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Abstract

Land tenure security has long been touted as key to increased performance of the agricultural sector in developing countries. At the same time, off-farm employment is seen as a strategy to diversify rural economies. This paper utilizes household level panel data to analyse the impact of a land certification program on farmers' off-farm participation and activity choices in the Central Highlands of Ethiopia. Identification of the program's impact relies on the sequential nature of its implementation and application of the Difference-in-Differences strategy. Our results suggest that certification is a significant determinant of participation in off-farm employment. However, the impact differs substantially between different types of off-farm activities. While land certification is associated with an increased probability of participation in non-agricultural activities requiring unskilled labor, it reduces the probability of engaging in work on others' farms. In addition, the effect of the program depends on the size of landholdings. The differences in the responsiveness of different off-farm activities to both certification and farm size indicate the need to recognize the complex relationships between reform policies that enhance land tenure and the non agricultural sub-sector in rural areas. In light of similar previous studies, the major contributions of the paper are twofold: assessment of the effects of enhanced land tenure security on activities outside agriculture and evaluation of the role of farm size in determining off-farm participation.

Key Words: off-farm employment, land certification, farm size, Ethiopia

JL Codes: Q15, Q18, C35

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1. Introduction

Small-scale agriculture is a major employer in many poor countries. Ethiopia is no exception. The heavy dependence on small holder and low productivity agriculture makes a large share of the population vulnerable to weather and production-related shocks. Land certification has been one strategy to increase productivity. In addition, diversification of livelihood, particularly toward off-farm activities, has been suggested as a means of reducing vulnerability, as well as transforming the overall economy (Ellis 2000; Barrett et al. 2001; Lanjouw and Lanjouw 2001). This paper evaluates the extent to which a land certification program in Ethiopia impacts participation in off-farm employment and activity choice of rural households in the central highlands of Ethiopia.

Participation in off-farm activities may be driven by both push and pull factors. Households may be pushed into alternative livelihoods due to food insecurity, for example, or pulled into such activities due to demand from other sectors.[2] A household's ability and need to engage in off-farm activities thus depends to a large extent on its endowment of labor, land and other productive resources (Woldehana and Oskam 2001; Holden et al. 2004; Shi et al. 2007). Farmers' ability to participate in off-farm employment may also be determined by

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[2] In settings where farming is associated with low profits and high risk, "distress-push" diversification may motivate off-farm participation. In such instances, the non-farm sector serves as insurance against diminishing returns to assets and as risk management in the agricultural sector (Barrett et al. 2001; Block and Webb 2001; Rijkers and Söderbom 2013). Diversification due to "demand-pull" factors, on the other hand, is often motivated by seasonal and interpersonal aggregation of household income and consumption, as well as economies of scope in livelihood diversification (Davis 2003). In addition, participation in off-farm employment may depend on the ability to participate, e.g., depending on human and physical capital endowments (Deininger and Olinto 2001; Escobal 2001; Woldehana and Oskam 2001; Van den Berg and Kumbi 2006; Lanjouw et al. 2007; Bezu and Barrett 2012).

tenure security, because leaving the farm may be associated with a risk of losing the land in settings where the land system is characterized by tenure insecurity (Do and Iyer 2008; Deininger et al. 2008; Jin and Deininger 2009).

Ethiopia's current land tenure system makes for an ideal case to study the effect of improved tenure security on off-farm participation, for two main reasons. First and foremost, the land rights for Ethiopia's farming masses have been associated with inherent tenure insecurity, partly caused by the fact that farmers hold only usufruct rights to land and all land is formally owned by the state (Crewett et al. 2008). Second, the country has recently implemented a land certification program aimed at reducing tenure insecurity resulting from usufruct land rights.

Accordingly, the central hypothesis of this paper is that land certification enhances tenure security, which in turn enhances participation in off-farm employment. Tenure security may affect incentives to engage in off-farm activities, both directly and indirectly. The direct effect consists mainly of a reduction in the expected cost of being away from the land (i.e., a reduction in the risk of land loss through redistribution).[3] The indirect effects operate via farm level intensification (e.g., investments in soil conservation (Holden et al. 2009; Deininger et al. 2011) and increased use of external inputs (Holden and Yohannes 2002). While the direct effect is expected to be positive, farm level intensification may affect off-farm participation both positively and negatively. On the one hand, farming intensification may lead to an increased need for labor on the farm, and this naturally reduces the amount of labor available to engage in off-farm activities. If investment in the farm increases efficiency, on the other hand, this may free up labor available for participation in off-farm employment. In addition, we hypothesize that the impact of certification varies depending on the type of off-farm activities. We base this hypothesis on the fact that the different off-farm activities have differing relationships with on-farm activities (affecting on-farm labor demand), as well as varying needs for physical proximity to the farmer's own farm (affecting concerns about land redistribution, discussed above).

In the empirical study, we use survey data obtained from the Amhara National Regional State of Ethiopia, containing information on household level off-farm employment participation, to estimate the effect of the land certification program on off-farm participation and on individual off-farm activities. We further analyze the effects of farm size and

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[3] If off-farm activities are interpreted as a signal of excess landholdings by the government, and if the government has the right to redistribute land, farmers may avoid productive off-farm activities. If land certification reduces the insecurity related to being away from the farm, we thus may expect an increase in productive off-farm engagements, as individuals would no longer be constrained by the repercussions of tenure insecurity.

availability of adult labor. The empirical strategy follows the Difference-in-Differences method widely employed in impact assessment studies and exploits the gradual implementation of the certification program as an identification strategy.

Our study is closely related to Zhang et al. (2004) and to Jin and Deininger (2009), who analyze the relationship between tenure security and off-farm employment in China. It is also related to Deininger et al. (2008) and to Do and Iyer (2008), who conduct a similar analysis on Indian and Vietnamese data, respectively. Jin and Deininger (2009) use household panel data to analyze the link between access to land rental markets and occupational diversification. Their results suggest that land rental markets have a positive effect on engagement in off-farm activities. Similar results are found in Zhang et al. (2004) and in Deininger et al. (2008).

In contrast to the above-mentioned studies, our study is primarily interested in off-farm employment as an outcome variable. We also employ a measure of tenure security that is more general than increased activity in rental markets. The study most closely related to ours is by Do and Iyers (2008), who investigate the impact of a land certification program on the time spent on non-farm activities. Like our study, their identification strategy relies on the non-uniform timing of the land certification across the country.

Our study is closely related to a few previous studies investigating the association between tenure security and non-farm employment (Jin and Deininger (2009), Zhang et al. (2004), and Deininger et al. (2012) on China; Deininger et al. (2008) on India; and Do and Iyers (2008) on Vietnam). Using a household panel dataset, Jin and Deininger (2009) investigate the contribution of a land rental market to occupational diversification, where the likelihood of renting out land is associated with income diversification and migration in China. The positive relationship between off-farm employment opportunities and the likelihood of renting out land is also found in Zhang et al. (2004). Exploiting cross-state variation in land rental restrictions, using a household panel dataset, Deininger et al. (2008) find that the land rental market is more active in locations with high levels of non-farm activities in India.[4] Unlike the above studies, our study is primarily interested in non-farm employment as an outcome variable and employs a measure of tenure security that is more general than increased rental markets, which is only one of the many outcomes of land certification programs. Moreover, our study looks into the impact of certification on activity choice, an issue not covered in previous studies. Our analysis of certification at both a village

[4] Lohmar (1999) also found that tenure insecurity, as measured by percentage of households with land changes due to village-wide relocation, is negatively associated with probability of participation in off-farm activities.

and household level is also uncommon in previous studies, which look into certification at a province level only.

The study most closely related to ours is by Do and Iyers (2008), who investigate the impact of a land certification program on the time spent on non-farm activities using the DiD approach. Like our study, their identification strategy relies on the non-uniform timing of land certification across the country. The role of tenure security for off-farm employment participation is largely overlooked in the African literature. We also refine the study of participation in the non-farm sector by looking at various activity choices within the sector.

The rest of the paper is organized as follows. Section 2 provides background information on the development of land tenure policies and the certification program in Ethiopia. Section 3 provides information on the datasets used for the analysis and discusses descriptive evidence. Section 4 provides methodological discussion on the estimation strategy and presents the econometric models used. Baseline results together with their robustness checks are presented in Section 5. Finally, Section 6 concludes and discusses policy implications of the study.

2. The Land Tenure System in Ethiopia and the Land Certification Program: Background

2.1 Evolution of Land Tenure Policies in Ethiopia

Under the feudalistic system characterizing Ethiopia's political and economic landscape until 1975, the elite held all land and farmers' tenure security hinged upon the quality of tenant-landlord relations. The feudalistic system was ended and replaced by a socialist state (Derg) in 1975 with the overthrow of Emperor Haile Selassie. Under the Derg, all land was nationalized and redistributed to farmers via peasant associations.[5] Land rights were defined on a usufruct basis with no transfer rights to sell, lease, mortgage or sharecrop.[6] Due to increasing population pressure, government land redistribution was frequently implemented, and the maximum landholding per family was set at ten hectares. Eligibility and access to land was contingent on a physical presence on the land. Taken together, the system was characterized by a very high level of tenure insecurity, including a ban on land rental activities that is believed to have effectively prevented any migration or pursuit of alternative livelihoods for rural landholders (Kebede 2002; Adnew and Abdi 2005).

[5] Peasant associations are local level administrative organs mandated to handle land related matters

[6] Transfer via inheritance was allowed, but only to immediate family members and only if permission from the peasant association had been acquired.

In 1991, the Derg was overthrown and replaced by the Ethiopian People's Revolutionary Democratic Front (EPRDF). The 1995 constitution introduced a few improvements in tenure security, e.g., a requirement that farmers exposed to expropriation have the right to compensation for any investments made on the land and an extension in the time farmers are allowed to lease out land. However, the new government, to a large extent, maintained the land policy of the Derg: land was defined as public property, which farmers were forbidden to sell or to use for other means of exchange, and farmers were required to leave the land if it was needed for public purposes. As a consequence, the 1995 constitution is believed to have only partially resolved the tenure insecurity problems of rural land holders (Adnew and Abdi, 2005).

