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Abstract

This paper analyses the impact of a low cost and restricted rights land certification program on the productivity of female-headed households. The analysis is based on plot level panel data from the East Gojjam and South Wollo Zones in the Amhara region of Ethiopia. The results suggest a positive and significant effect of certification on plot-level productivity, particularly on plots rented out to other operators. In addition, the results show that certification has different impacts on male and female productivity with female-headed households gaining significantly more and with zonal differences in the effectiveness of certification impacts.

Key Words: Ethiopia, Female Headed Households, Productivity, Land Market, Certification

JEL Classification: D2, Q12, Q15

1. Introduction

In many developing countries, traditional land tenure systems have been relatively rigid and highly intertwined with socio-cultural customs (Nega and Gebreselassie, 2003). With the current pressure on land due to increases in population density and changes in the economic environment, these systems are often malfunctioning (Deininger*et al.*, 2008a).

Women are often disadvantaged in both statutory and traditional land tenure systems (Agarwal, 1994; Quisumbing *et al*., 1996 Lastarria-Cornhiel, 1997; Kevane and Gary, 1999). Across Africa in particular, women's rights to property often derive from men in the household while their use of land is consequently constrained by the choices of the men (Dey, 1981; Okali, 1983; Crummy, 2000; Yngstrom, 2002). Ownership rights to land, and control over it in terms of production and management decisions, are arguably critical to productivity. Thus reforms that strive to improve land rights could go a long way to improve the economic position of rural women. Accordingly, the analysis of this paper examines if improved tenure security, in terms of formal land registration, has improved the productivity of farmers in general and that of female farmers in particular. More specifically, we estimate the impact of the Ethiopian Land Certificate Program on plot level productivity in the Amhara region in Ethiopia.

Since the 1990s, most African countries have passed new land legislation to remedy some of the perceived shortcomings of existing systems (Deininger*et al*., 2011). However, the degree to which these reforms have brought about the desired economic effects, and particularly if they have improved the status of women, remains debatable[1]. With mixed outcomes of early attempts at land titling in Africa, and considerable evidence linking the failure of reforms to their design and implementation, fresh and innovative methods that overcome the shortcomings of previous programs have generated renewed interest (Deininger *et al.*, 2008a).

The Ethiopian land certification program is a low-cost, bottom-up program, which ascribes farmers written user-rights to demarcated pieces of land. It differs from traditional land titling interventions in terms of, among other things, a greater emphasis on gender equity, e.g. certificates are issued in the name of both spouses (Deininger *et al.*, 2011). Analyzing such pro-gender features of the program in terms of the actual productivity benefits to women is, therefore, highly relevant.

Features of the Ethiopian land certification program have been previously assessed in relation to several economic variables of interest. A recent study by Holden *et al.* (2011) shows that the land certification program in the Tigray Region in Ethiopia enhanced female heads of household's participation in the land rental market. The same effect has also been found for the Amhara Region by Deininger *et al.* (2011). However, as pointed out by Deininger *et al.* (2011), analyzing the effect of land certification on the productivity of female farmers may contribute to important insights on the impacts of the program.

The purpose of this paper is to partially address the gap in related studies, and to assess features of the Ethiopian land certification program on the productivity of female-headed households, based on data from the Amhara region[2]. We hypothesize that land certification can help reduce the gender gap in land productivity in two main ways: (i) by increasing women's participation in the land rental market and land transfer to more efficient producers and, (ii) by increasing efficiency in the productivity of the non-leased portion of their land.

Our identification strategy relies on the timing of the implementation of the program. Since the program was applied to villages at different points in time, the implementation process creates a quasi-natural experiment, in which villages that had not yet received certificates in 2007 are taken as the control group. In order to assess the impact of certification on land productivity, we employ a difference-in-differences method. The paper is organized as follows. Section 2 gives a brief background on Ethiopian land policy, women's land rights, and the certification program. The survey strategy and data are discussed in section 4 while the estimation methodology, along with some considerations in the estimation procedure, is provided in section 5. Section 6 presents the empirical findings and section 7 concludes the paper.

2. Land reform, participation in the land rental market, and the productivity of female-owned land: A conceptual framework

The central hypothesis of this paper is that female-headed households, in the absence of land certification, have a lower level of tenure security than male-headed households. Given that the land certification program improves tenure security for all certificate holders equally, the program would then allow forhigher overall tenure security for female-headed households. Furthermore, as enhanced tenure security generally leads to increased productivity, the land certification program is likely to enhance farm level productivity. It therefore follows that the larger the increase in tenure security enjoyed by female-headed households due to the certification program, the greater the expected increase in the productivity of female-owned farms.

The importance of improved tenure security, a highly functioning land rental market and improved productivity in improving the social and economic status of rural women in Ethiopia cannot be overstated. First, there are reasons to believe that tenure insecurity, induced by the state-owned tenure system, is relatively stronger for women. Bezabih and Holden (2009) argue that the systematically lower tenure security of women is attributable to sociocultural constraints that dictate the terms of land use, and to the fact that women's access to land on their own rights has only recently been recognized. In particular, female landowners tend to be persuaded into renting out land to relatives and in-laws, who assume informal access rights towards the land[3].

Second, due to the taboo against women undertaking major farming activities (such as plowing with oxen), female-headed households are heavily reliant on the land rental market for production (Gebreselassie, 2005)[4]. However, due to the low degree of tenure security, land market participation by female-headed households is likely to be lower than what is optimal, given their labor needs. As Rozelle *et al.* (2002)[5] argues the risk of land loss constitutes a form of transaction cost in the land rental markets, which constrains their functioning. To the extent that land legislation programs bring about increased tenure security and, thereby, an improvement in the functioning of the land rental market, gains in efficiency are likely to follow (Teklu and Lemi, 2004; Deininger and Jin, 2006).

Given this and the ever-persistent gender gaps in agricultural productivity[6] an analysis of the recent land certification in Ethiopia has the potential to shed light on the particular contribution of secure land rights to the economic wellbeing of rural women.

While the certification program, and the resulting increased tenure security, is expected to have both short and long-term effects in enhancing productivity, we focus on the short-term effects.Namely this refers to the impact through participation in the land rental market. This emphasis on the land market is relevant in our case for two reasons. First, the analysis is based on data immediately after certification making only short-term effects quantifiable. Second, as was discussed above, the functioning of the land rental market has particular significance for the case under study.

3. Ethiopian Land Policy, the Evolution of Women's Land Rights, and the Land Certification Program

Rural women in Ethiopia have historically held an inferior position in relation to men in terms of property rights. Prior to 1975, Ethiopia's long feudalistic system of land tenure rarely recognized independent land ownership by women, except through marriage and inheritance. While women could inherit land from their parents or deceased husbands, women's direct access to land from the government has been uncommon (Crummy, 2000).

The overthrow of the last imperial government in 1975 abruptly instituted a series of measures that changed the political and economic landscape of the country from a feudal system to a socialist state (Kebede, 2002). Among the many radical measures, the land reform proclamation of February 1975 nationalized all rural lands.The state announced that all land was now owned by the state and given to farmers on a right-to-use (usufruct) basis, organized via peasant associations (Kebede, 2008). The farmers' membership in the peasant associations made them claimants, endowed with rights such as access, some management rights, and limited exclusion rights. Per the 1975 legislation, spouses enjoyed joint ownership of the land, implying that on paper men and women were entitled to the same land rights. However, women's rights to land depended on marriage and were, in most cases, not registered separately (Crewett *et al*., 2008).

