Impact of land rental on smallholders' commercialization

Evidence from northern Ethiopia:

A Panel Data Analysis

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Paper prepared for presentation at the "2018 WORLD BANK CONFERENCE ON LAND AND POVERTY" The World Bank - Washington DC, March 19-23, 2018.

Abstract

The purpose of this study is to examine whether participation in the land rental market from the demand side affects participation and degree of participation in the output market of smallholder farmers. We use a correlated random effects probit and tobit models to analyze the effect of area rented in on participation and degree of participation in the output market as crop seller. We apply a control function approach to control for possible endogeneity associated with access to area rented in. Results show that for a change of area rented in by one ha, the likelihood of participation in the output market as a crop seller increased by about 8 % and degree of participation increased by about Birr 602-616 per household per year. Thus, promoting land rental market appeared to have a more robust impact on smallholder commercialization in a land-scarce economy.

Keywords:, Commercialization, land rental, random effect,

1. Introduction

The continuing shift towards a more market-based economy is a central characteristic of transition economies. This transitional process is typified by the shift in resource allocation mainly land and labor, from subsistence production to cash and high-value crop production. Along with the adoption of proven, appropriate and productive agricultural technologies, an increase in per capita land in land-scarce countries like in Ethiopia is one way of transforming, from the low input use and low productivity into high input use, high productivity and commercialized agriculture (Negatu & Roth, 2002). In developing countries, farmers can acquire land through various forms. For instance, the study of Holden et al. (2013), discussed the wide land acquiring approaches accomplished in India and Srilanka (land to the tiller), in South Africa and Malawi (market-assisted land redistribution), in Ethiopia and Vetinum (low-cost land registration and certification). Apart from this, the emerging of the land rental market in developing countries including Sub-Saharan Africa (SSA) provides an alternative way of access to land through land use right transfer from a land rich to land-poor households (Chamberlin & Ricker-Gilbert, 2016; Holden et al., 2009). This land use right transfer consists one component for easing the transition from subsistence to the market-oriented agriculture.

The correlation between land rental market and commercialization in transition economies (agriculture with dual structure) [1] has received some attention in a literature (Kan et al., 2006). This implies that proficient farmers acquire access to land through rental market, operate it efficiently and improve production (Jin & Deininger, 2009). However, the increase in agricultural productivity is not an end in itself, rather considered an intermediate outcome, which farmers aim to improve their well-being through greater engagement into the output market (Gebreselassie, 2007). Recent studies revealed that output market participation is strongly associated with access to land in a land rental market (Luu Due Khai et al., 2013; Rahman, 2010). The study of Lerman (2004) shows that adjusting operational farm size through the land rental market is one important factor in achieving a higher level of commercialization in the transition economies. However, these works use cross-sectional data that limit the ability to see the pattern of the impact over time and put minimum effort to fix the endogeneity problem that could arise from participation in the land rental market. Other studies also show the impact of land rental market on a broader range of total income and food security, land productivity, land equity and efficiency (Chamberlin & RickerGilbert,

2016; Holden & Ghebru, 2016; Jin & Jayne, 2013). Yet, in SSA, there is scant empirical studies that have systematically examined the impact of participation in the land rental market on smallholders' commercialization. This is attributed by surplus product over home food requirement and has an important implication on food security. Farmers with surplus product would have a positive marketed output (net seller of food crops and they are food secured).

The poverty-reduction strategy adopted by Ethiopia seeks to achieve growth and transformation through improving smallholder's market participation. To facilitate the transformation, the government undertakes substantial measures such as, abolished of price controls over outputs, gradual reduction of state control on farm input, remove the restriction of land use transferability, promote credit service, stepping up the agricultural extension systems and reform promotions (Bezabih et al., 2011; Sharp et al., 2007). Region-wise, the low-cost land registration and certification reform that took place for the first time in the country in 1998/99 has stimulated the land rental market (Holden & Ghebru, 2011). This reform has made non- land resource-poor and inefficient landlord households more willing to rent out their land to efficient and potential tenant households. With this consideration in mind, this study investigates whether participation in the land rental market in the northern region of Ethiopia can pave the way for smallholder output market participation by making more land available for efficient and more market-oriented farmer. In this paper, we are more interested in the effect on tenant households, however, as it is these tenants that potentially may scale up their production for the market.

The study does have some policy relevance as the current push in the commercialization of smallholders needs to be empirically supported in land scarcity economy. First, it tries to see how participation in the land rental market from the demand side affects smallholder's commercialization, defined as the proportion of crop output sold to total crop income (Alene et al., 2008; Gebremedhin et al., 2009; Lerman, 2004). Second, the current study uses an impact assessment method, which controls for the endogeneity of participation (this might arise from the unobservable and observable heterogeneities) in the land rental market and uses household panel data contain potential tenant households.

The remaining parts of the paper are organized as follows. The next section deals with the theoretical framework and hypotheses for empirical testing, followed by the data source and descriptive statistics in the third section. The estimation method and strategies are presented

in the fourth section. Estimation results are presented in the discussion part while the last section deals with concluding remarks.

2. Theoretical framework and hypotheses

In the short run, farmers in developing countries adjust the land size through the land rental market quicker than other means (Tatwangire & Holden, 2013). On the one hand, adjusting the desired land size through an inheritance land of an individual as it is made in Ethiopia is observed infrequently, while; the household features (size and composition) change over time. On the other hand, variation in the non-land resource endowment makes inequitable land management. Land rental market adjusts the desired land size among smallholder farmers through attracting operators with better non-land resource endowments (Tatwangire & Holden, 2013). This shows higher benefit is derived from rented in land by tenant households compared to the average households that acquired land through inheritance. It is expected that farmers who are in a place of access to land through rental market are, more competent to improve their well-being through increasing productivity and output market participation.