In an effort to enhance tenure security and improve utilization of land, further steps were taken by the federal and regional governments of Ethiopia. In particular, the Rural Land Administration and Use Proclamation was drafted in 1997 (and revised in 2005 by the Ministry of Agriculture and Rural Development) to give farmers who hold title certificates the right to pass land rights on to their family members, to lease out plots to other farmers and investors based on the land administration rules without being displaced, and to use land as collateral (Adnew and Abdi, 2005). In 2002, the regional states received greater legislative powers enabling them to form their own land-related policies, and new regional structures for land administration (such as the Environmental Protection Land Use and Administration Authority, EPLUA) were established. The main objectives of the certification program were to improve tenure security through land registration and titling, to promote better land management and investment, and to reduce conflicts among farmers over land boundaries and user rights.

2.2 The Land Certification Program in Ethiopia

The Ethiopian land certification program was first initiated in the Tigray region in 1998, followed by the Amhara region in 2003/2004. Oromia and SNNP started certification in 2007. The program is a variant of the land legislation programs that many African countries have been implementing since the 1990s to remedy some of the perceived shortcomings of existing systems. It differs from traditional land reform programs in terms of the relatively low cost at which it has been implemented and the participatory nature of the program. Between 1998 and 2007, it has been estimated that over 5 million farm households have certified their land holdings in the four regions of Ethiopia (Deininger et al. 2011; Adnew and Abdi 2005). The cost has been estimated to be about 1 USD per farm plot or 3.5 USD per household (Deininger et al. 2008). Given that conventional titling costs up to about 150 USD per household in Madagascar (Jacoby and Minten 2007), the Ethiopian program can indeed be argued to be low-cost. The certificates ascribe farmers with written user rights to demarcated pieces of land. Before the final certificate is issued, the document is subject to a series of negotiations between participating farmers and implementing officials (Deininger et al. 2011).

The implementation of the program is conducted through Land Administration Committees (LACs) at the *woreda*[7] level in five distinct steps. First, an awareness raising meeting regarding the purpose and organization of land registration and certification is conducted between the woreda and kebele administration and farmers (Palm 2010). In the second step, Land Administration and Use Committees (LACs) are elected, and the elected LAC members are trained. During the third step, individual households' plots are identified and demarcated jointly by LAC members, the designated household and households with neighboring fields (Adnew and Abdi 2005). In the fourth step, the registered information is entered on the forms and any outstanding conflict is passed to the courts; the result of the land adjudication is then presented to the public for a month-long verification in order to allow for corrections. In the final step, the book of holdings is registered. The legal status of the holding is registered by the woreda EPLAUA head together with the LAC chairperson (Olsson and Magnérus 2007; Palm 2010). Certified households are provided with a document which typically includes the names and photographs of the household head and spouse, the size and location of the land holding, and the neighbors of the demarcated land of the household.

Previous impact evaluation studies of the certification program indicate that the program has boosted farmers' perceptions of tenure security and has improved land rental market participation of female-headed farm households (Deininger et al. 2011; Holden et al. 2011; Bezabih et al. 2011). The program's impact has been assessed in relation to agricultural productivity (Holden et al. 2009; Deininger et al. 2011; Bezabih et al. 2012) and land related investments such as soil and water conservation (Holden et al. 2009; Deininger et al. 2011). However, to our knowledge, no study has previously analyzed the extent to which the land certification program has affected rural households' participation in off-farm activities.

[7] The *kebele* is the smallest administrative unit in Ethiopia, while the *woreda* is the next largest, formed of a collection of kebeles.

3. Data and Descriptive Statistics

To implement the analysis, we use panel data collected through a set of rural household surveys, collected during the 2005 and 2007 cropping seasons.[8] The surveyed households are located in two zones (South Wollo and East Gojjam) of the Amhara National Regional State, a region that encompasses part of the northern and central highlands of Ethiopia. The choice of the two zones is intended to reflect the agro-ecological diversity within the region, with East Gojjam having high agricultural potential and less rugged topography, and enjoying a more reliable rainfall pattern, than South Wollo. The sample consists of a panel of 1720 households (about 120 from each Kebele) randomly selected in 14 Kebeles (seven from each zone)[9][10].

The rural household survey was designed independently of the implementation of the certification program, and therefore includes households that were covered by the certification program and those that were not. In addition, the first three rounds of the survey were effectively conducted before the implementation of the program. This makes these rounds an ideal baseline for estimating the effects of the program. The last round of the survey, conducted in 2007, was designed to gather information on the features of the certification program that enable analysis of the impact of the program on different variables of interest. As noted in Section 2, the certification program was introduced in the region in 2003/2004, although full scale implementation started in 2005. The survey contains detailed data on off-farm employment participation, agricultural production, physical farm characteristics, indicators of tenure security and details on the process of land certification. The construction of the certification, off-farm employment and other explanatory variables are discussed below.

[8] This multi-year survey was conducted by the Ethiopian Development Research Institute and Addis Ababa University, in collaboration with the University of Gothenburg, and with financial support from the Swedish International Development Cooperation Agency (Sida) since 2000. To date, four rounds of the Ethiopian Environmental Household Survey (EEHS) have been collected, during 2000, 2002, 2005, and 2007. The last two rounds of the survey will be used in the main analysis, while part of the information in the first two rounds is used for robustness checks, as discussed in the subsequent sections.

[9] Due to the panel nature of the data, attrition bias could be a potential problem. However, a simple inspection of the data showed that attrition may not be a problem, as the households covered in the last two survey rounds have been fairly similar.

[10] 247 out of the 2,617 households (9.44 percent) surveyed in 2005 did not participate in the last round of the survey. Of these, 82 households were living in kebeles reached by the certification program and 165 were living in kebeles not reached by the program before the last round of the survey. Our tests for attrition bias show that there is a significant difference in the risk of attriting in kebeles reached and not reached by the certification program. However, we find no evidence of attrition bias in terms of our outcome variable. To test for attrition bias, we estimate a Heckman selection model where the first step is selection into staying in the sample and the second step estimates the probability of engaging in off-farm activities corrected for selection bias. The coefficient on the inverse mills ratio was insignificant in all specifications.

3.1 The Certification Variable

The certification program is characterized by a gradual rollout, where certification in each kebele occurs in a rapid, campaign-style. The gradual rollout implementation was adopted because the initial plan of simultaneously reaching all woredas (and kebeles) within the region could not be realized.[11] Our dataset contains information on whether or not a household had a certificate of its landholdings 12 months prior to the last survey round. This makes it possible to define the intervention at a household level. However, many of the households that are marked as "non-certified" in the data are in reality waiting for their formal documents and have been excluded for temporary reasons such as shortage of papers or delays in their program registration. Indeed, in villages where a considerable number of the households were not certified at the time of the last survey or were not certain that they would be certified, all were eventually certified. Because spillover effects are likely, defining certification at a kebele level may also be justified.

We therefore use two means of identifying certified households: at the household and kebele levels. If a given household had acquired certification at least 12 months before the last round of the survey (in 2007), the household is labeled as "certified" according to a household level definition of certification. For the kebele level certification, we define a dummy certification variable, which takes the value of one if the kebele to which a given household belongs was reached by the program 12 months prior to the 2007 survey round and a value of zero otherwise. It should be noted that, because most of the control group had already received information about the program or undergone the registration process, our estimates reflect a lower bound of the total effect of the program (Deininger et al. 2011).

3.2 Participation in Off-Farm Activities and Off-farm Employment Activity Choice

Our off-farm employment variables distinguish between participation and activity choice measures. Participation in off-farm activities is a binary variable, which represents the outcome of participation in any off-farm employment activity. The variable takes the value of one if the household engages in any off-farm activity, and the value zero if there was no participation in any such activity. The off-farm activity choice variables are represented by 14 different activities. However, due to low frequencies in some activities, we have merged the categories into five. The first two categories include *farm worker* (agricultural activities on other people's farms) and *free worker* (labor sharing arrangements where people contribute labor freely but also expect the favor back in terms of labor contribution). The third category,

[11] This is reported to be due to shortages in financial and manpower resources both at kebele and woreda levels.

professional work, includes teaching, mechanics, driving, clerical jobs, administrative work, health work, building and crafts making. In the fourth category, *unskilled* off-farm activity includes household help, shop keeping, security guard, and other miscellaneous activities. The last category is food-for-work – a program where participants are involved in public infrastructural development such as building conservation structures, dry-weather roads, or tree planting, and are paid in kind. Increases in farm work, free work, unskilled work and professional work due to the certification program are considered positive outcomes, because these activities are labor diversification strategies likely to improve household welfare. However, increased participation in food-for-work activities is less likely to be an intended effect of the program, as engagement in this type of activity points instead to a vulnerability of the household.

Table 1 presents the distribution of individuals across different off-farm activities in 2005 (before the program) and in 2007 (after the program). The first two columns are for the pooled sample, the second two are for kebeles reached by the program in 2007 and the last two are for kebeles not reached by the program in 2007. As Table 1 shows, most households do not engage in off-farm activities, but there seems to be a trend toward more engagement. Around 88 percent of the households did not engage in any off-farm activities in 2005. In 2007, this figure had fallen to 79 percent. Table 1 further reveals that the trends across different activities are very different. While engagement in professional work increased substantially during the study period (from 0.82 percent to 4.79 percent), participation in farm work outside of one's own farm decreased (from 5.16 percent to 1.9 percent). It is also notable that engagement in food-for-work activities increased from 0.14 percent in 2005 to 9.57 percent in 2007.

Although relatively more individuals in certification villages engaged in off-farm activities (15.7 percent) than in non-certification villages (9.3 percent), the structure of participation in the different off-farm activities was relatively similar in certification and non-certification villages in 2005 (i.e., prior to certification). In 2007, the difference in off-farm participation (all activities) is smaller, but, if we look at the individual activities, we see that the pattern is slightly different in certification and non-certification villages. Participation in farm work on others' land and free work fell much more in certification villages than in non-certification villages, while participation in professional work, unskilled work and food-for-work increased more.