The EPRDF[7]-led government that overthrew the military government (Derg) in 1991 largely maintained the land policy of its predecessor, keeping all rural and urban land under public (government) ownership (Gebreselassie, 2006). Significant changes included formal confirmation that land rights are to be granted to men and women, including the right to lease out land. However, most regions limit the period of the lease and restrict leasing rights to only a share of the farmland. While, in terms of legislation, these are important improvements in women's land rights, divorced women still lack secure land rights. This is possibly due to informal constraints such as relationships with in-laws, which may curtail these rights (Crewett *et al.,* 2008).

The Ethiopian certification program, initiated in response to widespread concerns over land tenure insecurityassociated with state land ownership, has contributed to the largest delivery of non-freehold land rights per time unit in Sub-Saharan Africa. The program follows the Federal Rural Land Administration Proclamation 1997, revised in 2005, and has been implemented in the four most populous regions of the country: Tigray, Amhara, Oromiya, and the Southern Nations and Nationalities (SNNR) (Adenew and Abdi, 2005).

The overarching responsibility for implementation of the land registration process and the development of a Land Administration System in the region lies within the Environmental Protection, Land Administration & Use Authority (EPLAUA) (Adinew and Dadi, 2005).

The focus of the empirical analysis in this paper is on the Amhara National Regional State (ANRS), in which the program commenced in 2004. The process of land registration starts with an awareness meeting between the Woreda and Kebele[8] administration and farmers about the purpose and organization of land registration and certification (Palm, 2010). The discussions are followed by the election of Land

Administration and Use Committees (LACs), along with provision of training for the elected LAC members. This is a local consultation process in which most of the input for adjudication and demarcation of land are provided by the local community (Abebe, 2010). The neighbourhood of farm households are jointly with LAC members walking the farm fields in order to identify the individual household plots and plot borders with neighbours as witnesses prior to entering this information into forms. Any outstanding conflict is passed to the courts and the result of the land adjudication is presented to the public for a month long verification in order to allow for corrections. Responsibility for approving the legal status of the holding is held by the Woreda EPLAUA head together with theLAUC chairperson. The actual evidence of registration is issued in two forms (stages). First, the LAC of the Woreda issues temporary certificates based on the approved field sheet information; mainly as a way of ensuring that paper evidence is given to the certificate recipients before the actual certificate. The Book of Holdings is issued by the Woreda (Olsson and Magnérus, 2007; Palm, 2010).

4. Survey strategy and data

The data used for the empirical analysis is taken from the Sustainable Land Management Survey, conducted in 2005 and 2007in the zones of East Gojjam and South Wollo of the ANRS. In each round, the data on more than 1,500 randomly selected households and over 7,500 plots was collected. The sample covers 14 Kebeles from five different Woredas in the two regional zones. About half of the sampled Kebeles in each zone received certification at least 12 months before the beginning of the survey in 2007.

The empirical analysis is conducted separately for the two zones owing to their heterogeneity. These two zones belong to the broad High Potential Cereal (HPC) category of the Ethiopian highlands which encompasses the north-central and south-eastern highlands, characterized by mixed crop-livestock farming (Zeleke *et al.*, 2010). A narrower classification, however, shows that East Gojjam has considerably more productive potential than South Wollo (Alemaw and Persson, 2006). The South Wollo Zone, unlike East Gojjam, is also routinely threatened by drought and hunger (Amare*et al*., 2000).

Our separate analysis of the two zones is also in line with persistent arguments among development practitioners and researchers for analysing heterogeneous environments in Ethiopia separately (Amare *et al*., 2000; Jabbar *et al.*, 2000; Chamberlin and Schmidt, 2011).In regards to this, it has been a common practice amongst researchers to explicitly take into account agro-ecological variations in analyzing technological adoption and agricultural productivity[9].

4.1. The choice of control and treatment kebeles and the common trend assumption

As discussed in section 3, the certification program was designed such that all the Woredas in the region were divided into three groups and the registration was sequentially rolled out into the three different Woreda groups. As per the discussion with officials from the EULPEA, the choice of which Woredas to reach first is based on a combination of factors such as the Woreda administrative capacity and Woreda facilities[10].

Since this gradual rollout which creates a geographic discontinuity, is the basis upon which Woredas/Kebeles are categorized as control and treatment groups, appropriate identification of the program impacts relies on the fact that these control and treatment groups are not systematically different from each other with respect to the major variable of interest-productivity[11]. The essence of randomness regarding the treatment and control villages lies in the need to ensure that the change in the outcome variable is attributed solely to the effects of the treatment. In other words, for the Woredas to be randomly chosen, it is required that the differences with respect to Woreda administrative capacity is not strongly associated with other crucial Woreda features such as population, demography, agricultural potential,and the level of economic development. If the non-certified and certified Woredas are not systematically different in terms offactors that are likely to influence productivity, a key variable of interest in this paper, then the sequential certification process could be considered random.

The primary criteria that we used to establish that the sampling of treated and control Woredas in the survey was random, is that there is no difference in the location of Woredas relative to the main road/nearest town. This measure of remoteness represents access to information, technology, and markets. These factors are crucial yet unobserved determinants of productivity which can be strongly associated with distance to road and town. As per our survey data, the average distance of the nearby town from the treatment and control villages is 69.5 and 72.5 minutes respectively. Similarly the average distance from a nearby main road is 24 and 37 minutes, respectively. This shows that, there is no pattern which makes the certified and non-certified Woredas significantly farther or nearer from the main road. These findings lend support to our assumption that the differential temporal treatment of the program across the different Woredas can be taken as a quasi-experiment to identify the causality between the policy and changes in gender-based differentials in productivity.

This identification strategy is in line with Deininger *et al.* (2011) who argues that the gradual rollout, in which some Woredas received certification prior to others, creates a geographic discontinuity that enables potential identification of program impacts.

Closely related to the random choice of Woredas is the common trend assumption, which holds if the unobserved influenceson productivity does not change in different ways between the control and treatment groups during the period under consideration.This implies thatthe general trend in productivity in the treated and not treated groups would have been the same in the absence of treatment.

The common trend assumption is fundamentally untestable after the introduction of the program. We therefore rely on the pattern of yield before the introduction of the program to validate the assumption. It should be noted that although the survey data includes two rounds prior to 2005, these rounds do not contain the full sample of villages included in the 2005-2007 rounds and some critical explanatory variables of interest. Hence, we use the pre-2005 data for conducting the test of the common trend assumption, and the 2005 and 2007 rounds for our impact assessment of the program.

We analyse to what extent it is possible to establish that the trend in productivity, given observable variations that can be controlled for, is the same for the treatment and control group. *Figures 1a* and *1b* depict the predicted yield patterns prior to and after the introduction of the certification program.The pattern of predicted yields in the treated villages is parallel to that of the control villages during the pre-policy change period in the years 2000 and 2002, particularly for the South Wollo sample while the pattern is less defined in East Gojjam. It should be noted that the yield corresponding to the treatment group is lower than the control group in the pre-policy change period. This situation substantially favors our empirical design because the treatment group's yield has a distribution very close to that of the control group post-policy change period.This finding is similar to Deininger *et al.* (2011) who, using the same data for their analysis, finds no evidence of a difference in trendswithin their variables of interest.

<< Figure 1 here>>

4.2 ***Construction of the certification variable***

The certification/treatment variable is constructed at a Kebele level as opposed to household or plot level. Defining certification at thehousehold level would require that households within certified villages that did not receive certification were unaffected by the certification process. However, as the majority ofhouseholds received certificates in the certified villages, spillover effects are likely. In addition, the households that did not receive certificates were mainly excluded for temporary reasons such as shortage of papers or delays in registering the households to the program. This implies that the group of households who did not receive certification in the certified villages are mainly households waiting for their certificate. Treating these households as non-certified would contribute to bias due to measurement errors[12].