Ethiopia has applied an egalitarian land distribution by the 1974/5 land reform. Based on family size, nearly 84 % of rural households had access to farmland (Gebremedhin et al., 2009). Though land sale is constitutionally prohibited in the country, equalization of land to non-land resource among the farm households is realized through the land rental market (Teklu, 2004). This endowment based land size equalization builds a favorable condition for potential renters (tenants) to operate the land not only for home consumption but also increase production for sale (Teklu, 2004). In developing countries, major part of agricultural activities lie intermediately between a solely commercial farm and pure subsistence farm (i.e., produce, consume and sale the surplus). In particular, the dominant features of agriculture in the study area, northern Ethiopia are consistent with this setup. Then, any analysis of smallholder farmer's behavior should allow for the study nature of non-separable farm household model i.e., production and consumption decisions held simultaneously (Singh et al., 1986).

With these thoughts in mind and following the non-separability farm household model Singh et al. (1986), we assumed that tenant households' utility function is expressed as $U = (Q_i - Q_i^c)\ w_i, l,\ a_i)$. Where Q_i is the total crop income of household *''i''*. Q_i^c is a vector of consumed crops from own production valued at market price (P^c). w_i is household income

from other activities. l is leisure and a_i is household characteristics. Farm household maximizes the utility function subject to three constraints. First, production function constraints related to the output of *N* crops with respect to labor input *(L),* non land capital endowment *(A),* and rented in land *(K*)*. Labor input (*L*) is the sum of family labor (L_i) and hired labor *(L_d)*. Assume family and hired labor are close subsitute. Second, a time constraint *(T)* treated as the sum of family labor *(L_i),* hired out labor *(h_i),* and liesure (*l*). Third, a budget constraint equates the market value of own production crops plus any other source of income (w_i). The follow up mathematical derivation is presented at the annex part.

The benefit derived from area rented in is estimated from the ratio of the value of marginal product of area rented in to the value of marginal product of non-land endowment. The effect of area rented in on farmer's crop income is through adjusting the desired land size. Thus, we expect that households who have access to rent in additional unit of land would increase the operational land size, doing their best to improve production and produce surplus product. Right after this, a household would like to participate in the output market as a seller of food crops.

Following the study of Alene et al. (2008); Gebremedhin et al. (2009), a household participates in the output market as a seller of food crops when the proportion of crop output to total crop income exported to market for sale is positive. In developing countries, due to market imperfection, output market participation is affected by transaction costs (Barrett, 2008; Key et al., 2000). Transaction costs are classified as fixed and proportional. Fixed transaction costs are non-variant with the volume of crop transacted but basically deter participation in the output market such as; the cost of searching and processing information, negotiating and enforcing contracts and monitoring agents. On the other hand, proportional transaction costs are costs proportionally related to the quantity of output transacted such as; cost associated with transport, time taken to nearby market and to all-weather roads. See for the detail in Alene et al. (2008). How the proportional transaction cost affects output market participation is discussed as follow.

Let $\tau_{qi}{}^{v}$ and p_{qi} denote the proportional transaction cost and market price per unit of output sold, respectively. On the one hand, the transaction cost adjusted output price for seller of food crops is $P'_q(p_{qi-}\tau_{qi}{}^{v})$. This implies that the effect of transaction cost in the output market is included through the downward adjustment in output price. On the other hand, it is included through the upward adjustment $P'_q(p_{qi+}\tau_{qi}{}^{v})$ in the output market for buyer of food crops (De

Janvry et al., 1995). Nevertheless, we hypothesize that potential tenant is more likely to participate as a seller than as a buyer of food crops, the output market participation is typically explained by the downward adjustment of the output price.

Hypotheses

In setting the hypotheses for empirical testing, the focus is on assessing the impact of area rented in on smallholder's commercialization. However, to capture the *ceteris paribus* effects of some factors, we need also to control for other important variables that might influence smallholder's commercialization.

(H_1) Area rented in

Access to land is an important factor for the strengthening of smallholder agriculture and commercialization. In the study region, the implementation of low-cost land registration and certification reform enhances the tenure security of landholders. This, in turn, motivates to the non-land resource-poor households (landlords) to participate in the land rental market. This land use right transfer leads to create a conducive environment for tenants access to extra land and improve productivity (Holden et al., 2007; Pender & Alemu, 2007). Therefore, we hypothesize that area rented in is a potential determinant of smallholder commercialization. This may also assess by observing whether the marketed output has changed over the period from 2005/06 to 2014/15 production seasons by tenant households.

(H_2): Household characteristics

Age of household head is considered an indicator of farming experience. On the one hand, elder headed households have more resource endowment proxy by asset and livestock. This is because wealth is the cumulative effect of a long period of farming activities that young heads lack to do so. Hence, the variable age may enhance marketed output through its wealth effect or risk neutralize effect (Pender & Alemu, 2007). On the other hand, elder household heads are less efficient to farm their land themselves and perhaps produce less surplus product (Holden et al., 2007). Thus, they are less likely to participate in the output market as a seller of food crop (life cycle effect). Therefore, the effect of age on output market participation is ambiguous. Nevertheless, we expect that young headed households and households with literate heads could have better farming potential, access to information, and can exploit market opportunities. Hence, they are more likely to participate in the output market as a seller of food crops.

(H_3) Household resource endowments

In developing countries including Ethiopia, factor markets are imperfect (Sadoulet & De

Janvry, 1995). Under such circumstances, households' resource endowments proxy by land, active labor force and oxen play a crucial role in the efficiency of smallholder farming (Gebremedhin et al., 2009). Therefore, we expect that such households would have a better place in the output market as a seller of food crops. We also expect , ownership of information devices (mobile, television and radio) are positively associated with higher market participation through reducing fixed transaction cost.

(H_4): Community-level characteristics

The host of village-level variables such as agricultural potential (access to irrigation) and market infrastructure would have a positive effect on commercialization. We expect that households access to irrigation would likely to capture higher marketed output implying that more of the irrigated plot is used to produce high-value and cash crops and harvested more than one time per year (Gebregziabher et al., 2009). We also use the observable community-level factors such as; time spent to reach the nearby market and to district office proxy for proportional transaction cost variables. We expect that households reside far distant to district and nearby market do will have a low likelihood and degree of participation in the output market (Asfaw et al., 2011).