3.3 Other Control Variables

The relevant summary statistics for our control variables are presented in Table 2. The first panel of the table contains summary statistics for the pooled sample, while the second and third panel depict statistics for certified and non-certified villages, respectively. The statistics presented are for the entire time period (2005 and 2007).

As can be seen in Table 2, the average age of the household head is about 51 (49 in certified villages and 51 in non-certified villages) in the sample. 14 percent of the surveyed households have a female head of household. The share of female-headed households is slightly higher in treated villages (16 percent) compared to non-treated villages (12 percent). About half of the households have an illiterate household head (51 percent and 56 percent in certified and non-certified villages, respectively). Households have, on average, two females and two males of working age (above 15 years), 4.6 livestock (tropical livestock units) and 1.8 oxen. Households in certified villages hold slightly more livestock and oxen than households in non-certified villages.

Because physical farm characteristics may influence labor demand on the farm, we also include variables related to soil and land. As can be seen in Table 2, households in our sample have user rights to 2.5 hectares of land on average. The mean plot area is 0.3 hectare. About 56 percent of the plots in the sample are defined as fertile, while 10 percent of the plots are located on infertile soil. The share of plots with infertile soil is slightly higher in kebeles not reached by the certification program (11 percent versus 8 percent in certification kebeles). Finally, a majority of the plots are located on flat land (71 percent). However, a slightly higher share of plots in non-certified kebeles is located on steep slopes (6 percent versus 2 percent).

3.4 Tenure Security Variables

In order to measure tenure security, we use experience of land loss and expected changes in land holdings in the coming five years.[12] In kebeles reached by the certification program in 2007, 6 percent had experienced land loss. This figure is higher in our control group, where 10 percent had lost land in the 5 years preceding the surveys. 14 percent expect to lose land in the future (13 percent in certification kebeles and 15 percent in the control group), while 32 percent expect no change in landholdings (36 percent and 29 percent in certification and non-certification kebeles, respectively).

4. Empirical Strategy

In order to estimate the effect of the certification program on engagement in off-farm activities, we combine the non-parametric approach of propensity score matching with the

[12] The question is formulated as "In the coming five years, do you expect increase, decrease or no change in uncertainty in your land holdings?" Experience of land loss is constructed as a dummy variable assuming a value of 1 is there is any past experience with respect to changes in the size of land holdings, and zero otherwise.

Differences-in-Differences (DiD) method. The essence of the propensity score estimation is to balance the observed distribution of covariates across households in the control and treatment groups, thereby reducing bias in the measurement of the program impacts that are associated with observables (Rosenbaum and Rubin 1985). The DiD method is suitable for identifying the effects of a random program intervention in which information on the variables of interest exists before and after the introduction of the program. Such a program typically targets a certain group of individuals (treated group) while the remaining group of individuals (control group) is not exposed to the program (Wooldridge 2002). In our case, the approach measures the impact of the land certification program by comparing the change in off-farm participation and off-farm activity choice of households in certified kebeles/households (treatment group) with the corresponding change for households in non-certified kebeles/households (control group).

However, the DiD approach is only a valid approach if the assumption of a parallel trend in certified and non-certified kebeles/households is fulfilled,[13] which could be potentially invalidated by the presence of unobservable time variant differences. Because the presence of such unobservables is inherently non-testable, we employ methods of indirectly testing for the presence of common trends, or validating the so-called common-trend assumption.

4.1. The Propensity Score Matching Method

In order to find a group of treated households/kebeles similar to the control households/kebeles in all the relevant treatment characteristics, we start with estimating a standard logit certification model, as given in Equation (1).

$$P_{it} = \alpha + H_{it} + u_{it} \tag{1}$$

where, for household *i* and year *t*, P_{it} is a dummy variable representing participation in the program or not; H_{it} is a vector of variables used as determinants of the likelihood of participation; and u_{it} is the error term, following a logistic distribution. The essence of the logit equation is that it forms a basis for estimating the propensity score from predicted values of Equation (1), which enables the generation of a comparison group by picking the

[13] Violation of the common trend assumption implies that the effect of certification may not be identified because there are underlying factors that cause the variable of interest to respond differently in the control and treatment villages.

"nearest neighbor" with similar characteristics for each participant (Jalan and Ravallion 2003)[14].

The propensity score is given by:

$$e(x) = \Pr(w = 1)|X = x = E(w|X = x)(2)$$

where *w* is the indicator of exposure to treatment, and *x* is a multidimensional vector of pre-treatment characteristics. The choice of covariates to be included in the propensity score estimation is based on the principle of maintaining a balance in using common variables and, at the same time, meeting the common support criteria (Jalan and Ravallion 2003). After matching, there should be no systematic differences in the distribution of covariates between the two groups; as a result, the pseudo-*R*2 upon matching should be fairly low and the joint significance of all covariates should be rejected.

4.2 The Difference-in-Differences Method

The Difference-in-Difference analysis of impacts of certification on off-farm participation is carried out on the matched sample generated from the propensity score matching analysis discussed in Section 4.1. The hypothesized relationship between certification and participation in off-farm employment is represented by Equation (3).

$$\Pr(R_{it} = 1) = \alpha_o + \alpha_1 P_i + \alpha_2 T_t + \alpha_3 P_i * T_t + \alpha_4 X_{it} + \alpha_i + \varepsilon_{it} \qquad (3)$$

where R_{it} is a dummy variable identifying the respondent household i's off-farm participation status at time t. P_i is a dummy variable identifying whether or not the respondent household is located in a treated kebele. T_t represents a time dummy equal to one for the post-program period and zero otherwise. The coefficient of the interaction variable $P_i * T_t$ thus captures the impact of certification. Finally, X_{it} is a vector of other control variables, including socioeconomic and physical farm characteristics, with potential effects on off-farm participation; α_i represents time-invariant household specific characteristics; and the error term is denoted by ε_{it} .

The parameters of interest in Equation (3) are α_1, α_2 and α_3. α_1 represents pre-existing differences in off-farm participation between the treated and control groups in 2005, while α_2 represents the change in off-farm participation in the control and treatment villages

[14] The nearest-neighbor matching method, compared to other weighted matching methods, such as kernel matching, allows for identifying the specific matched observations that would be employed in the subsequent difference-in-difference analysis.

between 2005 and 2007. Our major parameter of interest is α_3, which captures by how much the likelihood of participation changed in the treated villages, as compared to the control group.

We expand Equation (3) to incorporate the potential impact of farm size. The role of farm size is represented by a variable that measures a household's total landholdings and its interaction with the certification variable (post-certification variable), denoted by F_{it} and $P_i T_t * F_{it}$, respectively. In Equation (4), the direct effect of farm size on off-farm participation is captured by α_4, whereas $\alpha_5 \neq 0$ captures heterogeneous impact of the certification among holders of various sized farms due to the association between tenure security and farm size.

$$R_{it} = \alpha_o + \alpha_1 P_i + \alpha_2 T_t + \alpha_3 P_i * T_t + \alpha_4 F_{it} + \alpha_5 P_i T_t * F_{it} + \alpha_6 X_{it} + \alpha_i + \varepsilon_{it} \quad (4)$$

The probability of engaging in any type of off-farm activity is analyzed using the standard random effects logit model, while the activity choice model is analyzed using the multinomial logit model. As in the case of dichotomous logit models, the multinomial logit is based on random utility theory. In other words, individuals who report that a member of their household has participated in off-farm employment are assumed to choose the alternative with the highest utility. In our analysis, individuals choose between five alternatives: agricultural work on other people's fields (daily labor), food-for-work, skilled off-farm work and other off-farm employment. Accordingly, the multinomial logit specification is given in (5).

$$A_{it} = \beta_o + \beta_1 P_i + \beta_2 T_t + \beta_3 P_i * T_t + \beta_4 F_{it} + \beta_5 P_i T_t * F_{it} + \beta_6 X_{it} + \beta_i + \vartheta_{it} \quad (5)$$

where A_{it} is a variable representing the respondent household i's off-farm activity choice status at time t, β represents the estimable coefficients and ϑ_{it} is the error term.

Our estimation strategy for both off-farm participation and activity choice is associated with a number of challenges. First, the presence of household specific effects that are not accounted for by the observed covariates could lead to omitted variable bias. In order to correct for this potential bias, we follow Mundlak's (1978) approach of incorporating the relationship between the time varying regressors k_{it} and the household fixed effect (α_i for the participation regression and β_i for the activity choice regression). This enables controlling for unobserved heterogeneity by adding the means of time varying covariates, also known as the pseudo fixed effects or the Mundlak-Chamberlain's Random Effects Model. In particular, α_i can be approximated by a linear function:

$$\alpha_i = a\bar{k}_i + \eta_{it}\ ,\ \eta_{it} \sim iid(0, \sigma_\eta^2\ ) \qquad (6)$$

Substituting expression (6) in Equation (4) gives the estimable Equation in (7):

$$R_{it} = \alpha_o + \alpha_1 P_i + \alpha_2 T_t + \alpha_3 P_i * T_t + \alpha_4 F_{it} + \alpha_5 P_i T_t * F_{it} + \alpha_6 X_{it} + a\bar{z}_i + \psi_{it} \qquad (7)$$

A similar transformation into Equation (5) gives the estimable equation in (8):

$$A_{it} = \beta_o + \beta_1 P_i + \beta_2 T_t + \beta_3 P_i * T_t + \beta_4 F_{it} + \beta_5 P_i T_t * F_{it} + \beta_6 X_{it} + \beta_i + a\bar{z}_i + \psi_{it} \qquad (8)$$

4.3 Randomness of Treatment and Control Kebeles and the Common Trend Assumption

The second estimation challenge is the proper identification of the program impacts using the DiD estimator, which relies on the randomized choice of treatment and control kebeles. In particular, if the choice of kebeles certified early in the process is systematically related to factors that may affect our outcome variable, the measurement of the treatment impact may be biased. In order to evaluate the degree of randomness in implementation, we examined the criteria behind the choices. Correspondence with the administrative officials from the EPLAUA confirmed that, in many cases, the kebeles were simply picked randomly based on woreda administrative capacity. Hence, if administrative capacity is not strongly associated with factors that affect off-farm participation, then the geographical discontinuity in program implementation offers a valid identification strategy. To establish whether the sampling of treated and control kebeles in the survey was random, a simple test was conducted in terms of the difference in the location of kebeles relative to the main road/nearest town. This variable could serve as a measure of remoteness, representing access to information, technology, and markets. Accordingly, the average distance of the nearby town from the treatment and control kebeles is calculated to be 69.5 and 72.5 minutes, respectively, as per our survey data.[15] The average distance from a nearby main road is also about 24 and 37 minutes for the treatment and control kebeles, respectively. These figures give no indication that the treatment and control kebeles differ significantly in terms of access to information, technology and markets.

