, distance to all-weather roads, and rainfall data. The monthly mean rainfall data were captured from monthly satellite records at community level.

4.2. Model specification

The conceptual model is operationalized in order to estimate factors affecting the land rental market participation by tenant and landlord households using maximum likelihood estimation method. A balanced panel of 320 households were constructed in order to implement the estimation of a generalized random effect order probit model. It is noted that land rental market model specification has three outcomes. That is landlord, self-operated, and tenant. Following Jin and Deininger (2009), I sorted out the land rental market participation regimes in order of the outcomes that tenant (renting in land) with a value of "1", self-operated (neither renting in nor renting out of land) with a value of "0", and landlord (renting out land) with a value of "-1". With three outcomes variables of panel data set, previous studies use pooled order probit model to analyze the determinants of the land rental market participation in a single estimation (Bellemare, 2009; Jin & Deininger, 2009; Jin & Jayne, 2013). However, this method has two potential limitations: First, the traditional order probit model lacks to control the unobservable heterogeneity effect that appears in the data set. Second, magnitude and sign of estimated coefficients do not vary across the likelihood decisions of renting in and renting out of land. For example, if the independent variable changes (assume increases), the cumulative distribution of coefficient shifts either to the likelihood of renting in or the likelihood of renting out of land but not shift in the slope of the distribution¹ (see, Jin & Deininger, 2009; Bellemare, 2009; Jin & Jayne, 2013 for the detailed review). Thus, by relaxing the assumption of equal threshold (parallel line of assumption) for decisions in renting in or renting out of land, the generalized random effect order probit model has a merit to the pooled order probit model. In the generalized ordered probit model, the threshold parameters are individual specific and vary across the covariates for

renting in and renting out of land. In a panel data representation, the non-linear function of decisions on renting in and renting out of land is expressed as follows:

$$y_{ijt} * = \beta' X'_{it} + C_i + \varepsilon_{ijt}$$
(16)

Where y * is the non linear dependent variable that represents participation decision in the land rental market with value of (1/0) as a tenant, landlord or self-operated. X is a vector of explanatory variables explain the land rental market participation process. Selection of control variables is based on previous literature on land rental market process under transaction cost and input market imperfections (Skoufias, 1995). The control variables can be expressed as household features, household endowments, plot characteristics and community level factors. Young, male, and literate headed households are expected to participate in renting in land; while aged, female and illiterate headed households participate in renting out of land. The intuition is, young and literate headed households are well informed and better acquainted with updated economic and market information; that enable to exploit the opportunities from renting in land. Similarly, male headed households have better farming experience (more of labor activities) and motivated to cultivate relatively large size of land compared to their counter part, female headed households. In the study region, tenant households are wealthier than landlord households (reverse share tenancy), households with extra number of oxen, adult labor are expected to participate in the land rental market as a tenant compared to their counter part landlord households. β is a vector of unknown parameters expected to be estimated, and C is household level unobservable heterogeneity effect. ε is the unobserved factors that explain the land rental market participation. i, j & t are individual, land rental market participation regimes, and time identifiers, respectively. Following Wooldridge (2010), farm household participates in the land rental market regime jth if:

$$\Pr(\mathbf{y}_{it} = 1 | \mathbf{X}_{it}, \mathbf{C}_i) = F(-\mathbf{X}'_{it}\beta_1 - \mathbf{C}_i)$$
(17)

$$Pr(y_{jt} = 0|X_{it}, C_i) = F(-X'_{it}\beta_0 - C_i) - F(-X'_{it}\beta_1 - C_i)$$
(18)

$$\Pr(y_{jt} = -1|X_{it}, C_i) = 1 - F(-X'_{it}\beta_{-1} - C_i) j = 1,0 \& -1$$
(19)

I estimate the model with the *regoprob2* command for generalized random effect order probit model with auto-fit options in STATA 13.