3. Data and descriptive statistics

3. 1 The data

The data used in this paper come from a panel of household surveys conducted in 2005/06, 2009/10 and 2014/15 production seasons in rural Tigrai, northern Ethiopia. All households in the sample set were rural households with farming as the main source of livelihood (crop and livestock production). Two-stage stratified random sampling technique was applied as of Hagos and Holden (2003). The first stage stratified communities based on the variations in agricultural production potential, access to irrigation and market, population density and agroecology diversification. In the second stage, communities were randomly sampled within each stratum, and a random sample of 24 to 25 households was sampled from the sampled communities.

The data we used were an unbalanced panel. This is due to some attrition and inclusion of additional communities and households over the subsequent survey rounds. A probit attrition model was used to assess and control the attrition bias through exploiting the baseline data from 2005/06.The dropout and remaining households in each survey round were used to construct the dependent attrition dummy variable and estimated on household and community level variables. If the explanatory variables explain the attrition dummy

significantly (at the 5 % level), attrition is an issue in the analysis implying that it is systematic. See the detail in the method section.

The survey incorporated detailed questions on household features, land rental, and output market participation. The household composition and characteristics captured as head's gender, age, and the number of active labor force. The gender distribution of household's head helps to control of plots making most farming decisions. The human productive element of the household (active labor force) presents the ability to undertake the laborious task, apply their effort to exploit the land rental and output market opportunities. The household's output market participation survey includes the types and quantities of agricultural products (staple food and cash crops) produced, consumed and sold using community-level median price[2]. The household survey was supplemented by community-level data that included travel time to destination markets, all-weather roads and access to irrigation.

3.2 Descriptive analyses

Table 1 presents the t-test and chi-square comparison of selected variables of tenancy status of farm households across the production seasons. Some of the characteristics used as the explanatory variables of the estimated models we present further. The unbalanced dataset contains 1421 farm households and of which about 25 % are tenants who seek extra land to adjust with their non-land resource endowment at least in one of the three production seasons. Average age of tenant households is lower than the non-tenant households in the production periods of 2005/06 and 2009/10 and the difference is statistically significant at the 1 and 5 % level, respectively. This indicates the importance of human capital associated with young age heads in operating the farm efficiently compared to elder headed households. Female headed tenant households are significantly lower than the non-tenant households, suggests the requirement of male labor in ploughing the land. Furthermore, education status of tenant households (illiterate =1) is significantly lower than non-tenants in all of the production periods, indicates the importance of better human capital in operating the land in an efficient way and exploit market opportunities.

In the imperfect land and output markets, household's resource endowment such as family labor, oxen, and non-oxen livestock play an important role in explaining land and output market participations. Results in Table 1 show that there is a significant difference in labor endowment (male adult) and the number of oxen between tenant and non-tenant average households. The difference is statistically significant at the 1 % level in all production periods. Empirical studies show that land size is a key determinant of smallholder

commercialization in land-scarce transition economies (Lerman, 2004; Rahman, 2010). The intuition is that operating large land size improves crop production and enables to generate surplus products, and possibly supply for sale. We observe that tenant households are distinguished in terms of operating sizeable land and generating higher crop income compared to non-tenant average households in two and three of the production periods, (Table 1). As a result, tenant households are distinguished in terms of market integration, measured both as amount of crop sold and share of farm households produced marketable surplus in the production seasons. This directs towards in supporting the first hypothesis (**H_1**).

In the subsequent part of the paper, rigorous analytical models are estimated to verify whether the difference in mean marketed output remains unchanged after controlling for all confounding factors. To measure the impact of land rental on the participation and degree of participation in the output market, it is necessary to take into account, the fact that farm households who rented in additional unit of land might have achieved a higher level of market participation even if they had not participated in the land rental market.

Table 1 here

4 Estimation method and strategies

4.1 Estimation methods

We operationalize the theoretical model so as to estimate the impact of area rented in on participation and extent of participation in the output market and testing the proposed hypotheses in section II. Household's output market participation in selling crop output (Q_i) is modeled as a two -stage decision. First, a household decides whether to participate in the output market as a seller of food crops or not. In the second stage, a household decides on the extent of crop output for sale. Therefore, household decision to sell crop output is modeled as a function of household characteristics, community level, and unobservable individual heterogeneity. Following Gebremedhin et al. (2009), Chamberlin and Ricker -Gilbert (2016), we develop the following specification to show the relation.

$$Q_{it}^{*} = \phi X'_{it} + \rho R_{it} + \alpha_i + \vartheta V'_{it} + {}_{it.} \quad (1)$$

Where Q^{*} is the likelihood of household participates in the output market as a crop seller with value one, and zero otherwise. X' is a vector of controlled household level variables include: (a) the number of male and female adults, (b) land and non-land endowments such as oxen and non-oxen livestock (in TLU). The non-land endowments may not be considered as strictly exogenous and we run models without and with these variables. Whereas, the landholding is considered exogenous variable as it is less frequently adjusted over time in the

study communities, (c) household head's characteristics, including sex, age and, educational status. When controlling the strict exogenous variables, we include their time invariant means as well as deviations from the mean. While this is like using the Mundlack Chamberlain device, it allows us to assess the importance of resource endowment levels versus changes in these. Area rented in variable in equation (1) is represented by R, with corresponding parameter ρ. α_i is unobservable heterogeneity effect. V is a vector of community level variables includes; distance to nearby market, district office, the presence of irrigation and community dummy. . is the unobservable effect of the model. *''i''* and *''t''* are individual and time identifiers, respectively. We also used year dummy that might have caused a change in participation and extent of participation in the output market in the 2009/10 and 2014/15 production periods in reference to 2005/06.

The inflation-adjusted value of crop sold at a time ''t'' is only observed for households participated in the output market as a seller of food crop and the level of commercialization is computed as the ratio of value of crop output sold to the total crop income (Alene et al., 2008; Gebremedhin et al., 2009; Gebreselassie, 2007). More specifically, the extent of output market participation is expressed as follows:

$$Q_{it} = \varphi X'_{it} + \theta R_{it} + \alpha_i + \pi V'_{it} + \mu_{it.} \quad (2)$$

The parameters of equation (1 and 2) are interpreted as marginal returns of participation and intensity of participation to these characteristics (Jaleta et al., 2009). The impact specification of equation (1 and 2) is estimated when R_{it} treated as a censored variable and with a positive value for the households who participated in the land rental market as a tenant, zero otherwise. Since participation in the land rental market is self-selection hence, it is potential endogenous variable. That is, $cov(R_{it}, _{.it} \neq 0) and\ cov\ (R_{it}, \mu_{.it} \neq 0)$ in the participation and degree of participation of output market models, respectively. This self-selection may arise from the time-invariant or time variant household characteristics.