4.3. Description of the variables used in the regressions

The variables used in the regressions are described in *Table 1*. The descriptive statistics of the variables are presented in *Tables 2* and *3,* respectively. The first two columns in *Tables 2* and *3* present the descriptive statistics for the certified and non-certified villages, in each zone. The third and fourth columns present the descriptive statistics for female-headed households, followed by the descriptive statistics for male-headed households only.

As can be seen in *Tables 2* and *3*, the average productivity is significantly higher in certified Kebeles in both East Gojjam and South Wollo. *Tables 2* and *3* also show that households in certified Kebeles rent out land to a slightly lesser extent than households in the non-certified Kebeles. Plots in certified villages to a higher extent have red colored soil in both regional zones. However, while the proportion of plots with fertile soil is significantly higher in certification Kebeles in South Wollo, the opposite holds for East Gojjam. The average plot size owned by male-headed households in certification villages in East Gojjam is larger than the average plot area in the control group, while the opposite holds true in South Wollo.

<<Table 2>>

<< Table 3>>

As can be seen in the lower sections of *Tables 2* and *3,* slightly over half the respondents in the sample are illiterate. For female-headed households, this figure is very high; almost 90 percent are illiterate. While the proportion of illiterate male head of households in East Gojjam is significantly lower in certified Kebeles, there is no significant difference in literacy between certification and non-certification Kebeles overall. The average number of male and female adults per hectare is about 2. Female-headed households have lower number of adult male members and higher number of adult female members. In East Gojjam, households in certification kebeles have a significantly higher number of male adults while the opposite holds true in South Wollo. In East Gojjam, male-headed households in certification Kebeles own significantly more land than their counterparts in non-certification Kebeles. In contrast, the landholdings of male-headed households in certification Kebeles in South Wollo are significantly lower than in non-certification Kebeles in the same zone. With regards to indicators of wealth, such as number of oxen and livestock, there are no significant differences between certification and non-certification villages.

Measures of tenure insecurity, such as experience of conflict, are fairly similar across control and treatment villages as well as among male and female headed households However, experience of loss of land via redistribution or other factors indicates that the control villages have had as high as 15% of the households experiencing loss of land with a larger portion of them being men.

Of the tenant characteristics included in the analysis, slightly over 35% of the tenants in the certified Kebeles and slightly over 40% in the control Kebeles are under 30 years of age. The proportion of young tenants to female-headed households is fairly similar in the control and treatment Kebeles while male-headed households in treatment Kebeles have a much smaller share of young tenants compared to male-headed households in the control kebeles. Around 75% of the tenants own land. However, tenants to male-headed households are landless to a much higher extent. Finally, *Tables 2* and *3* show that the average tenants's oxen ownership islarger than the average landlord's ownership, thus suggesting that there may be reverse tenancy relationships.

These results are in general agreement with expectations that the control and treatment villages, while quite similar, may not be identical in every respect. By virtue of the geographical discontinuity that enables labelling villages as certified and non-certified, these differences reflect the composition of the resulting samples rather than selection into treatment. The treatment variable in the succeeding sections accounts for such *ex-ante* differences in the treatment and control samples.

A graphical illustration of the distribution in farm plot-level productivity of the total sample and for female-headed households pre- and post-certification for treated and untreated villages is given in *Figure 2* below.

<< Figure 2 here>>

As can be seen in *Figures 2b* and *2d*, the distribution of value of yield per hectare was relatively similar between certified and non-certified kebeles before certification. However, especially for female-headed households, there is a clear shift towards a higher level of productivity after certification.

Given our choice of level for the treatment variable, our econometric analysis will result in conservative results, as some non-certified plots are included in the "treatment" group. The results will further constitute a lower bound due to the relatively short time horizon since implementation. For instance, some effects such as potential investments, the productivity effects of which only occur over a longer time interval, will not feature in such short-term measures.

5. **Econometric approach**

To identify the possible impacts of land certification on productivity, we employ the difference-in-difference approach. The specification compares the change in land productivity of certified Kebeles (treatment group) with the corresponding change in non-certified kebeles (control group). By enabling control for both observed and unobserved differences between the control and treatment groups (Wooldridge, 2002; Li *et al.*, 2010), the difference-in-difference method captures the causal effect of the program on plot level productivity.

5.1 Productivity Analysis with Certification

Our econometric analysis on the impact of certification starts with assessing the relationships between certification and productivity on all the plots in the survey. Accordingly, the plot level pooled productivity equation is given by:[13]

$$\ln(y_{pit}) = \alpha + \lambda_t + \delta\tau_t + \vartheta c_v + \phi\tau_t c_v + \gamma g_i + \theta g_i c_v + \varpi S_{it} + \mu X_{pit} + w_i + u_{pit} \qquad (1)$$

where, for Kebele *v*, household *i*, plot *p*, and year *t*, $\ln(y_{pit})$ is the log of the value of output per hectare;$\tau_t$is a year dummy for 2007 (after certification) and c_v is a dummy variable identifying whether the plot is located in a treatment or control village. The coefficient on the interaction variable, $\tau_t c_v$, thus corresponds to the effect of certification. We will henceforth refer to this variable as post-treatment. S_{it} represents observable socioeconomic characteristics, excluding gender, and X_{pit} is a vector of observable physical plot characteristics. Finally, w_i represents unobservable time-invariant household characteristics and u_{pit} denotes the remainder disturbance that can vary over time as well asacross households. In order to analyze the specific impacts of certification on our group of interest, female-headed households, and the relationship between certification and participation in the land market, we also run separate regressions for plots owned by female-headed households and rented out plots.

Since it may be presumed that the observed covariates are correlated with the unobserved individual effects, and since we want to keep time-invariant variables such as gender visible, our estimation procedure involves the pseudo-fixed effects estimation approach (Wooldridge, 2002). The approach involves explicitly modeling the relationship between time varying regressors and the unobservable effect in an auxiliary regression (Mundlak, 1978). In particular $w_i$can be approximated by its linear projection onto the observed explanatory variables:

$$w_i = +\omega Z_{it} + r_i \quad (2)$$

where r_i represents the random error term, and Z_{it} is vector of all the time-varying

$$\ln(y_{pit}) = \alpha + \lambda_t + \delta\tau_t + \vartheta c_v + \phi\tau_t c_v + \gamma g_i + \theta g_i c_v + \varpi S_{it+}\mu X_{pit} + \omega\bar{Z}_{it} + v_{pit} \quad (3)$$

regressors in equation (2). Averaging over t for a given observational unit *i* and substituting the resulting expression into equation (1) gives:

$$v_{pit} = r_i + u_{it}.$$

5.2 Analysis of the impact of certification on rented out and own-managed plots

The decision to rent out a portion of all the plots and operate on the rest of the plots within the household is likely to be non-random if rented out plots have systematically different characteristics from self-managed plots. In particular, unobserved variables may influence both the decision to rent out and productivity, resulting in inconsistent estimates of the effect of renting out on productivity. In such instances, an appropriate model of analysis is the endogenous switching regression model (Lee, 1981; Maddala, 1983), a system of equations consisting of the rent out equation and productivity regimes for rent out and own managed categories[14].

Since our estimation deals with selection bias and unobserved heterogeneity simultaneously, individual additive effects of both sources of estimation bias may be correlated with each other. Accordingly, Wooldridge (1995) as well as Dustmann and Rochina-Barrachina(2007) suggest obtaining inverse Mill's ratio for each time period in the selection equation and using the resulting inverse Mill's ratio in the succeeding productivity equations.

Equation (4) represents the plot selection whileequations (5) and (6) represent self-managed and rented out plots. In order to ensure identification of the decision to rent out land, in addition to the set of standard control variables, two variables that are not included in the productivity regressions are included: experience of past land-related conflict and experience of losses in land holdings, as represented by $Conflict$ and $Loss$ in equation (4) below.