5. Results and discussions

5.1. Descriptive statistics

The mean and standard errors of variables used in the econometric analysis are presented in Table 1. The data set contain 960 farm households of which on average, 47.3 % of households participated in the land rental market (i.e., about 23 % are tenant households and 24.3 % are landlord households). Majority of farm households were self-operators (52.7 %). The share of female-headed households account for 25.5%. The proportion of landlord households decreased from 24.1% in 2005/06 to 23.1% in 2009/10 and then increased to 25.6% in 2014/ 15 cropping season. On average, the proportion of tenant households account 28.1 % in 2005/ 06, this has been significantly decreased to 17.5 % in 2009/10 and sharply increased to 23.1 % in 2014/15 cropping season. From the data set, there is no consistent pattern of land rental market participation between landlord and tenant households given the panel nature of the data. This might be due to tough competition among tenant households to get a fraction of landlord households and perhaps some tenant households may exit from renting in

land in the subsequent production season. There is limited variation on owned land size across the survey periods, this may indicate that land distribution and redistribution happens infrequently in the study region.

Table 1 also indicates a variation on age category of sampled households across the survey periods. The proportion of heads with age less or equal to 35 years, defined as a young head has declined from 10.6 % in 2005/06 to 5.9 % in 2009/10 and significantly declined to 2.5 % in 2014/15 cropping season. That is expected. The panel (balanced) nature of the data tracks the same household in the following survey period and unable to include new and young entrants as land renters. In contrast, the proportion of household heads with age range between 35 to 60 years, defined as productive age slightly increased from 57.2 % in 2005/06 to 58.4% in 2009/2010, but significantly decreased to 44 % in 2014/15 cropping season. However, proportion of household heads with age above 60 years named as unproductive age is increased from 32.2 % in 2005/06 to 35.6% in 2009/ 10 and this has been significantly increased to 53.1 % in 2014/15 cropping season. This suggests that the greater portion of changes in the head's age has occurred in household heads more than 35 years.

Table 1. Summary statistics	of varia	bles use	d in the	econom	netric and	ilysis by	survey	year
	Survey period							
Variable's description	200	5/06	/06 2009/10 2014/15		Total			
Household is a tenant (yes = 1)	0.281	(0.025)	0.175	(0.021)	0.231	(0.024)	0.229	(0.0149
Households is landlord (yes = 1)	0.241	(0.024)	0.231	(0.024)	0.256	(0.024)	0.243	(0.014)
Household is self-operator (yes = 1)	0.522	(0.028)	0.597	(0.027)	0.544	(0.028)	0.554	(0.016)
Head's gender (female = 1)	0.253	(0.024)	0.250	(0.024)	0.263	(0.025)	0.255	(0.014)
Head's age < 35 years (yes = 1)	0.106	(0.017)	0.059	(0.013)	0.025	(0.009)	0.064	(0.008)
Head's age 35–60 years (yes = 1)	0.572	(0.028)	0.584	(0.028)	0.444	(0.028)	0.533	(0.016)
Head's age >60 years(yes = 1)	0.322	(0.026)	0.356	(0.027)	0.531	(0.028)	0.403	(0.016)
Head's education (illiterate = 1)	0.800	(0.022)	0.691	(0.026)	0.688	(0.026)	0.726	(0.014)
Family size (number)	5.628	(0.135)	5.356	(0.132)	5.806	(0.137)	5.597	(0.078)
Male adult (number)	1.500	(0.064)	1.647	(0.072)	2.172	(0.079)	1.773	(0.043)
Female adult (number)	1.460	(0.047)	1.419	(0.054)	1.418	(0.066)	1.531	(0.033)
Dependent family (number)	2.900	(0.079)	2.763	(0.074)	2.303	(0.068)	2.675	(0.044)
Oxen own, dummy (yes = 1)	0.596	(0.027)	0.606	(0.027)	0.621	(0.027)	0.608	(0.016)
Oxen own (number)	0.938	(0.055)	0.994	(0.052)	1.006	(0.055)	0.979	(0.031)
Access to credit, dummy (yes = 1)	0.419	(0.028)	0.398	(0.027)	0.453	(0.028)	0.423	(0.016)
Livestock (TLU)	1.353	(0.088)	1.584	(0.091)	3.579	(0.191)	2.172	(0.083)
Distance to market (hour)	1.374	(0.023)	1.484	(0.050)	1.373	(0.054)	1.410	(0.026)
Distance to all weather road (hour)	2.930	(0.096)	2.925	(0.094)	2.635	(0.097)	2.830	(0.055)
Own land (ha)	0.958	(0.041)	0.950	(0.036)	0.932	(0.038)	0.947	(0.022)
Share cropping rental (yes = 1)	0.988	(0.006)	0.981	(0.008)	0.919	(0.015)	0.963	(0.006)
Mean rainfall 2 years lag (mm)	66.042	(1.897)	98.392	(2.822)	116.856	(2.293)	93.764	(1.525)
Rainfall variability 2 years lag (mm)	46.757	(0.757)	51.483	(1.215)	83.036	(1.214)	60.425	(0.813)
Distance to plot (hr)	0.453	(0.026)	0.452	(0.028)	0.511	(0.026)	0.472	(0.015)