[15] It should be noted that proximity to roads is a mere indicator of a set of confounding factors that affect the decision to participate in off-farm employment. As we discuss below, the test for the common trend assumption is a more formal way of assessing the randomness in the choice of the treatment and control kebeles. It should also be noted that, given modern telecommunication technology, e.g., internet, social media etc., one may question the role of physical distance, especially in access to information. However, modern communication coverage remains minimal and even those “traditional” types of modern communication such as telephone access remain road-side based.

While the random choice of kebeles is a necessary condition for accurately identifying the program effects, the so-called common (or parallel) trend assumption forms the sufficient condition. The essence of the DiD approach is to attribute any change over time in the difference in outcomes between the control and treatment villages to the certification program, having controlled for a range of explanatory factors. The common trend assumption asserts that, in the absence of the treatment, one would expect parallel movement between the treatment and control groups, essentially attributing the effect of changes in the treatment group to the program only. An ideal test for this parallel movement would be to assess whether, in the absence of the program, the trends in the two groups would have been identical. However, this is unobservable, implying that the common trend assumption is fundamentally untestable after the introduction of the program. As an alternative, it is possible to test whether there were common trends in the treatment and control villages in the period *before* the introduction of the program. To this effect, we used two methods: comparing the average outcomes after controlling for a range of explanatory variables, and testing for 'placebo' effects.

In order to do so, Equation (3) is estimated with different intercept terms for each year and for each treatment category, using data for periods prior to the commencement of the certification program. The presence of parallel trends is supported by the absence of differences in the intercept terms between control and treatment villages over all the periods, and vice versa for the lack of common trends. The results for the common trend assumption test are presented in Section 5.4.

5. Results

In this section, we present the results of our empirical analysis. The section is outlined as follows: we start by discussing the results of our matching procedure and then proceed by discussing the decision to participate in off-farm activities. Finally, we display our results for individual off-farm activities.

5.1 The Propensity Score Matching Results

The matching procedure is carried out using a one-to-one nearest neighbor matching with Caliper. As discussed in Section 4.1, our matching procedure is based on a set of relevant variables, which are presumed to affect the probability of both selection into certification and off-farm participation. The variables included are: size of landholdings and mean plot area, color of soil, fertility of soil, slope of plot, tropical units of livestock, number of oxen, literacy of household head, number of male adults in the household and to what extent the household has experienced land-related conflict and land loss. The choice of variables is based on the socioeconomic or physical farm characteristics that potentially affect selection into the program. The result of the logit estimation in the PSM matching procedure is depicted in Table 3 below. As can be seen in the table, the most influential variables for selection into a certification kebele is average plot area. In other words, in the unmatched sample, households with larger average plots were more likely to live in kebeles that were reached by the certification program.

The result of the matching procedure, in terms of a reduction in bias in systematic selection into the program, is depicted in Figure 1 and Figure 2 below.[16] As can be seen in the figures, matching substantially reduces the bias.

The matched sample consists of a total of 2478 observations distributed over the two years. This is the sample used for the empirical analysis below.[17]

5.2 Off-farm Employment Participation Results

We begin by examining the effect of the certification program on general off-farm participation using a panel logit regression technique. Table 4 presents the results from the analysis of the off-farm participation equation. Because our descriptive statistics suggest that there may be different trends in agricultural and non-agricultural off-farm activities, we estimate two regressions: one for participation in *any* off-farm activity and one for participation in non-agricultural off-farm activities. Accordingly, Table 4 displays the results for off-farm activities excluding work on others' land in panel 1 (Columns 1-4), and the results for participation in any off-farm activity (including farm work) in the second panel (Columns 5-8). We present the results for four different models. Model I only contains plot characteristics and socioeconomic variables as covariates. In Model II, we add controls for living in a certification village before and after treatment, and in Model III we also include farm size interacted with living in a certification village before and after treatment. Finally, Model IV contains controls for different measures of tenure security. Because we are running a random effects logit, marginal effects are not valid (since they assume that the individual effect is zero). Consequently, Table 4 displays coefficient estimates.

As can be seen in the table, the definition of off-farm work matters to a significant extent. If we include *all* types of off-farm work, i.e., including work on other households' land, our estimation results suggest that certification (*post_treatment*) is associated with a *reduced* likelihood of participating in off-farm activities (Columns 5-8). However, if we remove farm work from our off-farm variables, we find that the certification had a positive

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[16] The results of the logistic regression on which the propensity scores are based and the common support results are not reported but are available from the authors upon request.

[17] See the appendix for the household level identification.

and strongly significant effect on participation in off-farm activities. This could be because we have a significant share of the off-farm activities in the farm sector.

Our results reveal significant links between the size of landholdings and off-farm participation, particularly when non-agricultural off-farm activities are considered. The link, however, is insignificant when off-farm activities in the farm sector are included as off-farm categories. This could be because the off-farm activities in the farm sector also include unpaid work or shared labor, as well other semi-paid arrangements. The negative coefficient of certification conditional on farm size indicates that large farm size would lead to reduction in participation in off-farm participation, possibly due to the certification-related intensification we discussed in the introduction. Alternatively, owners of smaller farm size would be more likely to participate in off-farm activities after certification because of increased tenure security (outweighing the intensification effects because the farm sizes are smaller).

Turning to the tenure insecurity variables, we find that households with previous experiences of land loss are more prone to engage in off-farm activities regardless of the measure of these activities. This result may appear surprising at first sight: because control over land is often correlated with continuous use of land, we may expect that households with experiences of land loss would be more prone to stay on their land. However, land loss is also likely to imply a reduction in land holdings, and thus that households with experiences of land loss may find it necessary to work elsewhere.

Concerning the rest of the covariates, we find that female-headed households are less likely to engage in off-farm work that includes work on other households' land, whereas households with a larger number of male and female adults are more likely to participate in off-farm activities that exclude agricultural activities on other people's farms. For participation in off-farm activities excluding farm work, only the number of male adults matters.

The results generally hold when defining the certification variable at the household level. However, as can be seen in Table A1 in the appendix, the sample size is much smaller in this case. This is because many households living in kebeles reached by the program in 2007 had not yet received their certificates at the time of the survey. Our results for the household level identification suggest that, for off-farm activities excluding farm work, the slope and soil characteristics are significantly correlated with the participation decision. More specifically, we find that households that own a large share of plots with black or red soil are more likely to participate than households that own plots with other color soil, while households whose plots are located on steep slopes are less likely to participate. Holding other factors constant, the importance of plot characteristics with respect to off-farm participation could be associated with the respective labor demands. Accordingly, steep slope plots may require more conservation work, reducing the availability of spare labor hours for off-farm activities.

5.3 Off-farm Employment Activity Choice Results

In order to assess the impact of the certification program on activity choice, we also estimate a multinomial logit regression. We cluster standard errors at the household level to account for possible correlations in error terms. Table 5 presents the predictive margins emanating from the estimation. Columns 1-5 display the predictive probability of being in each activity. The reference group is those with no participation in off-farm employment.

The certification program is associated with an increased likelihood of participating in unskilled non-agricultural work and in the food-for-work program, but a reduced probability of engaging in professional work. We find no significant effects on the likelihood of participating in paid farm work or in labor sharing arrangements (free work). The largest effect found is for unskilled work in the non-agricultural sector. However, we also find a relatively large effect on the likelihood of participating in food-for-work activities. Concerning farm size, we find that the size of landholdings in itself reduces the probability of engaging in food-for-work activities. However, we also find that certification significantly reduces the probability of engaging in unskilled work for households with large landholdings.

Concerning the rest of the covariates, the results in Table 5 suggest that female-headed households are significantly more likely to have household members engaged in professional work, while households with an illiterate head are significantly less likely to have professionally active members. Households with a relatively larger number of male and female adults are significantly more likely to engage in unskilled off-farm work and food-for-work activities. Households with many female adults are, however, less likely to engage in professional work. Finally, we also find that households with a larger number of oxen tend to engage in unpaid labor sharing agreements.

For the household level certification, the relatively small sample size made it impossible to estimate the full multinomial logit (due to very few observations in some of the categories). We were therefore forced to reduce the number of covariates and to only estimate the probability of engaging in labor sharing arrangements, unskilled work and food-for-work compared to no off-farm participation.[18] The results suggest that certification reduced the probability of engaging in unpaid labor sharing arrangements and increased the probability of

[18] As can be seen in Table A2, we have removed square of age of the household head, share of red and black soil, mean plot area, share of medium fertile soil and share of medium sloped plots from the analysis. These variables were chosen for removal based on the lack of significance of their coefficients in other regressions.

engaging in unskilled work. No statistically significant effect on food-for-work activities was found. However, this last finding may also have been a consequence of the small sample size.