The decision to rent out a plot as represented by equation (4):

$$L_{pit} = \begin{cases} 1 \; if \; \alpha + \lambda_t + \delta\tau_t + \vartheta c_v + \phi\tau_t c_v + \gamma g_i + \theta g_i c_v + \varpi S_{it} + \varrho Conflict + \varsigma Loss + \mu X_{pit} + \beta \bar{R}_{it} + \omega \bar{Z}_{it} + u \\ 0 \; otherwise \end{cases}$$

WhereL_{pit} is an indicator variable equal to 1 if the plot is leased out and zero otherwise. A similar specification as (3) applies to self-managed and rented-out plots, as given in equations (5) and (6), respectively:

$$\ln\left(y_{pit}\right)^{N} = \alpha + \lambda_t + \delta\tau_t + \vartheta c_v + \phi\tau_t c_v + \gamma g_i + \theta g_i c_v + \varpi S_{it} + \mu X_{pit} + \phi imr_i + \omega \bar{Z}_{it} + v_{pit} \quad ($$

$$\ln\left(y_{pit}\right)^{R} = \alpha + \lambda_t + \delta\tau_t + \vartheta c_v + \phi\tau_t c_v + \gamma g_i + \theta g_i c_v + \varpi S_{it} + \mu \tilde{X}_{pit} + \phi imr_{it} + \omega \bar{Z}_{it} + v_{pit} \quad ($$

where the superscripts *N* and *R* represent self-managed and rented-out plots, respectively. The variable *imr* stands for the inverse Mill's ratio from the plot rent equation.

6. Results and Discussion

6.1 Determinants of productivity: the impact of certification

Table 4 presents the estimation results of the productivity analysis with controls for the impacts of certification on the pooled sample as well as on rented-out and female owned plots for each of the zones.

As can be seen in Table 4, the results suggest that certification has a positive and significant effect on female-owned plots but not for the pooled plots and rented out plots in the Gojjam sample. This indicates that female landowners who received certification gained in productivity compared to female land-owners who received no certification. In the South Wollo sample, certification had a positive and significant impact for the pooled plots regression with insignificant coefficients corresponding to traded out plots and female owned plots. However, in the South Wollo sample, the coefficient on the interaction variable between post-treatment and female-headed households is positive and significant. This result suggests that, taking account of all the plots in the sample, the certification program has had a significantly positive impact on plot productivity for both men and women, but that the route these positive effects take may differ between men and women and between the two geographical zones. Overall, the above results confirm that female-headed households have gained significantly from the certification, in terms of increased productivity.

The coefficients on renting out corresponding to the pooled and female owned plots are positive and significant indicating that rented out plots are of higher productivity. Our results further suggest that being able to read and write largely has insignificant impacts on productivity except for female landlords in the South Wollo sample, where illiterate female-headed households have significantly lower productivity. Similarly, farm size (total landholdings) has a negative and significant effect on the productivity of female owned plots only in the South Wollo sample.

However, plot size is consistently and significantly associated with lower productivity across plot groups and zones, indicating possible intensity in the use of productivity inputs in smaller plots.The number of male adults per hectare have a positive but non-significant coefficient across all the regressions. The number of oxen has a positive impact on productivity in the pooled plot regression across the two zones. Of the soil characteristics, flat slope, and fertile plots appear to be the most significant determinants of productivity, while soil color is insignificant.

While oxen are a binding constraint in productivity, tenant's oxen ownership is not a significant determinant of productivity across the two zones. This may perhaps be explained by the fact that almost all tenants have oxen and rarely use the landlord's oxen in the sharecropping arrangement. This implies that tenants' oxen availability is almost a prerequisite in such arrangements (that is fulfilled), and thus a non-binding constraint. Tenant land ownership is a significant and positive determinant of productivity in East Gojjam while it is a significant and negative determinant of productivity in South Wollo. The age of the tenant has a positive and significant effect only in the East Gojjam sample.

<< Table 4 about here >>

6.2. The impact of certification on the productivity of rented out and self-managed plots

Table 5 presents' estimates of the productivity analysis separately for rented out and self-managed plots, taking into account the possible systematic selection of plots into the respective categories. The table is split into panels with the first panel representing results from the East Gojjam sample and the second panel presenting results from the South Wollo sample. The first column in each panel presents the results from the plot selection estimation. The remaining columns present the results from the productivity regressions for the rented out and self-managed plots, respectively.

<< Table 5 about here >>

As can be seen in Table 5, the effects of certification on the decision to rent out land differ between the two zones: While certification increases the probability to rent out land to a significant extent for the pooled sample in East Gojjam, it mainly affects female-headed households in South Wollo. This result supports the hypothesis that certification is especially beneficial for women in terms of increased tendency to rent out land. The results further suggest that experience of land conflict is negatively associated with land market participation in East Gojjam, while experience of land loss is more important in South Wollo. Female-headed and older household heads are significantly more likely to rent out land in both zones. The age of the household head and the ability to read and write are not significant determinants of the decision to rent out land in neither zone. Total land holding is a negative determinant of the renting out decision in the Gojjam sample, conforming to the expectation that households with large farm sizes could be discouraged from renting out land for fear of being targets of redistribution[15]. However, the results suggest that plot size is positively correlated with the decision to rent out land in the Wollo sample. Number of male adults per household, and the male adults per household, rose to two; both have significantly positive effects on the decision to rent out land in the Gojjam sample. The reverse holds true for the Wollo sample. As would be expected, the number of oxen has a significantly negative effect on the decision to rent out. Finally, fertile plots (lem) are less likely to be rented out than less fertile plots.

Turning to the effects on productivity, we see that certification has a significant and positive effect on productivity of self-managed plots in both regional zones, while the effect is insignificant for rented out plots. However, the coefficient on the interaction variable between female head of household and post-treatment is significant and positive in South Wollo. This indicates that certification, in addition to increasing the probability to participate in the land rental market, also increased productivity on rented out plots owned by female landlords in this zone.

The non-significant effect of male labor in the regression on rented out plots points to the reduction in the constraint when land is rented out. The same holds for oxen and livestock.

As can be seen in the table, the coefficient on the inverse Mills ratio (imr) is negative and significant for rented out plots in East Gojjam. This result suggests that rented out plots have systematically lower level of productivity than self-managed plots. For ease of interpretation, *Tables 6* and *7* contain elasticities corresponding to the productivity regressions in *Tables 4* and *5*, respectively.

7. Conclusions

The central hypothesis tested in this paper is to what extent gender based differences in tenure insecurity allows for heterogeneousimpacts of the Ethiopian Land Certification program on productivity. The intention of the land certification program in Ethiopia is to reduce the inherent insecurity of land holdings associated with state ownership of land. Female landowners are systematically more tenure insecure and more reliant on the land-lease market than male-headed households. In accordance with this, previous studies have found that the productivity differentials between male- and female-headed householdsareexplained by differences in tenure insecurity (Holden and Bezabih 2008; Bezabih and Holden 2009). Hence, if efficient, the Ethiopian Land Certification program has the potential to ease constraints related to tenure security, such as limited land market participation, and to promote better land management and investment, as well asbetter production decisions due to a more secure sense of ownership.

Our results suggest that, in accordance with expectations, certification has had positive effects on productivity. Furthermore, our empirical analysis shows that the certification program has been particularly important for female-headed households as it relaxes constraints related to tenure security by a relatively greater margin for these households and therefore enables them achieve a relatively higher productivity gain from the intervention. Finally, we show that the increase in productivity of female-headed households partly stems from the positive impact of certification on female-headed households' tendency to participate in the land rental market.