Number in parentheses are standard errors. Source: NUMBU and MU household panel survey.

The literacy status of household heads also shows that 72.6 % of heads were without formal education implying that farming demands more labor with low human capital. Almost 60% of farm households own at least one ox, given its importance in farming activities. Sharecropping rental contract arrangement is dominant in the study area and it accounts about 96.3% of the sampled households.

The mean and statistical difference of key control variables of landlord and tenant households are presented in Table 2. Tenants and landlords are distinguished in terms of household head's characteristics, households' resource endowment expressed in terms of family labor, oxen, and total livestocks. There is a significant difference between gender and age of landlord and tenant headed households in all of the three age categories. This implies that on average, the greater portion of landlord households were headed by female and aged people where less likely to operate their land by themselves. The data set also depicted that landlord households are poorer than tenant households in terms of oxen and total livestock unit and the difference is statistically significant at the 1 % level. There is no significant variation in the extent of own landholdings between the landlord and tenant households. This may indicate that the driving force of participating in the land rental market from the supply and demand side is partly departed from the inequality of extent of land ownership among the smallholders.

5.2. Econometric results

The results of a generalized random effect order probit model for decisions in renting in and renting out of land are presented in Table 3. I used two alternative model specifications, the standard order probit model and the generalized random effect order probit model. The standard order probit estimation allows the same vector of parameter for each outcome. This implies that variables that affect the likelihood decision of renting in land and renting out of land were taken from one estimation and interpreted as the pathway that will lead to the

Table 2. Mean comparison of selected variables across landlord and tenant households							
Variable's name	Tenants	(N = 214)	Sig diff.	Landlords (N = 244)			
Head's gender (female = 1)	0.084	(0.019)	<***	0.463	(0.031)		
Head's age is ≤ 35 year(yes = 1)	0.037	(0.012)	<**	0.069	(0.016)		
Head's age 35– 60 years (yes = 1)	0.649	(0.032)	>***	0.483	(0.032)		
Head's age > 60 year (yes = 1)	0.313	(0.031)	<***	0.446	(0.031)		
Head's education (illiterate = 1)	0.621	(0.033)	<***	0.778	(0.026)		
Male adult(number)	2.18	(0.087)	>***	1.34	(0.080)		
Female adult (number)	1.64	(0.067)	>***	1.34	(0.066)		
Oxen owned (number)	1.490	(0.070)	>***	0.561	(0.054)		
Tropical Livestock (LTU)	3.23	(0.188)	>***	1.52	(0.153)		
Own land (ha)	0.964	(0.053)		1.02	(0.048)		

Note: *** & **, refers significant level at 1 % & 5 %, respectively. Numbers in parentheses are standard errors Source: NMBU and MU household panel.