The vector of parameters in equation (1 and 2) can be estimated using fixed effect estimator (FE) so that household level unobservable heterogeneity can be removed through the demeaning process. However, due to the unbalanced panel of the data, fixed effect estimator is inappropriate. This is because some households (16.2 %) of total sample participated only ones in the survey rounds. Estimating the within regression with a bunch of zeros in the

dependent and independent variables affects both the slope and intercept of the regression line. And this leads to coefficients with unadjusted standard error. Hence, fixed effect model is less likely to assess the effect of variables that have little or zero within group variation (Cameron & Trivedi, 2009). Random effect, on the other hand, leaves uncontrolled households level unobservable heterogeneity. Thus, we cannot use pure fixed effect or random effect estimator. Instead, we unify the two models (fixed and random effect) and develop Correlated Random Effect or the Mundlack- Chamberlain approach following the work of Mundlak (1978) and Chamberlain (1992). One benefit of CRE estimator is that it includes the mean value of time-varying household variables into the regression analysis to control the time-invariant factors (Wooldridge, 2009). In the Mundlack- Chamberlain equation, the unobservable heterogeneity variable is expressed as a function of averaging household's time variant and another auxiliary variable.

$$\alpha_i = \omega \bar{X}_i + a_i + U_{it} \quad (3)$$

Plug equation (3) into equation (1 and 2) gives full Mundlack- Chamberlain equation providing that $U_{it} + {}_{it} = \epsilon_{it}$, and estimate equation 1 with correlated random effect probit and equation 2 with correlated random effect Tobit model, respectively. To handle the potential attrition biased, a probit attrition model was estimated on the baseline 2005/06 and the subsequent survey rounds (i.e., 2009/10 and 2014/15). The probit attrition results are presented in Annex Table 1. The results indicate that several of the variables were significant and attrition was therefore non-random and potentially leads to bias. To correct for the potential bias, we construct an Inverse Millis Ratio (IMR) and included as a regressor in the Mundlack-Chamberlin specification. The insignificance of IMR in the marketed output model results (Table 2 and Table 3 indicates that attrition does not have an effect on the impact estimation.

4.2 Estimation strategies

The impact analysis is based on observational data where farm households do not have equal access to rent in land. Then, access to rented in land is treated as non-random and un controlling to this self-selection biase leads to the problem of endogeneity and makes the impact analysis cumbersome (Wooldridge, 2005). Here, the potential source of endogeneity could be unobservable individual heterogeneity. For instance, a farmer with better farm management skill and kinship partner can adjust the operational land size through rented in addition land than households without skill and kinship partner.

Providentially, the study uses panel data and can ease the process of controlling the problem. This implies that the unobservable individual heterogeneity is time-invariant within the household so that, the Mundlack- Chamberlin specification removes from the model (Wooldridge, 1995). Nonetheless, despite the elimination of the time-invariant factors using the Mundlack Chamberlin specification, still, there is a possibility that area rented in could be endogenous in the outcome equation (1 and 2) due to potential correlation with leftover household level observable heterogeneity. The possible way of solving the endogeneity sourced from observable heterogeneity is using the instrumental variable method. Alternatively, for linearly endogenous regressors, a control function approach relies on the alike kinds of identification conditions (Wooldridge, 2009, 2010). More specifically, equation (1 and 2) are specified separately into area rented in censored at zero (first stage) and the participation and extent of participation in the output market (second stage) equations in a MC approach, respectively as fellow:

$$R_{it} = \gamma_1 Z'_{it} + \gamma_2 X'_{it} + \gamma_3 V'_{it} + \gamma_4 \bar{X}_i + \mu_{it.} \quad (4)$$

$$Q^*_{it} = \phi X'_{it} + \rho_1 R_{it} + \rho_2 \hat{\mu}_{it.} + \vartheta V'_{it} + \theta \bar{X}_i + \epsilon_{it} \quad (5)$$

$$Q_{it} = \varphi X'_{it} + \theta_1 R_{it} + \theta_2 \hat{\mu}_{it.} + + \pi V'_{it} + \delta \bar{X}_i + \eta_{it} \quad (6)$$

The control function approach requires exclusion restriction variables (Z'_{it}) that have used in the reduced form equation (4), and uncorrelated with the error term equation in equation (5), $cov(Z'_{it}, \epsilon_{it}) = 0$, and equation (6), $cov(Z'_{it}, \eta_{it}) = 0$, but correlated with the potentially endogenous variable, $cov(R_{it}, Z'_{it}) \neq 0$. The residual from the random effect Tobit model ($\hat{\mu}_{it.}$) is then included as an explanatory variable in equation 5 and 6. The statistical significance of the residual provides a test for endogeneity of the area rented in variable. In this case, previous period land rental market participation reflects the persistence of tenancy implying that previous trade experience as tenant is meant to do, should stimulate land rental activity in latter period (Holden et al, 2007).

We see particular reason that in a sharecropping contract, state dependency explained the current rental market and the previous period tenant variable is considered as an instrument to the potential endogenous area rented in variable. We tested the statistical validity of this by including the instrument in the participation and degree of participation of the output market equations, respectively in one specification. If the instrument was insignificant in the participation and degree of participation in the output market but significant in the area rented

in equation, and if the error term from the first stage model (the difference between the observed and predicted area rented in) was significant in the participation and extent of participation of the output market models, then, endogeneity is an issue and was corrected for with the control function.