5.4 Robustness Checks

Figure 3a and Figure 3b illustrate the underlying trend in off-farm employment participation in treatment and control villages prior to the introduction of the program. The figures plot the mean probability of engaging in off-farm activities, having controlled for a set of explanatory variables.[19] Figure 3a depicts the pattern for participation in off-farm activities excluding farm work and shows a negative trend in off-farm participation both in the certification and non-certification kebeles before the certification program commenced. The negative trend is relatively stronger in certification kebeles; however, between 2005 and 2007, the trend in the kebeles reached by the program is reversed from negative to positive. While this graphical illustration does not provide conclusive evidence of a common trend, it lends some support to the hypothesis that the trend was not divergent before the program. The trend for all types of off-farm activities is much less clear. Figure 3b depicts the average tendency to engage in all types of off-farm activities for the years 2000-2007. In contrast to the results in Figure 3a, Figure 3b shows a U-shaped trend in both certification and non-certification kebeles. In accordance with the estimation results in Table 2, the positive trend after 2005 appears to be stronger in kebeles not reached by the certification program.

Testing for the Common Trends Assumption[20]

To test for any statistical difference in the trend between certification and non-certification kebeles, we also perform a test of "placebo effects." We do this by limiting the sample to the time period before the program started (in 2007 for our sample) and then adding fake treatment variables to the regression. In other words, we use information in the survey years 2000, 2002 and 2005 to examine whether there appear to be placebo treatment effects amongst households in the treated villages before the program was introduced. The estimated placebo treatment effects should, of course, ideally be close to zero and statistically insignificant. The results of the placebo effect analysis are presented in Table 6. The first panel in the table contains the result for off-farm activities excluding work on other households' farms, while the second panel depicts the results for participation in all off-farm

[19] The dependent variable here is participation in off-farm employment, while the explanatory variables are socioeconomic and physical farm characteristics, tenure security and participation in the certification program.

[20] The number of observations for each activity is too small to conduct placebo tests for activity choice. As a result, we rely on the common trends test results from the participation analysis.

activities. The individual columns represent different placebo tests. In each regression, we use a full set of control variables, kebele fixed effects and Chamberlain-Mundlak effects.

As can be seen in the table, we do find significant placebo effects regardless of whether we include farm work in the off-farm activity variable. However, while the off-farm variable containing farm work produces a significantly positive placebo effect in 2005, thus suggesting that a positive trend in certification kebeles started before the introduction of the program, the coefficient for the no-farm-work regression produces a significantly *negative* coefficient. In accordance with Figure 3a, this suggests that certification kebeles were on a significantly more negative trend concerning no-farm off-farm activities than were non-certification kebeles. To see how the introduction of the true program affects the placebo treatments, we also run a regression with both a placebo treatment and the true treatment (post-treatment). The results are presented in Columns 4 and 8 of Table 6. As can be seen in the table, the magnitude of the placebo effect falls, but the significance level remains the same. Interestingly enough, the positive and significant effect for the off-farm regression, excluding agricultural activities on other people's farms, is robust to the inclusion of the placebo variable.

The test results for the household level identification of certification are presented in Table A3. Overall, these results are supportive of our causal interpretation of the kebele level identification results.[21] For the regressions on all types of off-farm participation, we find placebo effects similar to those for the kebele level identification. However, for the no-farm regression, the statistically significant placebo effect in 2005 disappears, while we find a significantly positive effect in 2002. This suggests that the results at the household level are somewhat less reliable.

6. Conclusions

Given the pivotal importance of the land tenure system in rural economic dynamics, the land legislation programs implemented in many African countries since the 1990s have received due attention in the literature. Specifically, there have been considerable efforts to analyze the effects of such programs on agricultural productivity, land market participation and investment across Africa (e.g., Pinckney and Kimuyu 1994; Jacoby and Minten 2007; Ali et al. 2011).

[21] It should be noted that Deininger et al. (2011) and Bezabih et al. (2012), using the same data used in this study for their analysis, find no evidence of a difference in trends for soil conservation investment and agricultural productivity, their respective variables of interest.

The Ethiopian Land Certification Program has spurred a considerable amount of research, in particular on the impact of the program on agricultural investment and productivity (e.g., Deininger et al. 2011; Holden et al. 2011, 2012; Bezabih et al. 2012). However, to our knowledge, this is the first paper that assesses the effect of the program on off-farm participation. More specifically, we estimated the effect of the land certification program on participation in off-farm employment and on off-farm activity choice using data from the Central Highlands of Ethiopia. We base our hypothesis on the positive link that has been shown between the land certification program and tenure security (Bezabih et al. 2012). Given that tenure insecurity induces aversion toward leaving the land in pursuit of employment activities outside the farm, restoring tenure security could, in many situations, be expected to have positive off-farm employment consequences.

The empirical results emanating from the panel logit off-farm participation and multinomial logit activity choice models suggest that the effect of the certification program on off-farm activities depends on the type of activity. We find that, while land certification seems to have had a positive impact on the tendency to engage in unskilled non-agricultural work, it may have had a negative effect on farm work on others' land and on professional work. We can only speculate on the mechanisms behind these results, but if the group of households that consider engaging in unskilled off-farm activities are also the ones most affected by tenure insecurity, then our results may point to a reduction in tenure insecurity due to certification for these households. Our finding that the certification program had a positive and significant effect on food-for-work activities is slightly disturbing, since food-for-work cannot be said to be a productivity enhancing activity. However, if food insecure households previously abstained from leaving their land due to fear of redistribution or land conflict, and if the certification program contributed to these households engaging in activities that provide them with food, this effect is not inherently negative.

The negative effect of the program on professional labor activities may be explained by the fact that skilled and permanent off-farm employment activities possess characteristics that make them relatively inelastic to exogenous policy changes in the short run. For instance, skilled labor activities require investment in skills and working capital. Hence, the effect of changes in incentives may show only in the longer run. Another possibility is rigidity in the demand side of employment opportunities. While food for work activities have been able to absorb labor in off agricultural seasons, there is some reason to believe that a more flexible food-for-work employment program could increase off-farm employment rates during the agricultural seasons. Potential rigidities associated with such seasonality, as well as limited availability of skilled and non-farm employment opportunities, will make such activities generally unresponsive to policy changes.

Taken together, our results suggest that the Ethiopian Land Certification Program has affected engagement in off-farm activities. However, because the effect of the program seems to vary across different types of off-farm activities, and because such effects may take time to develop, there is a need for further studies on the subject as more data becomes available.

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Figures and Tables

Figure 1. Standardized Bias in Sample Before and After Matching

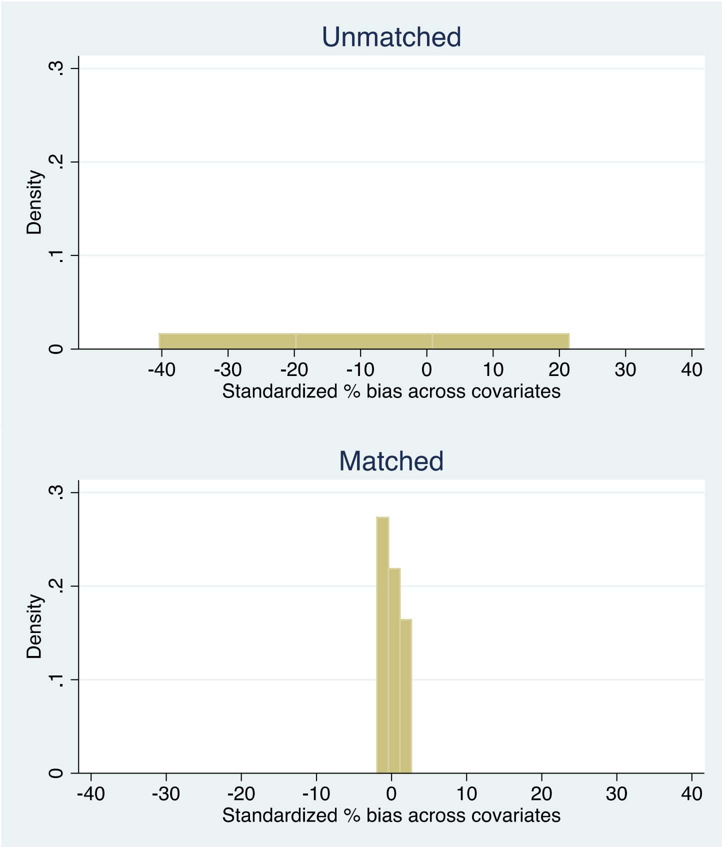
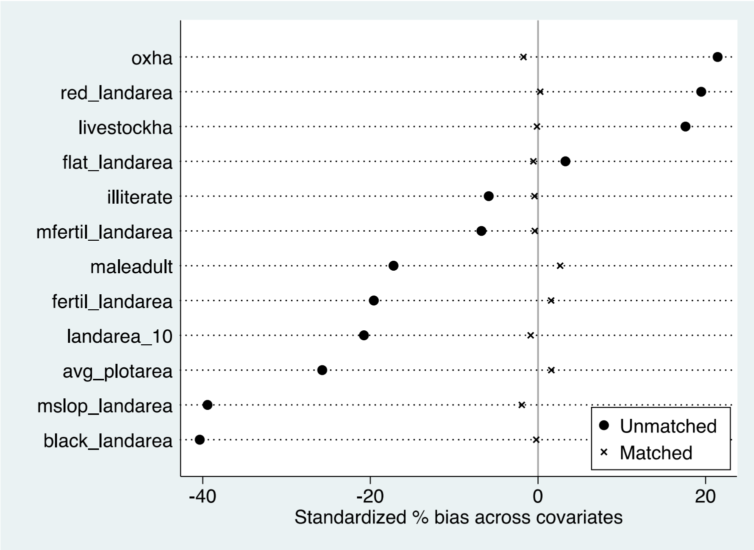


Figure 2. Bias in Individual Variables Before and After Matching



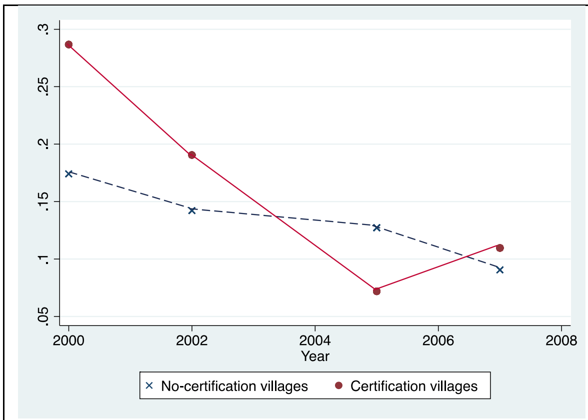


Figure 3a: Trend in share of individuals in off-farm activities in certified and non-certified villages (controlling for covariates): off-farm work (excluding agricultural off-farm work)