probability of renting in or renting out of land. The estimation process assumes that coefficients and magnitudes of control variables are quite the same for the likelihood of renting in and renting out of land. Moreover, the standard order probit estimation method disregards to control the possible unobservable heterogeneity effect of some time in-variant control variables (Pfarr et al., 2010). To fix such methodological problems, this study applies the generalized random effect ordered probit model and allows different vector of parameters for the likelihood decisions of renting in and renting out of land. This means that the model assesses and controls the unobservable heterogeneity effect in the threshold parameters as well as in the mean of the regression. Also, it helps to estimate the two categorical outcomes (likelihood of renting in and renting out) simultaneously with the auto fit option. The estimation procedure starts by testing the parallel lines of assumption using 5% level of significance as follows:

Step 1: Constraints for parallel lines imposed for head's sex (P Value = 0.9886)

Step 2: Constraints for parallel lines imposed for Ownland ha (P Value = 0.8148)

Step 3: Constraints for parallel lines imposed for oxenqty (P Value = 0.8021)

Step 4: Constraints for parallel lines imposed for rainfall variability of two years lag (P Value = 0.3804)

Step 5: Constraints for parallel lines imposed for head's age b/n 35 to 60 years (P Value = 0.2318)

Table 5. Factors are calling tand rental market participation (kenting in and renting out)									
	Generalized order probit								
Explanatory variable	Rentir	ng in	Renting out		Pooled order probit				
Head's gender (female = 1)	-0.800***	(0.127)	-0.800***	(0.127)	-0.765***	(0.126)			
Head's age > 35 years (yes = 1)	0.370**	(0.193)	0.370**	(0.193)	0.326*	(0.193)			
Head's age b/n 35 to 60 years (yes = 1)	0.240**	(0.095)	0.240**	(0.095)	0.243**	(0.095)			
Male adult (number)	0.158***	(0.038)	0.158***	(0.038)	0.151***	(0.038)			
Female adult (number)	0.070	(0.045)	0.070	(0.045)	0.067	(0.045)			
Oxen owned (number)	0.277***	(0.059)	0.277***	(0.059)	0.270***	(0.058)			
Own land (ha)	-0.268***	(0.079)	-0.268***	(0.079)	-0.230***	(0.078)			
Tropical Livestock (TLU)	0.021	(0.022)	0.021	(0.022)	0.020	(0.022)			
Plot distance from home (hr)	-0.696***	(0.135)	0.251*	(0.144)	-0.338***	(0.115)			
Distance to market (hr)	0.092*	(0.055)	0.092*	(0.055)	0.083	(0.054)			
Mean rainfall variability of rainy seasons (std. dev) two years lag	-0.001	(0.003)	-0.001	(0.003)	-0.001	(0.003)			
Mean rainfall of rainy seasons of two years lag to the survey period	0.001	(0.002)	-0.004**	(0.002)	-0.001	(0.002)			
Head's education (illiterate = 1)	0.128	(0.132)	-0.205*	(0.122)	-0.071	(0.102)			
Community fixed effect (yes =1)	yes		yes		yes				
cons	0.658***	(0.237)	-1.157***	(0.232)					

Table 3 Factors affecting land rental market participation (Renting in and renting out)

Dependent variable: probability of renting in and renting out of land in the land rental market. A generalized random effect order probit model was use to fix selection bias in relation to land rental market participation in the share tenancy market. This is extracted from a three-year balanced panel data for land rental market participation *: 10 %, **: 5 %, ***: 1 %, refers level of significance, respectively. Numbers in parentheses are robust standard errors clustered at household level.

Source: NMBU and MU household panel survey.