The major policy implication of the study is a confirmation that effective land reforms do improve the welfare, in terms of productivity, of rural households in general and of female-headed households in particular. The analysis and the results presented in this paper help address the gap in the literature on the role of reforms in improving economic performance of rural stakeholders in general, and the impact of certification in increasing the productivity of female farmers in particular. The clearest result emerging from our analysis is that the tenure-enhancing impacts of certification appear to boost productivity, most likely by encouraging proper land management. The impact of certification on enhancing female productivity is modestly positive and shows the potential of such reforms in reaching rural women.

Future studies that relate imperfections in the process of land reforms with intended economic outcomes can further illuminate our understanding of the relationship between female productivity and land reforms.

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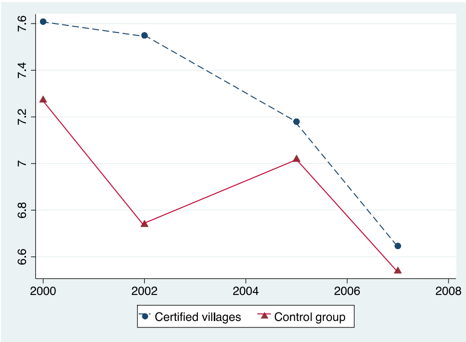

Figure 1a. Patterns of predicted average yield between certified and control villages, East Gojjam

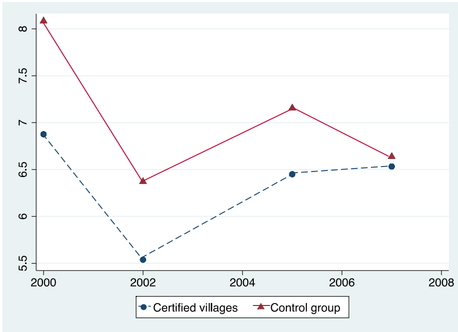

Figure 1b. Patterns of predicted average yield between certified and control villages, South Wollo

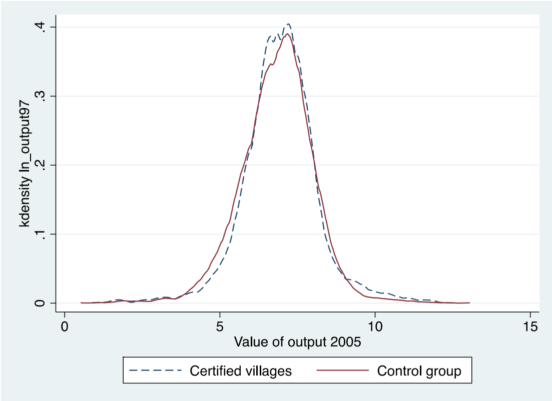

Figure 2a: Ln(value of output per ha), pre-certification (2005)

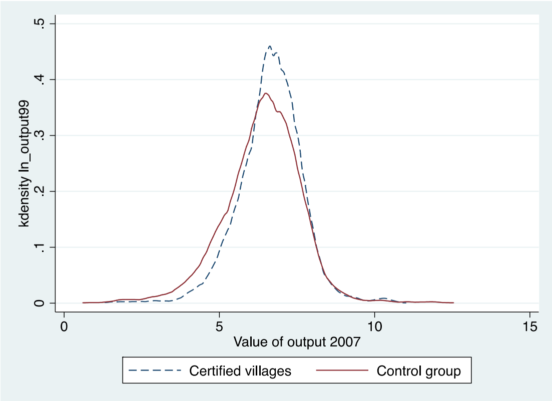

Figure 2b: Ln(value of output per ha), post-certification (2007)

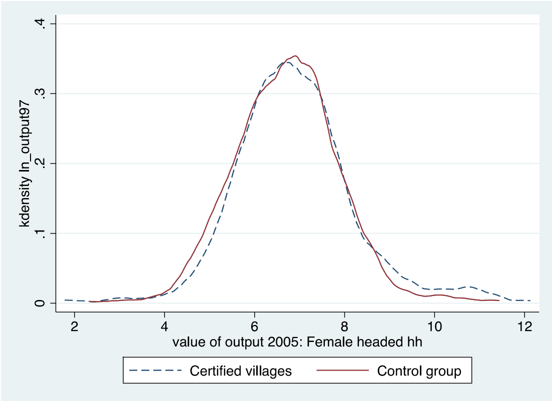

Figure 2c: Ln (value of output per ha). Female headed hh, pre-certification (2005)

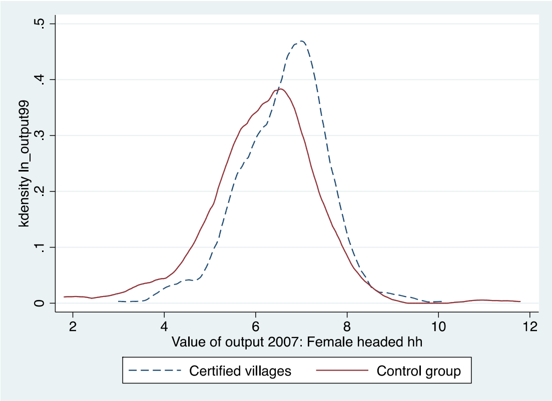

Figure 2d: Ln (value of output per ha). Female headed hh, post-certification (2007)

Table 1 Description of Variables Used in the Regressions

Variable name	Variable description
Socioeconomic characteristics	
Female head of hh	1 = female household head, 0 = male household head
Age of hh head	Household head's age (in years)
Household head illiterate	Head's formal education (1 = illiterate; 0 = other)
No.of maleadults	The number of male working-age family members of the household
No. of maleadults squared	The number of male working-age family members squared
No. of female adults	The number of female working-age family members of the household
Oxen per hectare	The number of oxen per hectare
Livestock per hectare	The number of livestock per hectare
Landholdings (ha)	Total farm size in hectare
Physical plot characteristics	
Fertile Plot	Plots with highly fertile soil (1 = fertile; 0 = not fertile)
Medium fertile plot	plots with moderately fertile soil plot (1 = medium; 0 = not medium)
Infertile plot (reference)	Infertile plot or other plot-fertility (1 = infertile; 0 = not infertile)
Black soil	Black soil in plot (1 = black; 0 = not black)
Red soil	Red soil in plot (1 = red; 0 = not red)
Other soil (reference)	Grey, sandy, white or dark red soil in plot (1 =other; 0 = other)
Flat slope	Flat plot (1 = flat; 0 = not flat)
Medium slope	Medium sloped plot (1 = medium; 0 = not medium)
Steep slope	Steep sloped plot (1 = steep; 0 = not steep)
Plot size in ha	Total plot size (in hectares)
Tenure security variables	
Conflict	Dummy variable for whether the household has experienced land related conflict in the past (1 = yes; 0 = no)
Changeland	Household has experienced a change in land in the past (1 = yes; 0 = no)
Tenant Characteristics	

Tenant is under 30 years	Dummy variable for whether tenant is under 30 years of age or not
Tenant owns land	Dummy variable for whether tenant owns land or not
No. of oxen owned by tenant	The number of oxen owned by the tenant
Land rented out to relative	Dummy variable for whether tenant is a relative or not
Plot distribution by rental categories	
Self-managed plots	A dummy variable indicating whether the plot is managed by the owner or not (1 = owner; 0 = no)
Rented-out plots	A dummy variable indicating whether the plot is rented out or not
Certification variables and land productivity	
Hh in the treated village	Plots in the certificate village (1 = treatment; 0 = no)
Post treatment	Plots in the certificate village for the Ethiopian year 1999 (1 = treatment; 0 = no)
Value of plot output per hectare	The log of the value of output per hectare