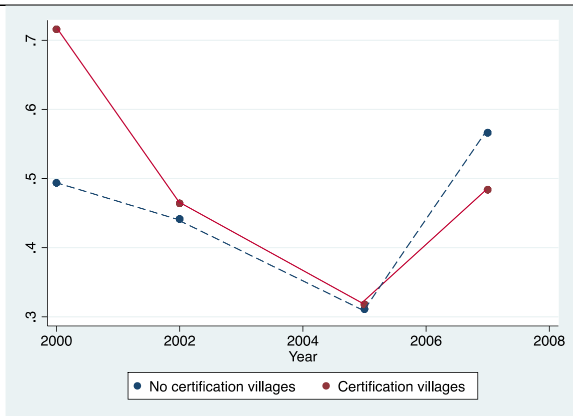


Figure 3b: Trend in share of individuals in off-farm activities in certified and non-certified villages (controlling for covariates): All off-farm work

Table 1. Participation in Off-farm Activities

	Pooled sample		Certification villages		Non-certification villages	
	2005	2007	2005	2007	2005	2007
Off-farm	11,79	21,33	15,67	22,10	9,26	20,80
No off-farm activity	88,21	78,67	84,33	77,90	90,74	79,20
Individual activities						
Farm work on other land	5,16	1,90	5,83	1,01	4,58	2,56
Free work	91,85	73,80	92,13	67,82	91,60	78,23
Professional work	0,82	4,79	0,58	4,62	1,02	4,91
Unskilled work	2,17	9,94	1,46	9,81	2,80	10,03
Food-for-work	0,14	9,57	0,29	16,74	0,00	4,27
Total (N)	7444	7735	2941	3172	4503	4563

Table 2. Descriptive Statistics of the Variables Used in the Regressions

	Pooled sample				Certification villages				Non-certification villages			
	Mean	Std.dev	Min	Max	Mean	Std.dev	Min	Max	Mean	Std.dev	Min	Max
Socio-economic variables												
Age of hh head	50,62	15,01	12,00	105,00	49,40	14,52	16,00	100,00	51,46	15,28	12,00	105,00
Gender of hh head	0,14	0,34	0,00	1,00	0,16	0,37	0,00	1,00	0,12	0,32	0,00	1,00
Hh head is illiterate	0,54	0,50	0,00	1,00	0,51	0,50	0,00	1,00	0,56	0,50	0,00	1,00
Size of household	5,38	2,33	1,00	17,00	5,29	2,32	1,00	14,00	5,44	2,33	1,00	17,00
N. male adults in hh	2,11	1,28	0,00	10,00	1,99	1,22	0,00	6,00	2,19	1,31	0,00	10,00
N female adults in hh	2,02	1,10	0,00	9,00	1,98	1,12	0,00	7,00	2,05	1,09	0,00	9,00
N Livestock (TLU) ny hh	4,60	3,58	0,00	38,72	5,45	4,05	0,00	38,72	4,01	3,08	0,00	21,20
N Oxen by hh	1,80	1,47	0,00	16,00	2,05	1,72	0,00	16,00	1,63	1,24	0,00	7,00
Tenure security variables												
Experience of land loss	0,09	0,28	0,00	1,00	0,06	0,25	0,00	1,00	0,10	0,30	0,00	1,00
Expect loss of land in future	0,14	0,35	0,00	1,00	0,13	0,33	0,00	1,00	0,15	0,36	0,00	1,00
Expect increase in land in future	0,20	0,40	0,00	1,00	0,19	0,39	0,00	1,00	0,20	0,40	0,00	1,00
Expect no change in land	0,32	0,47	0,00	1,00	0,36	0,48	0,00	1,00	0,29	0,45	0,00	1,00
Uncertain about future land	0,34	0,47	0,00	1,00	0,32	0,47	0,00	1,00	0,36	0,48	0,00	1,00
Plot characteristics												
Land holdings (area in ha)	2,48	1,76	0,01	9,94	2,46	1,83	0,01	9,94	2,49	1,70	0,03	9,94
Mean plot area	0,32	0,22	0,00	2,04	0,31	0,21	0,00	1,72	0,33	0,22	0,00	2,04
Share of plots with												
Red soil	0,49	0,45	0,00	1,00	0,59	0,44	0,00	1,00	0,43	0,44	0,00	1,00
Black soil	0,42	0,44	0,00	1,00	0,36	0,44	0,00	1,00	0,45	0,44	0,00	1,00
Other soil	0,06	0,23	0,00	1,00	0,02	0,14	0,00	1,00	0,09	0,27	0,00	1,00

Fertile soil	0,56	0,46	0,00	1,00	0,61	0,46	0,00	1,00	0,53	0,46	0,00	1,00
Medium fertile soil	0,33	0,42	0,00	1,00	0,30	0,42	0,00	1,00	0,35	0,42	0,00	1,00
Non-fertile soil	0,10	0,25	0,00	1,00	0,08	0,22	0,00	1,00	0,11	0,27	0,00	1,00
Flat slope	0,71	0,41	0,00	1,00	0,79	0,37	0,00	1,00	0,65	0,43	0,00	1,00
Steep slope	0,05	0,19	0,00	1,00	0,02	0,13	0,00	1,00	0,06	0,21	0,00	1,00
Medium steep slope	0,24	0,37	0,00	1,00	0,17	0,34	0,00	1,00	0,28	0,39	0,00	1,00
N	2822				1155				1667			

Table 3. PSM logit result: selection into certification kebeles

	Pr(Certificate)
Hh head is illiterate	-0.053
	(0.068)
Total land area by hh	0.628
	(0.501)
Mean plot area	-0.829***
	(0.301)
N male adults in hh	-0.115***
	(0.032)
N livestock owned by hh	0.095***
	(0.018)
N oxen owned by hh	-0.075**
	(0.037)
Share of land with black soil	-0.054
	(0.072)
Share of land with red soil	0.262***
	(0.068
Share of land with flat slope	0.088
	(0.084)
Share of land with medium slope	-0.320***
	(0.092)
Share of land with fertile soil	-0.154**
	(0.064)
Share of land with medium fertile soil	-0.158**
	(0.064)
Experience of land loss	-0.401***
	(0.115)
Experience of land conflict	0.034
	(0.086)
N	1577
LR Chi square (14)	225.71
Pseudo R2	0.106

Table 4. Decision to Participate in Off-farm Activities (Kebele Level Certification). Random Effect Logit

	off-farm work (excluding agricultural off-farm work)				All off-farm work			
	Model I	Model II	Model III	Model IV	Model I	Model II	Model III	Model IV
Hh in treated village		**-2.315*** **	**-2.784*** **	**-2.789*** **		**-0.903*** **	**-0.869** **	**-0.931** **
		(0.514)	(0.635)	(0.639)		(0.333)	(0.407)	(0.411)
Post treatment		**1.632*** **	**3.102*** **	**3.103*** **		**-0.529** **	**-0.742** **	**-0.766** **
		(0.314)	(0.518)	(0.521)		(0.209)	(0.323)	(0.325)
Farm size*treatment			**0.374** **	**0.391** **			-0.034	-0.018
			(0.159)	(0.161)			(0.104)	(0.105)
Farm size*post treatment			**-0.781*** **	**-0.798*** **			0.086	0.082
			(0.210)	(0.211)			(0.107)	(0.108)
Experience of land loss				**0.472** **				**0.461*** **
				(0.231)				(0.176)
Expect decrease in land holdings				0.086				0.060
(Reference is no change)				(0.226)				(0.153)
Expect increase in land holdings				-0.005				-0.075
				(0.244)				(0.170)
Uncertain about future land				0.092				-0.138
				(0.178)				(0.130)
Year 2007	-0.079	**-0.640*** **	**-0.652*** **	**-0.609*** **	**1.284*** **	**1.482*** **	**1.486*** **	**1.513*** **
	(0.148)	(0.188)	(0.189)	(0.192)	(0.121)	(0.147)	(0.147)	(0.150)
Total land area by hh	-0.101	-0.113	-0.087	-0.099	-0.019	-0.016	-0.028	-0.042
	(0.097)	(0.101)	(0.104)	(0.105)	(0.064)	(0.064)	(0.068)	(0.069)
Age of household head	-0.025	-0.027	-0.030	-0.027	-0.001	-0.001	-0.001	0.002
	(0.034)	(0.035)	(0.035)	(0.036)	(0.027)	(0.027)	(0.027)	(0.027)