Step 6: Constraints for parallel lines imposed for female adult (P Value = 0.1673) Step 7: Constraints for parallel lines imposed for head's age \leq 35 years (P Value = 0.1243) Step 8: Constraints for parallel lines imposed for male adult (P Value = 0.1872) Step 9: Constraints for parallel lines imposed for TLU_Nox (P Value = 0.0834) Step 10: Constraints for parallel lines imposed for distance to market (P Value = 0.0630) Step 11: Constraints for parallel lines are not imposed for Plot distance (P Value = 0.00000) Mean rainfall two years lag (P Value = 0.00446)

Head's education (P Value = 0.02721)

The estimation process identifies variables which are constrained and unconstrained. Constrained variables refer to factors which do not make any significant difference effect between decisions on the likelihood of renting in or renting out of land (as described above from step 1 to step 11). Whereas, unconstrained variables refer to factors with P-value less than 0.05 and have significantly different effect between the two categorical outcomes (renting in and renting out of land). The Wald test of parallel lines of assumption also identifies variables that can make significantly different effect on the likelihood of renting in and renting out of land. In this estimation process, the first category is the likelihood decision of renting in land represented by mleq1 and the second category is the likelihood decision of renting out of land, represented by mleq2. These tests are presented as follow:

Wald test of parallel lines of assumption for the final model:

- (1) (1)[mleq1] head's sex—[mleq2]head's sex = 0
- (2) [mleq1]Own land_ha—[mleq2]Ownland_ha = 0
- (3) [mleq1]oxenqty—[mleq2]oxenqty = 0
- (4) [mleq1] rainfall variability of two years lag—[mleq2] rainfall variability of two years lag = 0
- (5) [mleq1] head's age b/ 35 to 60—[mleq2] head's age b/ 35 to 60 years = 0
- (6) [mleq1] female adult—[mleq2] female adult = 0
- (7) [mleq1] head's age ≤ 35 —[mleq2] head's age $\leq 35 = 0$
- (8) [mleq1] male adult—[mleq2] male adult = 0
- (9) [mleq1]TLU_Nox—[mleq2]TLU_Nox = 0
- (10) [mleq1] distance to market—[mleq2] distance to market = 0

chi2 (10) = 14.98Prob > chi2 = 0.1330

The chi-square test statistic indicates that the identified variables have no significantly different effect between the decisions on the likelihood of renting in and renting out of land. Factors that affect the land rental market participation with alternative specifications are presented in Table 3.

The generalized random effect order probit model reveals that most of the variables do not have significant variation effect between the decisions on the likelihood of renting in and renting out of land. This is typified by variables with the same coefficient and level of significance on the likelihood of renting in and renting out of land. The intuition is that given the input market imperfections (i.e., labor, oxen, and non-oxen livestock, credit) and no market clearing price on the sharecropping rental contract in the study region, the land rental market has been poorly performed.

Households with extra land size would like to participate in the land rental market as landlord while households with limited land size would like to participate in the land rental market as a tenant. But, the model response to extra unit of owned land is economically insignificant for the likelihood of renting in and renting out of land. This implies that land rental market process in the study region is constrained. Another justification of the rigidity in the land rental market is the low coefficient of own land holding size for the likelihood of renting in land. Under allocative efficiency, the coefficient of own land holding on the likelihood of renting in land should be -1 and for the likelihood of renting out of land should be +1 (Bliss & Stern, 1982). Therefore, the first hypothesis (H₁) is strongly rejected that pre- rental owned farm size has a positive and significant effect on the likelihood of renting out of land, while it has a negative and significant effect on likelihood of renting inland. This indicates that the existing land rental market process in the study region is weak to enhance the allocative efficiency.

The generalized random effect order probit model result also captured the effect of transaction cost on land rental market participation. This is typified by how distance to plot affects the likelihood of renting in and renting out of land. Table 3 shows plot distance affects positively and significantly the likelihood of renting out of land, while significantly and negatively affect the likelihood of renting in land. On average, for an increase of plot distance by one hour from homestead, the likelihood of renting out of land increased by 25.1% but the likelihood of renting in land decreased by 69.6% at the 10% and 1% level, respectively. These results point in the direction that I cannot reject hypothesis (H₂), which states that transaction cost proxy by distance to plot has a positive and significant effect on renting out of land. This result is consistent to other findings that plot distance affects the land rental market process (Ghebru & Holden, 2015; Skoufias, 1995; S. T. Holden et al., 2007).