5. Estimation results and discussion

The results in the form of Average Partial Effects of the correlated random effect probit model for smallholder's commercialization with alternative specifications are presented in Table 2. As stated earlier, we used a control function approach to handle self-selection related to area rented in and dummy tenant in the previous period was the instrumental variable left out in the second stage regressions. The second column in Table 2 is the first stage instrumental variable (IV) model of area rented in estimated using correlated random effect Tobit model. As shown, the previous period tenant variable was significant at the 1 % level and with a positive sign. This indicates past tenant experience has a positive effect on the latter period degree of tenant participation expressed in terms of area rented in. This confirms the state dependency of the land rental market in northern Ethiopia (Holden et al, 2007). The first model (Model- 1) in Table 2 includes the instrument to assess statistical validity of the instrument. As shown the instrument is significant on the first stage model at the 1 % level while, insignificant in the standard test level in the second stage model (Model 2). Furthermore, Table 2 included the generalized residuals from the first stage area rented in equation along with the observed area rented variable. The inclusion of the residuals test and control for the endogeneity of area rented in the output market. The error term from the first stage model was significant at the 1 % level with a positive sign in three of the models. Therefore, our control function approach appears to have worked nicely.

We used four different specifications of the second stage. Model 1 included the instrument as a test for its statistical validity, while Model 2 excluded the instrument but included the strict exogenous variables in their mean (not reported) and deviation from the mean. Model 3 included the non-strict exogenous household labor endowment variables in their deviation from the mean as of a Mundlack-Chamberlin device. Model 4 included other household resource endowment variable such as mobile phone. We used the alternative model specifications to assess the robustness of the results to the inclusion of potentially endogenous household endowment variables which may improve the likelihood of participation in the output market. The inclusion of deviation from the mean fixes the problem of multicollinearity.

Table 2 here

The variable area rented in the share tenancy market was significant at the 5 % level and with a positive sign in the three models of Table 2. This supports our first hypothesis ($\mathbf{H_1}$) that access to additional unit of land through land rental market increases the probability of participation in the output market as a crop seller. The coefficients show that the change in area rented in by one ha leads to enhance the probability of farm household participating in the output market as a crop seller by about 8 %, *ceteris paribus*. This result is much higher than for an average change of own land by one ha (Table 2). This is compelling evidence that land rental market promotes land use right transfer from less productive, to more productive farmers. This, in turn, paves higher marketable surplus. This spots out that land rental market strongly explains smallholder commercialization.

We wanted to explore whether the household head's characteristics such as: age, gender and literacy start to make a visible impact on the likelihood of output market participation. However, findings did not indicate a significant impact of head's age and gender in our sample, and we reject the second hypothesis partly ($\mathbf{H_2}$). Hence, being the young and male head, therefore, seem not to be an important driver of a higher probability of output market participation. The justification for this could be, due to factor market imperfection and high transaction cost of entry, young heads may suffer to join in the rental market and difficulty to adjust the operational land size. Thus, the likelihood of improving production and generating surplus product for market would become low. On the other hand, the change in literacy status of household heads have a higher probability of output market participation. The APE result shows that for a change in head's literacy *ceteris paribus*, the probability of participating in the output market as a crop seller increased by about 9.4 % in three of the models and the impact is statistically significant at the 5 % level. This implies that literate headed households perhaps associated with better farming skill and exploit the market opportunities than illiterate households. Hence, we fail to reject the second hypothesis **($\mathbf{H_2}$).**

With the inclusion of strict exogenous variable, an average increment in landholding significantly and positively affects the probability of output market participation at the 5 % level in Model 2 of Table 2. This indicates that land is the crucial factor in farming and efficient utilization of it enables to produce surplus product and turned out to make a positive and significant effect on output market participation as a crop seller. Thus, we do not have an evidence to reject hypothesis three ($\mathbf{H_3}$). Accordingly, *ceteris paribus*, for average change of landholding in one ha, the likelihood of participation in the output market changes by about

1.0 %. Our result appears to be consistent with the study of Alene et al., (2008) revealed that an increase per capita land leads to improve the participation in the output market of Kenyan maize sellers. A similar finding in Uganda shown that farmers with larger land size would have a greater degree of output market participation (Anetl et al., 2014).

Furthermore, the third hypothesis (**H_3**) states that household non-land endowments have a positive effect on the probability of output market participation. We treat these endowments as potential endogenous variables since they are adjusted over time and used as a robustness assessment by including in Model 3 and in Model 4. The inclusion of these variables as time-invariant and deviation from the mean do not affect key results. Furthermore, separate model results for labor endowment (male and female adult) and other (Mobile phone) do not have significant effect on the probability of output market participation. Therefore, partly, we reject the third hypothesis.

Hypothesis four (**H_4**) states that presence of community-level factors such as irrigation has a positive contribution to the probability of output market participation. The intuition is that household's with access to irrigation could plant their plots more than once per year compared to households without irrigation and more likely to produce surplus products beyond home consumption. More specifically, irrigated plots are used to grow high-value and cash crops Gebregziabher et al., (2009), and captured higher probability of output market participation. The results of Table 2 support our hypothesis that on average, households accessed to irrigation explained positively and significantly the probability of output market participation as a crop seller at the 1 % level in all models.

Ceteris paribus, one-way walking distance to the district office affects negatively and significantly the probability of output market participation as a crop seller at the 5 % level. That is expected. Distance leads to increase transaction cost and decreased the probability of participation in the output market. The APE results show that for a change of walking distance to the district office by one hour, the probability of participating in output market as a crop seller decreased by about 2.4 - 2.7 %. This result is consistent with the prior expectation and previous studies (Alene et al., 2008; Asfaw et al., 2011; Gebremedhin et al., 2009). We further assess the consistency and robustness of these findings and hypotheses

tests by inspecting the results from the correlated random effect Tobit models in the extent of output market participation discussed below.

The results of the correlated random effect Tobit for the impact of area rented in on the extent of participation in the output market in a form of Average Partial Effect are presented in Table 3. These models also assess the extent of strict exogenous variables and control for unobserved heterogeneity using the MC approach (Wooldridge, 2005).

Table 3 also included the first stage estimation for the factors associated with area rented in using the correlated random effect Tobit model. The result reveals that the exclusion restriction variable, dummy previous period tenant positively and statistically explain area rented in at the 1 % level. Then, the instrument is relevant. We used a control function approach by including the residual from the first stage Tobit model in the second stage model to look at the endogeneity problem. As we see the coefficient of the residual is statistically significant at the 1 % level and with a negative sign in all second stage models. That is expected. Due to market imperfection in the share tenancy market, past period tenant participation strongly affects latter period participation and extent of participation in the land rental market (Holden et al, 2007). This deters the new and potential tenants to join in the land rental market and thus, the predicted area rented in is greater than the actual area rented in.