Table 2 Descriptive Statistics of Variables Used in the Regressions: East Gojjam

Variable Names	Full sample			Female headed households			Male headed households		
	No certification Mean	Certification Mean	P-value	No certification Mean	Certification Mean	P-value	No certification Mean	Certification Mean	P-value
Household characteristics									
N	*882*	*427*		*110*	*44*		*772*	*383*	
Female head of hh	0.125	0.103	0.241						
Age of hh head	50.503	49.052	0.115	53.200	49.705	0.263	50.119	48.977	0.236
Hh head is illiterate	0.596	0.438	0.000	0.927	0.909	0.719	0.549	0.384	0.000
No. male adults	2.162	2.354	0.014	1.373	1.386	0.945	2.275	2.465	0.019
No. female adults	2.020	2.276	0.000	2.264	2.432	0.465	1.986	2.258	0.000
Landholdings (ha)	1.901	2.958	0.000	1.686	1.981	0.268	1.931	3.070	0.000
Livestock per hectare (tropical livestock unit)	2.619	2.697	0.638	1.600	2.475	0.412	2.764	2.722	0.763
Oxen per hectar	1.051	1.157	0.087	0.626	0.729	0.579	1.112	1.206	0.145
Experience of land conflict	0.272	0.230	0.093	0.300	0.227	0.351	0.268	0.230	0.153
Experience of loss of land	0.059	0.126	0.000	0.009	0.091	0.074	0.066	0.131	0.001
Plot level characteristics									
N	*4161*	*2802*		*405*	*199*		*3756*	*2603*	
Log value of yield	6.733	6.920	0.000	6.495	6.977	0.000	6.758	6.916	0.000
Rented out plots	0.091	0.080	0.109	0.301	0.352	0.218	0.068	0.059	0.146
Self-managed plots	0.909	0.920	0.109	0.699	0.648	0.218	0.932	0.941	0.146
Plot area (ha)	0.367	0.408	0.000	0.400	0.371	0.268	0.363	0.411	0.000

Fertile plot	0.400	0.308	0.000	0.477	0.387	0.036	0.392	0.302	0.000
Medium fertile plot	0.369	0.445	0.000	0.296	0.412	0.006	0.377	0.447	0.000
Infertile plot	0.229	0.247	0.090	0.227	0.201	0.459	0.229	0.250	0.055
Other fertile plot	0.001	0.000	0.014	0.000	0.000		0.002	0.000	0.014
Black soil	0.399	0.066	0.000	0.405	0.060	0.000	0.399	0.067	0.000
Red soil	0.525	0.920	0.000	0.467	0.899	0.000	0.531	0.922	0.000
Other color of soil	0.076	0.014	0.000	0.128	0.040	0.000	0.070	0.012	0.000
Steep slope	0.080	0.035	0.000	0.062	0.050	0.559	0.082	0.033	0.000
Medium slope	0.336	0.219	0.000	0.309	0.226	0.029	0.339	0.219	0.000
Flat slope	0.577	0.743	0.000	0.630	0.719	0.027	0.571	0.745	0.000
Tenant characteristics									
N	*150*	*91*		*50*	*21*		*100*	*70*	
Tenant is under 30 years	0.360	0.396	0.584	0.320	0.286	0.779	0.380	0.429	0.529
Tenant owns land	0.820	0.813	0.895	0.880	0.762	0.274	0.790	0.829	0.529
No. Oxen owned by tenant	2.113	3.747	0.000	2.000	4.762	0.002	2.170	3.443	0.000

Table 3 **Descriptive Statistics of Variables Used in the Regressions: South Wollo**

	Full sample			Female headed households			Male headed households		
Variable Names	No certification Mean	Certification Mean	P-value	No certification Mean	Certification Mean	P-value	No certification Mean	Certification Mean	P-value
Household characteristics									
N	1000	877		163	198		837	679	
Female head of hh	0.163	0.226	0.001						
Age of hh head	52.338	49.625	0.000	52.472	51.040	0.444	52.312	49.212	0.000
Hh head is illiterate	0.553	0.551	0.942	0.816	0.848	0.414	0.501	0.464	0.147
No. male adults	2.196	1.798	0.000	1.601	1.071	0.000	2.312	2.010	0.000
No. female adults	2.071	1.811	0.000	2.209	1.838	0.001	2.044	1.803	0.000
Landholdings (ha)	1.596	1.470	0.015	1.042	1.128	0.239	1.704	1.570	0.026
Livestock per hectar (tropical livestock unit)	3.339	5.839	0.004	3.112	5.573	0.348	3.383	5.916	0.002
Oxen per hectar	1.380	1.662	0.139	1.198	1.458	0.627	1.416	1.722	0.098
Experience of land conflict	0.174	0.153	0.215	0.196	0.152	0.267	0.170	0.153	0.385
Experience of loss of land	0.152	0.035	0.000	0.098	0.040	0.035	0.162	0.034	0.000
Plot level characteristics									
N	4011	4281		487	774		3524	3507	
Log value of yield	6.518	6.724	0.000	6.442	6.712	0.000	6.528	6.727	0.000
Rented out plots	0.087	0.077	0.085	0.265	0.264	0.959	0.062	0.035	0.000

Self-managed plots	0.913	0.923	0.085	0.735	0.736	0.959	0.938	0.965	0.000
Plot area (ha)	0.346	0.260	0.000	0.296	0.250	0.000	0.353	0.263	0.000
Fertile plot	0.524	0.669	0.000	0.581	0.677	0.001	0.516	0.667	0.000
Medium fertile plot	0.389	0.269	0.000	0.345	0.271	0.006	0.396	0.268	0.000
Infertile plot	0.085	0.063	0.000	0.074	0.052	0.120	0.086	0.065	0.001
Other fertile plot	0.002	0.000	0.008	0.000	0.000		0.002	0.000	0.008
Black soil	0.548	0.565	0.113	0.532	0.580	0.094	0.550	0.562	0.320
Red soil	0.320	0.399	0.000	0.333	0.388	0.047	0.318	0.402	0.000
Other color of soil	0.132	0.036	0.000	0.136	0.032	0.000	0.132	0.036	0.000
Steep slope	0.050	0.023	0.000	0.076	0.014	0.000	0.046	0.025	0.000
Medium slope	0.269	0.192	0.000	0.224	0.145	0.001	0.275	0.202	0.000
Flat slope	0.681	0.783	0.000	0.700	0.841	0.000	0.678	0.770	0.000
Tenant characteristics									
N	142	97		57	61		85	36	
Tenant is under 30 years	0.324	0.237	0.140	0.316	0.295	0.809	0.329	0.139	0.016
Tenant owns land	0.894	0.918	0.545	0.877	0.885	0.894	0.906	0.972	0.119
No. Oxen owned by tenant	2.204	2.227	0.863	2.263	2.148	0.500	2.165	2.361	0.367

Table 4. Analysis of the impact of certification on productivity (All plots, rented out plots, female owned plots)

	EAST GOJJAM			SOUTH WOLLO		
Variable Names	Pooled	Traded out plots	Female headedhh	Pooled	Traded out plots	Female headedhh
hh in treated village	0.929***	0.082	0.763***	-0.079	0.524	0.202
	(0.069)	(0.419)	(0.188)	(0.068)	(0.397)	(0.159)
post treatment	0.173***	0.146	0.303*	0.144**	-0.564	0.110
	(0.061)	(0.270)	(0.173)	(0.070)	(0.411)	(0.192)
*Female head * post treatment*	0.088	0.339		0.108	0.552*	
	(0.109)	(0.259)		(0.114)	(0.321)	
ethyear==1999	-0.337***	-0.363*	-0.425**	-0.295***	0.327	-0.120
	(0.045)	(0.189)	(0.168)	(0.047)	(0.230)	(0.145)
Female head of hh	-0.072	-0.356*		-0.182***	-0.496**	
	(0.060)	(0.188)		(0.069)	(0.199)	
Age of hh head	-0.003***	-0.004	-0.005	-0.001	0.006*	0.003
	(0.001)	(0.005)	(0.003)	(0.001)	(0.004)	(0.003)
rented out plots	0.222***		0.268***	0.147**		0.065
	(0.063)		(0.102)	(0.064)		(0.105)
Hh head id illiterate	0.050	0.243	0.058	-0.013	-0.123	-0.436***
	(0.036)	(0.176)	(0.224)	(0.045)	(0.148)	(0.134)
total land holdings by hh 10 ha	-0.488***	-1.453***	0.008	-1.231***	-1.437	-2.957***
	(0.135)	(0.417)	(0.427)	(0.248)	(0.928)	(1.148)
Plot size in hectars	-1.119***	-1.362***	-1.102***	-1.169***	-1.681***	-1.378***
	(0.063)	(0.177)	(0.170)	(0.091)	(0.324)	(0.267)
No. of male adults	-0.073	0.206	0.112	0.081	0.137	-0.172