Age of head squared	-0.000	-0.000	-0.000	-0.000	**-0.000***	**-0.000***	**-0.000***	**-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hh head is female	-0.250	-0.257	-0.315	-0.229	**-1.373***	**-1.387***	**-1.376***	**-1.389***
	(1.006)	(1.030)	(1.043)	(1.051)	(0.807)	(0.810)	(0.810)	(0.816)
Hh head is illiterate	-0.164	-0.170	-0.182	-0.168	0.052	0.046	0.047	0.059
	(0.163)	(0.168)	(0.170)	(0.171)	(0.118)	(0.119)	(0.119)	(0.119)
N male adults in hh	**0.292***	**0.304****	**0.307****	**0.322****	**0.277****	**0.278****	**0.280****	**0.282****
	(0.151)	(0.154)	(0.155)	(0.155)	(0.109)	(0.110)	(0.110)	(0.110)
N female adults in hh	0.405	0.405	0.421	0.407	**0.662***	**0.677****	**0.676****	**0.685****
	(0.415)	(0.424)	(0.428)	(0.432)	(0.342)	(0.343)	(0.343)	(0.346)
N male adults^2	-0.013	-0.013	-0.013	-0.014	**-0.014***	**-0.014***	**-0.014***	**-0.014***
	(0.011)	(0.012)	(0.012)	(0.012)	(0.008)	(0.008)	(0.008)	(0.008)
N female adults^2	-0.038	-0.038	-0.039	-0.038	**-0.073****	**-0.075****	**-0.075****	**-0.076****
	(0.042)	(0.043)	(0.043)	(0.044)	(0.035)	(0.035)	(0.035)	(0.035)
N oxen owned by hh	-0.157	-0.125	-0.126	-0.127	0.040	0.028	0.026	0.031
	(0.133)	(0.137)	(0.139)	(0.139)	(0.091)	(0.092)	(0.092)	(0.092)
N livestock owned by hh	0.023	0.018	0.023	0.023	0.025	0.029	0.028	0.028
	(0.057)	(0.059)	(0.060)	(0.060)	(0.039)	(0.039)	(0.039)	(0.039)
Share of plots: red soil	**0.675****	**0.619***	**0.631***	**0.657***	-0.068	-0.051	-0.057	-0.017
(Other color is reference)	(0.342)	(0.354)	(0.356)	(0.359)	(0.250)	(0.252)	(0.252)	(0.254)
share of plots: black soil	0.157	0.164	0.145	0.145	-0.091	-0.090	-0.091	-0.069
	(0.336)	(0.347)	(0.350)	(0.352)	(0.248)	(0.250)	(0.250)	(0.251)
Share of plots: non fertile soil	-0.152	-0.157	-0.179	-0.195	0.242	0.245	0.248	0.213
(Fertile soil is reference)	(0.433)	(0.446)	(0.449)	(0.451)	(0.290)	(0.292)	(0.292)	(0.294)
Share of plots: medium fertile soil	-0.127	-0.060	-0.057	-0.102	0.035	0.014	0.015	-0.019
	(0.221)	(0.228)	(0.231)	(0.233)	(0.166)	(0.167)	(0.167)	(0.168)
Share of plots: steep slope	-0.761	-0.679	-0.623	-0.622	-0.268	-0.265	-0.269	-0.258
(Flat slope is reference)	(0.521)	(0.537)	(0.543)	(0.545)	(0.368)	(0.371)	(0.370)	(0.371)
Share of plots: medium steep slope	0.062	-0.007	-0.002	-0.003	-0.095	-0.071	-0.068	-0.086
	(0.257)	(0.265)	(0.268)	(0.269)	(0.187)	(0.188)	(0.188)	(0.189)

Mean plot area	0.061	-0.028	-0.020	0.068	-0.428	-0.380	-0.362	-0.252
	(0.662)	(0.692)	(0.697)	(0.702)	(0.451)	(0.453)	(0.453)	(0.456)
Constant	-1.503	0.243	0.202	-0.031	-0.966	0.081	0.098	0.016
	(1.031)	(1.032)	(1.045)	(1.063)	(0.748)	(0.754)	(0.758)	(0.774)
lnsig2u constant	-1.251	-0.806	-0.681	-0.662	-0.833	-0.784	-0.785	-0.755
	(1.091)	(0.786)	(0.736)	(0.729)	(0.517)	(0.499)	(0.499)	(0.492)
Kebele fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Chamberlain-Mundlak effects	YES	YES	YES	YES	YES	YES	YES	YES
Chi-squared	138.832	144.847	146.312	147.440	293.059	292.891	293.340	293.103
N	2478	2478	2478	2478	2478	2478	2478	2478

Table 5. Multinominal Logit Results: Activity Choice (Kebele Level Certification). Predictive Margins

	Farm worker	Free worker	Professional	Unskilled	FFW
Hh in treated village	-0.001	0.014	0.018	-0.031	0.004
	(0.006)	(0.028)	(0.017)	(0.030)	(0.004)
Year 2007	-0.003	**0.106*** **	**0.042** **	**0.041*** **	**0.050*** **
	(0.006)	(0.022)	(0.020)	(0.008)	(0.007)
Post treatment	-0.001	0.030	**-0.035***	**0.071***	**0.031*** **
	(0.012)	(0.048)	(0.019)	(0.031)	(0.010)
Total land area by hh	-0.001	0.013	-0.004	-0.003	**-0.012** **
	(0.004)	(0.010)	(0.005)	(0.005)	(0.005)
Farm size*post treatment	-0.002	-0.009	0.005	**-0.014***	-0.004
	(0.005)	(0.012)	(0.004)	(0.008)	(0.005)
Age of household head	**-0.000** **	**-0.005*** **	-0.000	-0.000	-0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Hh head is female	-0.004	-0.112	**0.031***	0.019	0.003
	(0.011)	(0.069)	(0.017)	(0.027)	(0.016)
Hh head is illiterate	0.008	0.015	**-0.009***	-0.002	-0.011
	(0.005)	(0.019)	(0.005)	(0.007)	(0.007)
N male adults in hh	0.000	-0.000	0.001	**0.005** **	**0.005*** **
	(0.002)	(0.005)	(0.001)	(0.002)	(0.002)
N female adults in hh	0.001	-0.011	**-0.016*** **	-0.003	**0.008*** **
	(0.002)	(0.014)	(0.003)	(0.006)	(0.003)
N oxen owned by hh	**-0.005***	**0.058*** **	-0.003	**-0.009***	**-0.012** **
	(0.003)	(0.010)	(0.003)	(0.005)	(0.005)
N livestock owned by hh	0.001	0.001	0.000	-0.001	0.001
	(0.001)	(0.004)	(0.001)	(0.002)	(0.002)

Share of plots: red soil	0.010	-0.005	**-0.012****	0.001	-0.002
(Other color is reference)	(0.015)	(0.032)	(0.006)	(0.012)	(0.011)
share of plots: black soil	0.020	-0.023	**-0.012****	0.002	0.008
	(0.015)	(0.032)	(0.006)	(0.012)	(0.011)
Mean plot area	-0.014	-0.045	0.006	0.031	0.021
	(0.025)	(0.070)	(0.031)	(0.027)	(0.030)
Share of plots: non fertile soil	-0.012	-0.023	-0.008	-0.025	0.001
(Fertile soil is reference)	(0.012)	(0.036)	(0.011)	(0.015)	(0.015)
Share of plots: medium fertile soil	-0.002	-0.018	-0.003	-0.010	0.004
	(0.006)	(0.022)	(0.005)	(0.008)	(0.007)
Share of plots: steep slope	0.011	-0.009	0.001	-0.017	0.005
(Flat slope is reference)	(0.010)	(0.044)	(0.009)	(0.022)	(0.018)
Share of plots: medium steep slope	-0.016	0.001	-0.005	0.003	0.010
	(0.010)	(0.023)	(0.006)	(0.008)	(0.007)
Wald chi2(100)	20469.14				
Pseudo R2	0.155				
N	2610				

Table 6. Trend Analysis: Placebo Effects

	off-farm work (excluding agricultural off-farm work)				All off-farm work			
KEBELE LEVEL CERT	I	II	III	IV	I	II	III	IV
Placebo 2000	0.332				**-0.821*****			
	(0.472)				(0.225)			
Placebo 2002		**0.785*****				-0.142		
		(0.299)				(0.216)		
Placebo 2005			**-1.209*****	**-0.826*****			**0.819*****	**0.775*****
			(0.340)	(0.294)			(0.206)	(0.202)
Post treatment				**2.203*****				0.379
				(0.424)				(0.285)
Chi-squared	146.904	150.920	153.018	222.540	364.708	359.033	366.071	560.804
N	3193	3193	3193	4350	3193	3193	3193	4350

Appendix Figures

Figure A1. Standardized Bias in Sample Before and After Matching. Identification Based on Household Certification.

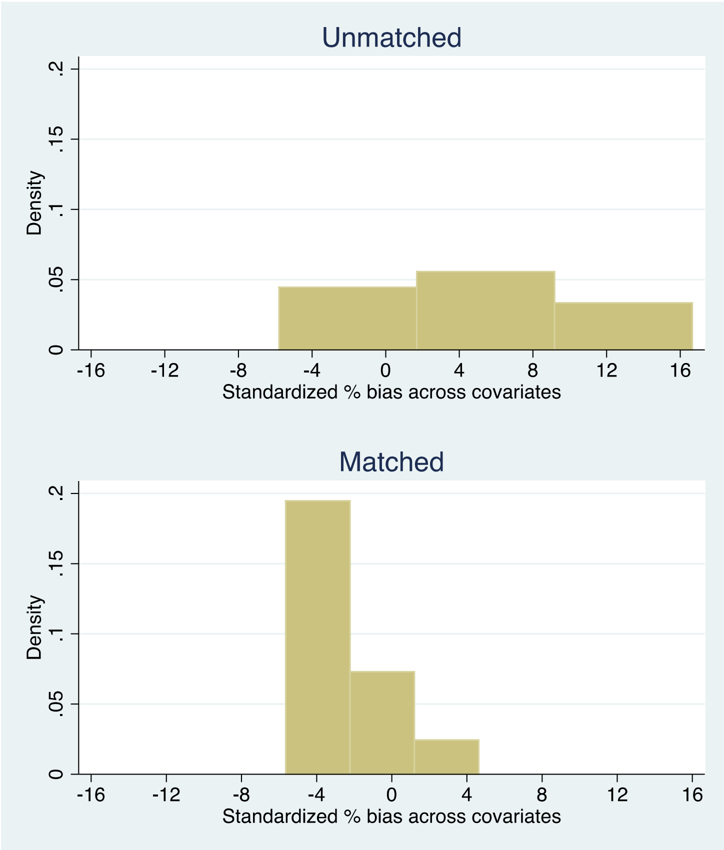
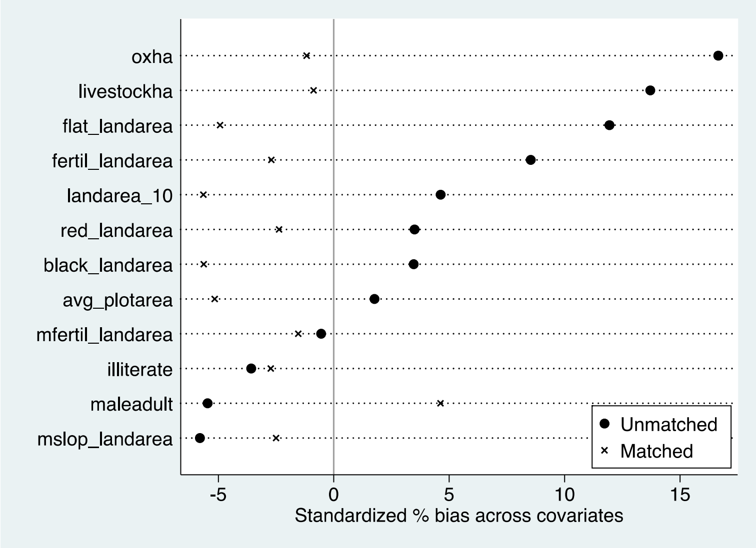


Figure A2. Bias in Individual Variables Before and After Matching. Identification Based on Household Certification.