Table 3 here

Mode 1 of Table 3 included the exclusion restriction variable in the second stage, to see the whether the instrument directly affects to the degree of output market participation or not. This is done by including the exclusion restriction along with the endogenous area rented in variable in one specification. Result shows that the exclusion restriction variable is insignificant at the standard test and thus, the instrument is valid. The attrition bias correcting variable (Inverse Mill's Ratio) happened to be significant at the 1% level, illustrated the appropriateness of using bootstrapping estimation procedure. Model 2 of Table 3 included the strict exogenous variables. Model 3 and Model 4 included the endogenous non-land resource variables family labor and mobile phone, respectively as a robustness check.

Results show that most of the variables that explain participation are also affect the intensity of participation as crop seller (in direction and significant). The area rented in variable has strong positive APE on the intensity of participation in all models at the 1 %

level. A change in area rented in by one ha, *ceteris paribus* affects the intensity of market participation by about 602- 608 Birr. The APE result supports the facilitation power of land rental market in the smallholder commercialization and further strengthen to support hypothesis one ($\mathbf{H_1}$).The correlated random effect Tobit estimation also shows insignificant effect of household head's feature on the extent of market participation as crop seller. This suggests that the influence of aged, illiteracy, as well as female-headed households on the extent of output market participation as crop seller, is not substantial.

The degree of participation in output market is influenced by irrigation and distance to district office with the expected sign. Irrigation is a potential determinant of the extent of output market participation at the 1 % level in all of the second stage models. This is due to the possibility of irrigated plots harvested more once per a year and produced high value or cash crops. The extent of output market participation has increased from Birr 2226- 2229 for average households accessed to irrigation compared to households without irrigation, controlling for other factors. Distance to the district town reduces degree of participation in the output market as a seller of food crops. This implies that increasing proportional transaction cost, the intensity of crop sold in the district town subjected to decrease. For a change in walking distance from homestead to the district town by an hour leads to decrease the extent of participation in the crop market as a seller from Birr 197 -210, *ceteris paribus.* Hence, we fail to reject the four hypothesis ($\mathbf{H_4}$).

6. Conclusion and policy implication

Transformation of smallholder agriculture towards market-oriented production system requires an approach that makes easy access to get additional farmland. The lower per capita land holding along with high population pressure in developing countries like Ethiopia is unlikely to improve marketable output. The low-cost land registration and certification reform implemented in the study region has carried out several benefits (Deininger et al., 2008; Holden et al., 2009; Holden & Ghebru, 2011). Among the others, prompting land rental market draws significant effect on the land use efficiency through the land use right transfer from less productive, but land rich to more productive and efficient, but land-poor farmer. We used non -separable farm household model and drew relevant hypothesis to test the relationship between land rental and smallholder commercialization, defined in terms of participation in output market as a crop seller in land scarcity region, Tigrai, northern Ethiopia. The data used for this study come from three rounds of unbalanced household panel data collected in 2005/06, 2009/10 & 2014/15 production seasons. We apply Correlated

Random Effect probit and tobit models with control function approach to control the endogeneity of degree of rental market participation in the output market. We tested a number of hypotheses to assess the robustness of the findings using alternative model specifications. The key results remain the same.

Albite the prevalence of constraints to the land rental market in the study region Holden et al., (2007), Holden and Ghebru, (2016), we found a positive correlation between area rented in and participation and degree of participation in the output market as a crop seller. The intuition is that land rental market stimulates the land use transfer from less productive to more productive and efficient farmers that can produce surplus product for sale. Under a small landholding system like in rural Ethiopia, the crucial strategy to augment the volume of crops produced and enables to lift up marketable surplus is through intensification of agricultural production. The findings of this paper clearly illustrate that promoting irrigation program is quite critical. This is because of the need to expand and strengthen the accessibility of irrigation to make intensive production within limited land size.

This study strengthens the existing notion that promoting land rental market is a crucial strategy to improve land use efficiency. This looks an important pathway in attaining the overall economic transformation through agricultural growth. Hence, it is important to design policies and strategies to enhance the participation of land poor -tenant households in the land rental market that strengths the corridor towards smallholder commercialization. Promoting irrigation program has also an indispensable contribution in augmenting smallholder commercialization in land-scarce economy.

Notes

[1] On the one hand, subsistence farmers, produce only for own consumption, and on the other hand, commercial farmers, who sell part of their output in the market.

[2] Variables presented in monetary values are inflation adjusted using the district consumer price index in reference to the base year survey (2005/06).

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Tables:

Table 1: Descriptive summary of variables used in the regression (mean/ t-value)

		2005/06			2009/10			2014/15		
Variables	Tenant(	N-tenant		tenant	N-tenant		tenant	N-tenant		
	N=106)	(N=250)	t-value	(N=95)	(N=344)	t-val	(N=151)	*(N=475)*	t-val	
Household characteristics										
Head sex(female=1)	0.103	0.348	***	0.08	0.327	***	.211	0.305	**	
Head age(year)	51.68	55.40	***	51.44	55.10	**	57.14	58.06		
Head education)illiterate=1)	0.55	0.73	****	0.27	0.50	***	0.5	0.62	***	
Wealth and endowment characteristics										
Male adult (count)	1.75	1.31	***	1.	1.45	*	2.15	1.86	**	
Female adult(count)	1.38	1.39		1.	1.36		1.76	1.47	***	
Oxen own (count)	1.38	0.74	***	1.62	0.94	***	1.61	0.90	***	
Tropical live stock (TLU)	1.85	1.00	***	2.59	1.38	***	5.69	2.88	***	
Off farm income (Birr/hh)	975	1096		1,85	1,585		2,926	3521		
Total crop income (Birr/hh)	2,819	1,698	***	6,221	2,685	***	28,035	15,374	**	
Operational farm size (ha)	1.53	0.95	***	1.76	0.97	***	1.17	1.10		
Household is crop seller (yes=1)	0.613	0.46	***	0.47	0.45		0.66	0.56	**	
Marketed output(Birr/hh)	329	204	***	1627	454	***	4136	2254	**	
Household saving (yes=1)	0.018	0.024		0.33	0.170	***	0.409	0.315	**	
Service and technology adoption variables										
Agricultural credit (Birr/hh)	2,222	1,923		2,87	2,176	**	16,307	17,101		
Fertilizer adoption (yes=1)	0.707	0.496	***	0.73	0.60	**	0.82	0.66	***	
Improved seed adoption (yes=1)	0.27	0.172	**	0.27	0.22		0.23	0.20		
Herbicides adoption (yes=1)	0.075	0.04		0.30	0.208	**	0.298	0.226	*	

***, **,* significant level at 1 %, 5 % & 10 %, respectively

Source: NMBU and MU panel household survey.