	(0.060)	(0.208)	(0.173)	(0.071)	(0.476)	(0.166)
No. of male adults squared	0.010	0.031	-0.038	0.007	-0.023	-0.001
	(0.007)	(0.036)	(0.033)	(0.008)	(0.032)	(0.013)
livestock per hectare	-0.008	-0.015	-0.013	0.005***	0.012	-0.007
	(0.011)	(0.049)	(0.009)	(0.002)	(0.061)	(0.004)
oxen per hectare	0.129***	-0.005	0.040	0.047***	0.098	0.077***
	(0.028)	(0.097)	(0.051)	(0.009)	(0.115)	(0.023)
Black soil	0.044	-0.062	-0.071	-0.028	0.066	-0.015
	(0.061)	(0.149)	(0.130)	(0.057)	(0.200)	(0.154)
Red soil	0.022	0.198	0.035	-0.019	0.010	0.051
	(0.059)	(0.124)	(0.134)	(0.057)	(0.226)	(0.149)
Flat slope	0.049	0.283	0.015	0.071	-0.169	-0.058
	(0.051)	(0.305)	(0.134)	(0.082)	(0.382)	(0.176)
Steep slope	0.028	0.248	0.040	0.038	-0.109	-0.055
	(0.056)	(0.277)	(0.146)	(0.085)	(0.374)	(0.189)
Fertile plot	0.015	0.019	-0.004	0.141**	0.193	0.198
	(0.037)	(0.170)	(0.141)	(0.066)	(0.250)	(0.126)
Medium fertile plot	0.024	-0.061	-0.109	0.090	0.047	0.326**
	(0.035)	(0.145)	(0.103)	(0.064)	(0.240)	(0.133)
Tenant is under 30 years		0.841**			0.175	
		(0.371)			(0.429)	
Tenant owns land		0.250			-0.453***	
		(0.176)			(0.174)	
No of oxen owned by tenant		0.055*			0.058	
		(0.033)			(0.094)	
land rented out to relative		0.265			0.044	

		(0.212)			(0.175)	
Constant	6.422***	6.502***	6.597***	7.492***	7.474***	7.705***
	(0.115)	(0.491)	(0.298)	(0.125)	(0.484)	(0.330)
chi2	1453.687	263.901	451.545	976.743	193.432	5141.059
r2	0.2916	0.3008	0.3827	0.2483	0.2470	0.3056
N	6925	412	604	8261	457	1261

Table 5: Determinants of productivity: regression estimates for rented out and self managed plots[xvi]

	EAST GOJJAM			SOUTH WOLLO		
Variable Names	Decision to rent out	Traded out plots	Self-managed plots	Decision to rent out	Traded out plots	Self-managed plots
hh in treated village	0.175	-0.010	0.935***	-0.044	0.412	-0.202**
	(0.284)	(0.668)	(0.073)	(0.320)	(0.499)	(0.095)
post treatment	0.257	0.162	0.192***	0.137	-0.517	0.226***
	(0.161)	(0.374)	(0.065)	(0.206)	(0.494)	(0.084)
ethyear==1999	-0.278***	-0.318	-0.368***	-0.507***	0.459*	-0.391***
	(0.099)	(0.235)	(0.043)	(0.123)	(0.245)	(0.043)
*Female head * post treatment*	0.006	0.361	0.097	0.541**	0.596*	0.061
	(0.304)	(0.327)	(0.166)	(0.244)	(0.321)	(0.131)
Female head of hh	0.956***	-0.517**	-0.014	1.484***	-0.747**	-0.061
	(0.190)	(0.241)	(0.080)	(0.223)	(0.341)	(0.100)
Age of hh head	0.018***	-0.009	-0.003*	0.029***	0.002	-0.000
	(0.004)	(0.006)	(0.002)	(0.006)	(0.007)	(0.001)
Hh head is illiterate	-0.092	0.391**	-0.007	-0.176	-0.143	-0.026

	(0.129)	(0.196)	(0.038)	(0.162)	(0.202)	(0.038)
total land holdings	-2.754***	-1.011*	-0.480***	-2.602***	-0.483	-1.088***
	(0.428)	(0.525)	(0.164)	(0.683)	(1.354)	(0.250)
Plot size in hectars	0.420***	-1.320***	-1.117***	0.544***	-1.793***	-1.171***
	(0.115)	(0.205)	(0.059)	(0.134)	(0.349)	(0.084)
No. of male adults	0.055	0.401	-0.102*	-0.718***	0.221	0.031
	(0.193)	(0.313)	(0.056)	(0.210)	(0.407)	(0.078)
No. of male adults squared	-0.054*	0.008	0.013*	0.120***	-0.034	0.018*
	(0.033)	(0.051)	(0.008)	(0.030)	(0.052)	(0.010)
livestock per hectare	0.013	-0.014	-0.001	-0.024	0.004	0.005
	(0.029)	(0.061)	(0.012)	(0.037)	(0.067)	(0.013)
oxen per hectare	-0.483***	0.012	0.109***	-0.238***	0.207	0.044**
	(0.085)	(0.142)	(0.029)	(0.085)	(0.145)	(0.020)
Fertile plot	-0.343***	0.042	0.002	-0.377**	0.168	0.088
	(0.113)	(0.139)	(0.037)	(0.181)	(0.242)	(0.060)
Medium fertile plot	-0.154	-0.053	0.038	-0.059	0.032	0.062
	(0.102)	(0.151)	(0.040)	(0.175)	(0.242)	(0.060)
Black soil	-0.208	-0.102	0.067	0.098	0.023	-0.036
	(0.183)	(0.180)	(0.071)	(0.167)	(0.250)	(0.062)
Red soil	-0.252	0.239	0.029	-0.254	0.017	-0.045
	(0.181)	(0.166)	(0.067)	(0.174)	(0.287)	(0.062)
Flat slope	-0.157	0.362	0.081	-0.037	-0.345	0.111
	(0.161)	(0.387)	(0.051)	(0.218)	(0.469)	(0.075)
Steep slope	0.009	0.321	0.044	0.172	-0.321	0.123
	(0.163)	(0.332)	(0.057)	(0.227)	(0.491)	(0.081)
conflict	0.324***			-0.059		

	(0.103)			(0.146)		
loss	-0.045			-0.589***		
	(0.231)			(0.215)		
Tenant is under 30 years		0.763*			0.216	
		(0.408)			(0.656)	
Tenant owns land		0.210			-0.358	
		(0.215)			(0.219)	
No of oxen owned by tenant		0.030			0.058	
		(0.042)			(0.107)	
land rented out to relative		0.262			0.076	
		(0.211)			(0.162)	
imr		*-1.026*	*0.503*		-2.065	1.276***
		(1.433)	(0.465)		(1.980)	(0.429)
Constant	-0.863**	7.183***	6.089***	-0.377	8.646***	6.731***
	(0.428)	(1.045)	(0.350)	(0.461)	(1.149)	(0.326)
lnsig2u						
Constant	0.380**			1.192***		
	(0.152)			(0.143)		
adjusted_r2		0.249	0.299	300.758	594.559	2693.236
chi2	306.4137	724.0638	2012.07		0.1930	0.2561
N	6925	412	6333	8261	457	7588