Appendix Tables

Table A1. Household Level Certification: Participation Results

	off-farm work (excluding agricultural off-farm work)				All off-farm work			
	Model I	Model II	Model III	Model IV	Model I	Model II	Model III	Model IV
Certified hh		**-0.944****	**-1.460****	**-1.429****		0.221	0.325	0.320
		(0.403)	(0.598)	(0.603)		(0.294)	(0.438)	(0.441)
Post-treatment		0.373	**1.085***	**1.126***		**-0.530***	**-0.824***	**-0.804***
		(0.444)	(0.599)	(0.604)		(0.310)	(0.428)	(0.433)
Farm size*certified hh			0.269	0.242			-0.055	-0.053
			(0.201)	(0.204)			(0.143)	(0.144)
Farm size*post treatment			-0.376*	-0.352*			0.124	0.123
			(0.207)	(0.209)			(0.132)	(0.133)
Experience of land loss				0.567				0.132
				(0.350)				(0.257)
Expect decrease in land holdings				0.184				0.028
(Reference is no change)				(0.342)				(0.221)
Expect increase in land holdings				0.221				-0.129
				(0.376)				(0.255)
Uncertain about future land holdings				0.152				-0.164
				(0.287)				(0.201)
Year 2007	-0.226	-0.452	-0.449	-0.405	**1.368*****	**1.685*****	**1.696*****	**1.666*****
	(0.235)	(0.346)	(0.346)	(0.352)	(0.182)	(0.267)	(0.268)	(0.271)
Total land area by hh	-0.060	-0.053	-0.035	-0.061	0.016	0.021	-0.012	-0.021

	(0.167)	(0.165)	(0.185)	(0.187)	(0.093)	(0.094)	(0.110)	(0.111)
Age of household head	-0.061	-0.050	-0.047	-0.047	0.006	0.006	0.005	0.004
	(0.055)	(0.055)	(0.055)	(0.055)	(0.041)	(0.041)	(0.041)	(0.041)
Age of head squared	0.000	0.000	0.000	0.000	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Hh head is female	-0.213	0.346	0.429	0.399	-0.788	-0.746	-0.721	-0.747
	(1.939)	(1.937)	(1.928)	(1.940)	(1.385)	(1.392)	(1.391)	(1.401)
Hh head is illiterate	-0.090	-0.014	-0.012	0.005	0.243	0.246	0.246	0.240
	(0.260)	(0.263)	(0.261)	(0.262)	(0.171)	(0.172)	(0.172)	(0.173)
N male adults in hh	0.426	**0.501***	0.485	**0.519***	**0.309***	**0.317***	**0.336***	**0.347***
	(0.296)	(0.298)	(0.296)	(0.296)	(0.177)	(0.180)	(0.181)	(0.182)
N female adults in hh	0.559	0.361	0.294	0.343	0.323	0.316	0.336	0.354
	(0.778)	(0.777)	(0.774)	(0.779)	(0.569)	(0.572)	(0.571)	(0.576)
N male adults^2	-0.020	-0.027	-0.027	-0.029	-0.018	-0.019	-0.020	-0.021
	(0.023)	(0.023)	(0.023)	(0.023)	(0.013)	(0.014)	(0.014)	(0.014)
N female adults^2	-0.034	-0.016	-0.010	-0.014	-0.030	-0.029	-0.031	-0.033
	(0.074)	(0.074)	(0.074)	(0.074)	(0.054)	(0.055)	(0.055)	(0.055)
N oxen owned by hh	-0.202	-0.226	-0.242	-0.235	0.171	0.168	0.176	0.178
	(0.222)	(0.223)	(0.223)	(0.224)	(0.138)	(0.138)	(0.139)	(0.140)
N livestock owned by hh	0.010	0.021	0.017	0.015	-0.019	-0.017	-0.018	-0.018
	(0.097)	(0.097)	(0.098)	(0.098)	(0.061)	(0.061)	(0.061)	(0.061)
Share of plots: red soil	**1.055***	**1.092***	**1.111***	**1.179****	0.125	0.154	0.133	0.163
(Other color is reference)	(0.594)	(0.596)	(0.594)	(0.598)	(0.383)	(0.385)	(0.386)	(0.387)
share of plots: black soil	**1.187****	**1.188****	**1.235****	**1.250****	0.425	0.450	0.439	0.462
	(0.559)	(0.559)	(0.558)	(0.561)	(0.372)	(0.375)	(0.375)	(0.376)
Share of plots: non fertile soil	0.092	0.071	-0.110	0.053	0.157	0.177	0.217	0.272
(Fertile soil is reference)	(1.189)	(1.175)	(1.202)	(1.213)	(0.683)	(0.686)	(0.693)	(0.698)
Share of plots: medium fertile soil	-0.289	-0.379	-0.374	-0.380	0.359	0.418	0.418	0.399
	(0.661)	(0.666)	(0.665)	(0.667)	(0.405)	(0.409)	(0.410)	(0.412)

Share of plots: steep slope	**-0.688***	**-0.752****	**-0.741****	**-0.761****	-0.127	-0.137	-0.131	-0.142
(Flat slope is reference)	(0.362)	(0.364)	(0.362)	(0.364)	(0.250)	(0.250)	(0.251)	(0.253)
Share of plots: medium steep slope	-0.405	-0.231	-0.163	-0.277	-0.267	-0.251	-0.260	-0.250
	(0.770)	(0.769)	(0.765)	(0.773)	(0.503)	(0.505)	(0.506)	(0.509)
Mean plot area	0.389	0.426	0.379	0.323	0.349	0.344	0.364	0.341
	(0.423)	(0.424)	(0.425)	(0.426)	(0.275)	(0.275)	(0.276)	(0.279)
Constant	-1.382	-0.929	-0.742	-1.160	-0.441	-0.562	-0.600	-0.574
	(1.789)	(1.795)	(1.787)	(1.807)	(1.178)	(1.195)	(1.210)	(1.231)
lnsig2u constant	-1.261	-1.409	-1.705	-1.882	-1.641	-1.593	-1.568	-1.518
	(1.844)	(2.038)	(2.654)	(3.149)	(1.533)	(1.476)	(1.446)	(1.385)
Kebele fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Chamberlain-Mundlak effects	YES	YES	YES	YES	YES	YES	YES	YES
Chi-squared	61.236	64.562	67.694	69.717	145.446	143.500	143.471	143.332
N	1115	1115	1115	1115	1115	1115	1115	1115

Table A2. Household Level Certification: Activity Choice

	Free work	Unskilled	FFW
Certificate hh	**0.303*** **	**-0.418*** **	**0.034*** **
	(0.045)	(0.069)	(0.011)
Year 2007	**0.149*** **	**0.035*** **	**0.046*** **
	(0.035)	(0.009)	(0.010)
Post treatment	**-0.150** **	**0.439*** **	-0.002
	(0.069)	(0.075)	(0.024)
Total land area by hh	0.011	-0.001	-0.015
	(0.012)	(0.007)	(0.013)
Farm size*post-treatment	-0.004	-0.004	-0.000
	(0.016)	(0.008)	(0.013)
Age of household head	**-0.005*** **	-0.000	0.000
	(0.001)	(0.000)	(0.000)
Hh head is female	-0.053	-0.003	-0.025
	(0.104)	(0.033)	(0.026)
Hh head is illiterate	0.038	-0.001	-0.009
	(0.029)	(0.012)	(0.011)
N male adults in hh	-0.000	**0.006** **	0.003
	(0.007)	(0.003)	(0.003)
N female adults in hh	-0.026	0.006	**0.010** **
	(0.024)	(0.006)	(0.004)
N oxen owned by hh	**0.071*** **	**-0.013* **	**-0.015* **
	(0.016)	(0.007)	(0.008)
N livestock owned by hh	-0.005	0.001	0.003
	(0.006)	(0.004)	(0.003)
Share of plots: non fertile soil	0.020	-0.019	0.007
	(0.048)	(0.021)	(0.019)
Share of plots: steep slope	0.037	-0.014	-0.004
	(0.056)	(0.032)	(0.029)
Wald chi2(100)	11778.63		
Pseudo R2	0,1663		
N	1149		

Table A3. Household Level Certification: Trend Analysis

	off-farm work (excluding agricultural off-farm work)				All off-farm work			
HH LEVEL CERT	I	II	III	IV	I	II	III	IV
Placebo 2000	**-1.036*** **				**-0.743*** **			
	(0.390)				(0.284)			
Placebo 2002		**0.649***				-0.415		
		(0.394)				(0.287)		
Placebo 2005			0.543	0.482			**1.252*** **	**1.222*** **
			(0.386)	(0.373)			(0.290)	(0.287)
Post treatment				**1.354*** **				**0.777** **
				(0.493)				(0.330)
Chi-squared	78.725	75.553	76.712	103.127	211.382	208.651	213.667	280.098
N	1356	1356	1356	1933	1356	1356	1356	1933