Table 2: Factors associated with output market participation as a crop seller: Correlated Random Effect probit (Area rented in treated as endogenous).

Explanatory variables	1.stage IV	Model 1	Model 2	Model 3	Model 4
Dummy, household was a tenant	0.329***	0.056			
in the previous period (yes=1)	(0.016)	(0.040)			
Residual for first stage			-0.059***	-0.056***	-0.057***
			(0.021)	(0.021)	(0.021)
Area rented in (ha)		0.009	0.079**	0.077**	0.077**
		(0.044)	(0.035)	(0.035)	(0.035)
Deviation(head sex,	-0.005	0.016	0.007	0.003	0.005
female =1)	(0.021)	(0.044)	(0.043)	(0.043)	(0.043)
Deviation(head age,	-0.0004	0.002	-0.00005	0.0001	-0.000
in year)	(0.001)	(0.004)	(0.004)	(0.005)	(0.004)
Deviation(head's	0.007	0.120**	0.094**	0.095**	0.094**
education, illiterate =1)	(0.021)	(0.047)	(0.046)	(0.047)	(0.046)
Deviation (won land , in ha)	-0.002	0.010	0.010**	0.006	0.008
	(0.013)	(0.033)	(0.033)	(0.033)	(0.033)
Deviation (Access to	-0.017	0.070	0.072*	0.072*	0.068
irrigation , yes=1)	(0.019)	(0.043)	(0.042)	(0.042)	(0.042)
Deviation (walking distance	0.004	0.010	0.010	0.014	0.009
to nearby market, in hr)	(0.008)	(0.019)	(0.019)	(0.019)	(0.019)
Deviation (Walking distance	-0.010	-0.027**	-0.027**	-0.024**	-0.026**
to district office, hr)	(0.006)	(0.012)	(0.011)	(0.012)	(0.011)
Deviation (Oxen won , in	0.025***	0.074***			
	(0.009)	(0.022)			
Deviation(Male adult , in	0.009			0.015	
number)	(0.008)			(0.019)	
Deviation (Female adult ,	0.007			0.015	
in number)	(0.009)			(0.021)	
Deviation (Mobile owned,	0.019				0.059
yes=1)	(0.028)				(0.069)
Inverse Millis Ration	-0.253	0.294	0.267	-0.200	0.219
	(0.256)	(0.501)	(0.474)	(0.566)	(0.479)
Dummy year=2009/10	-0.017	-0.010	-0.030	-0.026	-0.027
	(0.018)	(0.049)	(0.048)	(0.048)	(0.048)
Dummy year==2014/15	-0.016	0.075	0.080	0.078	0.070
	(0.021)	(0.048)	(0.049)	(0.051)	(0.051)
Community fixed effect	yes	yes	yes	yes	yes
Wald chi2	520.26	131.81	161.46	161.21	162.04
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000
Total observation	1421	1421	1421	1421	1421

*Dependent variable: probability of participation in the output market as a crop seller at household level. Correlated Random Effect probit Models. Selection bias in relation to area rented in the share tenancy market was tested for with a control function approach using previous period tenant serve as an instrument. The robustness of the results was tested by alternative estimations including the instrument in the second stage to test its statistical validity and by control for unobservable as follows: Control for unobservable household characteristics was included as the mean (not reported) and deviation from the mean of variables in the Mundlack-Chamberlin device extracted from a three-year panel model for output market participation *: 10 %, **: 5 %, ***: 1 %, refers level of significance. Numbers in parenthesis are standard errors.*
Source: NMBU and MU household panel survey.

Table 3: Factors associated with degree of output market participation as a crop seller:

Correlated Random Effect Tobit (Area rented in treated as endogenous).

Explanatory variables	1.stage IV	Model 1	Model 2	Model 3	Model 4
Dummy: household was	0.329***	455			
a tenant in the previous period (yes=1)	(0.016)	(293)			
Residual from first stage			-376***	-394***	-371***
			(140)	(146)	(143)
Area rented (ha)		375	607**	616**	602**
		(320)	(283)	(310)	(292)
Deviation (gender of household head	-0.005	187	110	155	102
Female =1)	(0.021)	(336)	(244)	(245)	(265)
Deviation (Age of household head	-0.0004	7.413	3.2	3.78	3.1
In year)	(0.001)	(11)	(11)	(11)	(11)
Deviation (Education status of	0.007	352	228	203	233
Household head, 1= illiterate)	(0.021)	(359)	(300)	(300)	(280)
Deviation (Own land in ha)	-0.002	131	101	117	94
	(0.013)	(248)	(190)	(194)	(187)
Deviation (Access to irrigation ,	-0.017	1092***	1103***	1107***	1073***
yes=1)	(0.019)	(321)	(364)	(364)	(359)
Deviation (Distance to nearby market	0.004	3.08	18	-7.3	12
in hour)	(0.008)	(150)	(144)	(142)	(137)
Deviation (Distance to District office in	-0.010	-216**	-200***	-210**	-197**
hour)	(0.006)	(93)	(85)	(86)	(84)
Deviation (Oxen own)	0.025***				
	(0.009)				
Deviation (Male adult , in number)	0.009			-18	
	(0.008)			(113)	
Deviation (Female adult, in number)	0.007			-112	
	(0.009)			(182)	
Deviation (Mobile phone own , yes=1)	0.019				295
	(0.028)				(532)
Inverse Millis Ratio (IMR)	-0.253	10971***	6881	9689	7018
	(0.256)	(3712)	(5038)	(6370)	(4952)
Dummy year=2009/10	-0.017	-215	-290	-312	-284
	(0.018)	(333)	(284)	(294)	(265)
Dummy year=2014/15	-0.016	869***	1054***	1039***	1003***
	(0.021)	(319)	(311)	(317)	(307)
Community fixed effect	yes	yes	yes	yes	yes
Wald chi2	520.26	188.74	112.50	108.19	112.64
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000
Left censored observation	748	748	748	748	748
Uncensored observation	673	673	673	673	673
Total observation	1421	1421	1421	1421	1421