Mean rainfall of rainy season of two years lag to the survey period has a negative lagged effect on the likelihood of renting out land at the 5 % level, while no significant lagged effect on the likelihood of getting out of land. This implies that the finding partly supports to the third hypothesis (H_3) states that rainfall has a lagged positive effect on renting in land while a lagged negative effect on renting out of land. I see a particular reason that for an increase of average rainfall for rainy season of two years lag to the survey period, the likelihood of participation in the land rental market from the landlord side decreases. The intuition is that post good rain season, production risk is low and the opportunity cost of renting out of land is high for landlord households and they decline to rent out extra unit of land, instead encourage to cultivate their land by themselves .

The effect of other variables on decision of renting in and renting out of land draws some implications. For instance, household head's characteristics provides a different inference on the landlord and tenant households. Head's education (1 = illiterate) explained negatively and significantly to landlord household while positively but insignificantly affects tenant households. This could be due to the requirement of better human capital enables to exploit the land rental market opportunities and therefore, the likelihood of participating in the land rental market as tenant becomes high.

6. Conclusions and policy implications

This paper examines factors affecting participation of renting in and renting out of land among smallholders in a semi-arid economy of northern Ethiopia. The main results of the study are as follows.

First, land rental market participation rates by the tenant and landlord households are relatively low, though there is considerable variation across the survey periods. This depicts

that the land rental market participation process in the study area is performed under a constrained environment.

The second finding of interest is that; tenant households are in a better status in terms of households' resource endowment (reverse share tenancy). This is consistent with other empirical studies in developing countries (Ghebru & Holden, 2015; Jin & Jayne, 2013).

Third, after controlling the unobservable heterogeneity effect, except plot distance, literacy level of household heads, and weather variable expressed by rainfall variability of two years lag to the survey period, several of the control variables do not have significantly different effect between decisions on renting in and renting out of land. This might be due to factor market imperfection and high transaction costs; and the land rental market in the study region is more likely explained by other factors that cannot address by this study. Finally, land rental markets in the study area do not fully equalize land to non-land ratio among smallholders.

From a policy perspective, it is believed that land rental market is one avenue of facilitating the rural transformation through improving productivity, land use efficiency and equity. However, the findings indicate that high and pervasive transaction costs, factor market imperfection, and spatial difference lead to low performance among the smallholders .Therefore, first, appropriate intervention to reduce costs of information and rental contract enforcement encourages to improve land rental market development. Second, improvement in infrastructure like schooling and road quality may create better awareness of land rental market and strive to exploit the land rental market opportunities. Third, unconstrained functioning of land rental markets would increase the share of households who participate in rental markets and lifting of some land rental market restrictions in the study region may lead to achieved better benefits.

Though the current study is limited to Tigrai, Ethiopia, the issues discussed are more likely to be of relevance to a wider range of developing countries (e.g., Malawi, India, Bangladesh, Zambia, China) that aim to make the transition from an agricultural to a more diversified economic structure. But this may have, for various reasons, restricted the scope for operation of land rental markets. This implies that other studies from other countries with different property right arrangements, perhaps bring different conclusions as land rental is not contingent on the specific property right arrangement (i.e., only use rights but not ownership rights) which is prevailed in Ethiopia. This may limit the conclusiveness of the current study in countries with valid and full land ownership rights.

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Notes

- Landlord household = potentially rented out land, selfoperator household = neither rented in nor rented out of land and tenant household = potentially rented in land in the land rental market. I use the same nomination throughout the paper.
- Off farm employment represents: casual workers, permanent employment, ex- soldiers, pensions and skill based jobs such as: carpenter, masonry, waving and handcrafts.

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