Table 6. Elasticities: Productivity

Variable Names	Pooled	Traded out plots	Female headed hh	Pooled	Traded out plots	Female headed hh
hh in treated village	0.929	0.082	0.763	-0.079	0.524	0.202
post treatment	0.173	0.146	0.303	0.144	-0.564	0.110
Female head post treatment	0.088	0.339		0.108	0.552	
ethyear==1999	-0.337	-0.363	-0.425	-0.295	0.327	-0.120
Female head of hh	-0.072	-0.356		-0.182	-0.496	
Age of hh head	-0.003	-0.004	-0.005	-0.001	0.006	0.003
rented out plots	0.222		0.268	0.147		0.065
Hh head is illiterate	0.050	0.243	0.058	-0.013	-0.123	-0.436
total land holdings by hh 10 ha	-0.488	-1.453	0.008	-1.231	-1.437	-2.957
Plot size in hectare	-1.119	-1.362	-1.102	-1.169	-1.681	-1.378
number of male adults	-0.073	0.206	0.112	0.081	0.137	-0.172
number of male adults squared	0.010	0.031	-0.038	0.007	-0.023	-0.001
Livestock per hectare	-0.008	-0.015	-0.013	0.005	0.012	-0.007
Oxen per hectare	0.129	-0.005	0.040	0.047	0.098	0.077
Black soil	0.044	-0.062	-0.071	-0.028	0.066	-0.015
Red soil	0.022	0.198	0.035	-0.019	0.010	0.051
Other color of soil	0.049	0.283	0.015	0.071	-0.169	-0.058
Steep slope	0.028	0.248	0.040	0.038	-0.109	-0.055
Medium slope	0.015	0.019	-0.004	0.141	0.193	0.198
Flat slope	0.024	-0.061	-0.109	0.090	0.047	0.326
Tenant is under 30 years		0.841			0.175	
Tenant owns land		0.250			-0.453	
No. Oxen owned by tenant		0.055			0.058	
Land rented out to relative		0.265			0.044	

Table 7. Elasticities: Switching regression

Variable Names	EAST GOJJAM Traded out plots	Self-managed plots	SOUTH WOLLO Traded out plots	plots
hhi treated village	-0.010	0.935	0.412	-0.202
post treatment	0.162	0.192	-0.517	0.226
ethyear==1999	-0.318	-0.368	0.459	-0.391
Female head post treatment	0.361	0.097	0.596	0.061
Female head of hh	-0.517	-0.014	-0.747	-0.061
Age of hh head	-0.009	-0.003	0.002	-0.000
Hh head is illiterate	0.391	-0.007	-0.143	-0.026
total land holdings by hh 10 ha	-1.011	-0.480	-0.483	-1.088
Plot size in hectare	-1.320	-1.117	-1.793	-1.171
Tenant is under 30 years	0.763		0.216	
Tenant owns land	0.210		-0.358	
No. Oxen owned by tenant	0.030		0.058	
land rented out to relative	0.262		0.076	
number of male adults	0.401	-0.102	0.221	0.031
number of male adults squared	0.008	0.013	-0.034	0.018
Livestock per hectare	-0.014	-0.001	0.004	0.005
Oxen per hectare	0.012	0.109	0.207	0.044
Black soil	-0.102	0.067	0.023	-0.036
Red soil	0.239	0.029	0.017	-0.045
Other color of soil	0.362	0.081	-0.345	0.111
Steep slope	0.321	0.044	-0.321	0.123
Medium slope	0.042	0.002	0.168	0.088
Flat slope	-0.053	0.038	0.032	0.062
imr	-1.026	0.503	-2.065	1.276

[1]Many land legislation programs do not consider gender structures concerning access to land, i.e. the programs are gender neutral (Yngstrom, 2002), and even when the programs attempt to explicitly strengthen women's property rights, lack of legal knowledge and weak implementation of the programs may limit women's ability to exercise their new rights (Deininger*et al.*, 2008b). Flawed implementation also causes land titling programs to benefit the wealthy and powerful at the expense of the poor and marginalized (Deininger *et al*., 2003; Cotula*et al*., 2004).Traditional institutions also suffer from a limited ability to deal with gender-related conflict and tend to be gender-biased (Khadiagala, 2001;Tripp, 2004).

[2]The focus of the analysis on the Amhara region has additional advantages in the analysis of the gender impacts of the program as there are fewer restrictions on the amount of land rented out in Amhara than in other Ethiopian regions (commonly having a maximum of 50 percent of land owned).

[3]This is confirmed to the authors upon informal discussions with the female-headed households who felt, although they are free by law to rent land to whomever they prefer, they would be alienated by their in-laws if they reject the tenancy arrangement.

[4]As Bliss and Stern (1982) argue, the markets for the complementary non-land factors (i.e. labor and oxen) are characterized by notorious imperfections and, thus, cannot play effective factor adjustment roles. Instead, land markets play a crucial role in matching operated land to other factor endowments of the household.

[5]Other studies that identify tenure insecurity as a major constraint in the land rental market include Deininger *et al.* (2008c),Ghebru and Holden (2008), Lunduka and Holden (2008), and Holden *et al.* (2011), .By implication, improvements in tenure security are shown to lead to increased participation in the land rental market (Deininger and Jin, 2006; Holden *et al.*, 2011).

[6]Examples include Nepal (Sridhar, 2008); India (Agarwal, 2003); Burkina Faso (Udry, 1996) Eritrea (Tikabo, 2003); Ethiopia (Holden *et al.*, 2001).

[7]EPRDF (Ethiopian People's Revolutionary Democratic Front) is the ruling political coalition in Ethiopia.

[8]Kebele is the smallest administrative unit in Ethiopia while Woreda is the next largest formed of a collection of Kebeles.

[9]In line with this, Kassie *et al.* (2010) explore the contributions of minimum tillage and CF technologies to net value of production in low-versus-high agricultural potential areas and find that the technologies have distinctively differential effectiveness in the two areas. Similarly, Benin (2006) shows that, high and low agricultural potential areas differ in adoption behavior with respect to improved land management practices.

[10]The original plan was to implement certification in all Woredas within the region simultaneously. However, due to shortages infinancial and manpower resources both at Kebele and Woreda levels, a strategic plan to implement certification sequentially was designed.

[11]The Kebeles in which the program was implemented at least 12 months prior to the survey in 2007 are taken as the treatment group and the rest of the Kebeles in our sample as the comparison group.

[12]Deininger *et al.* (2011) who use the East Gojjam portion of the same data in their analysis, define certification both at a household and village levels.

[13] As would be discussed in section 6, we analyze variants of equation (1) by including gender-certification-plot rent status interaction terms.

[14]The set up of our problem this way is similar to other studies which assess the role of rural factor markets. In line with this, Feng (2006) assesses the impact of land and labor market participation regimes on farm households' labor supply intensity, by estimating labor intensity equation for different land and labor market participation regimes, with the inverse mill's ratio from the participation decisions included additional explanatory variables. Additional example is a study by Carter and Yao (2002) who assess the role of land rental markets in on farm labor supply decision of Chinese households.

[15] While land redistribution has been stopped in the Amhara region since 1997, farmers still live with the experience of insecurity and the particular redistribution rule makes farmers with larger farm size per family number the primary target of redistribution.

[xvi] It should be noted that the inverse Mill's ratio is calculated from the probit regressions from the two years separately, following Wooldridge (1995), while the decision to rent out regression is a pseudo fixed effects regression that takes into account the post treatment variable that would not be accounted for in the separate probit regressions.