*Dependent variable: extent of participation in the output market as a crop seller at household level. Correlated Random Effect Tobit Models. Selection bias in relation to area rented in the share tenancy market was tested for with a control function approach using previous period tenant serve as an instrument. The robustness of the results was tested by alternative estimations including the instrument in the second stage to test its statistical validity and by control for unobservable as follows: Control for unobservable household characteristics was included as the mean (not reported) and deviation from the mean of variables in the Mundlack-Chamberlin device extracted from a three-year panel model for marketed output *: 10 %, **: 5 %, ***: 1 %, refers level of significance. Numbers in parenthesis are standard errors bootstrapped at household with 400 replications. Source: NMBU and MU panel household survey.*

Annex Table 1: Probit estimation of attrition biased for panel data (Attrite=1)

Explanatory variables	Coef
Gender of household head (female =1)	0.330***
	(0.116)
Age of household head (years)	0.003
	(0.003)
Population density (Persons/Km^2)	0.172*
	(0.103)
Male adult (count)	0.053**
	(0.087)
Female adult (count)	0.056**
	(0.059)
Oxen own (count)	0.092
	(0.065)
Tropical Livestock Units(TLU)	-0.175***
	(0.039)
Distance to nearby market (hrs)	-0.201**
	(0.078)
Distance to all weather roads(hrs)	-0.084**
	(0.035)
Own land (ha)	0.098
	(0.088)
_cons	-1.05***
	(0.301)
Number of observations	1421
Prob>chi2	0.0000

***, **, 1 %, 5% level of significance, respectively. Numbers in parenthesis are robust standard errors. Source:

NMBU and MU household panel

Annex 2: Mathematical derivative of area rented in (non- separable household model) The utility maximization problem in non-separable farm household model is expressed as follow.

$$Max\ U = U_i[\ Q_i(L, A, K*) - Q_i^c), w_i, l, a_i] \quad (1)$$

Subject to

Production function

$$Q_i = Q(L, A, K*, a_i) \quad (2)$$

Time constraint

$$T = L_i + l + h_i \quad (3)$$

Budget constraint

$$P^c Q_i^c + P^p Q_i^p = PQ_i + wh_i \quad (4)$$

The left-hand side of equation (4) is the expenditure part while the right-hand side is the income part of the budget constraint. In the study region, agriculture is a cyclic planning horizon and the area rented in mainly depends on the renter's resource endowment and varies across time. Hence, area rented in could be, therefore, treated as a variable input. Combining the three component constraints of smallholder behavior into a single constraint through substituting the production and time constraints into the budget constraint in the Lagrangian multiplier form gives as follow:

$$\mathcal{L} = U_i(Q_i(L, A, K*) - Q_i^c, l, a_i) + \lambda_1(T - L_i - l - h_i) + \lambda_2(\ PQ_i^c + PQ_i^p - w_i h_i - PQ_i). \quad (5)$$

The choice variables in equation (5) are non -land capital endowment (A) and area rented in (K*). The first order conditions (FOC) of the Lagrangian equation with respect to the non-land capital endowment (*A*) and area rented in (*K**) gives as follow[1].

$$\frac{\partial \mathcal{L}}{\partial A} = \frac{\partial U_i}{\partial Q_i}\frac{\partial Q_i}{\partial A} - \lambda_2 P \frac{\partial Q_i}{\partial A} = 0. \quad (6)$$

Where, $\frac{\partial U_i}{\partial A}$ = MU_A , marginal utility of non- land endowment.

$\frac{\partial Q_i}{\partial A}$ = MP_A , marginal product of non- land endowment.

[1] In this context, labor input can be treated as part of the non-land resource endowment of farm household and can be included in A.

Then, $MU_A = \lambda_2 P * MP_A$, $\lambda_2 = \frac{MU_A}{P*MP_A}$ = $\frac{MU_A}{VMP_A}$ (7)

Where, MU_A is the marginal utility derived from a given non-land endowment in the production function. VMP_A refers the value of marginal product of non-landndowment (i.e,. output price multplied by the marginal product of the endowment). Similarly, MU_{K*} is the marginal utility of area rented in while, VMP_{K*} is the value of marginal product of area rented in and expressed as follow:

$\frac{\partial \mathcal{L}}{\partial K*}$ = $\frac{\partial U_i}{\partial Q_i}\frac{\partial Q_i}{\partial K*} - \lambda_2 P\frac{\partial Q_i}{\partial K*} = 0$ (8)

$\frac{\partial U_i}{\partial K*}$ = MU_{K*} , marginal utility of rented in land.

$\frac{\partial Q_i}{\partial K*}$ = MP_{K*} , marginal product of rented in land.

This implies that

$MU_{K*} = \lambda_2 PMP_{K*}$, $\lambda_2 = \frac{MU_{K*}}{P*MP_{K*}} = \frac{MU_{K*}}{VMP_{K*}}$ (9)

Solving equations (7) and (9) as a system illustrates the possible relation between the ratio of the marginal utility to the value of marginal product of the respective inputs used. The relation is given by the following equation.

$\frac{MU_{K*}}{VMP_{K*}} = \frac{MU_A}{VMP_A}$. This implies that $MU_{K*} = \frac{MU_{A*}VMP_{K*}}{VMP_A}$ (10)

Since $MU_{K*} = \frac{\partial U_i}{\partial K*}$, in the Lagrangian utility maximization problem, the marginal impact of area rented in is given as.

$\frac{\partial \mathcal{L}}{\partial K*} = \frac{\partial U_i}{\partial K*} = \left[\frac{VMP_{K*}}{VMP_A}\right] MU_A$ (11)