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Impacts of Land Certification on Tenure Security, Investment, and Land Markets

Evidence from Ethiopia

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Abstract

Although early attempts at land titling in Africa were often unsuccessful, the need to secure rights in view of increased demand for land, options for registration of a continuum of individual or communal rights under new laws, and the scope for reducing costs by combining information technology with participatory methods have led to renewed interest. This paper uses a difference-in-difference approach to assess economic impacts of a low-cost registration program in Ethiopia that, over 5 years, covered some 20 million parcels. Despite policy constraints, the program increased tenure security, land-related investment, and rental market participation and yielded benefits significantly above the cost of implementation.

This paper—a product of the Sustainable Rural and Urban Development Team, Development Research Group—is part of a larger effort in the department to assess the impact of land policies. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at deininger@worldbank.org and dali1@worldbank.org.

Impacts of Land Certification on Tenure Security, Investment, and Land Markets: Evidence from Ethiopia

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1. Introduction

Two factors have led to increased recent interest in land registration and formalization of property rights to land in Africa. First, most African countries have, since the 1990s, passed new land legislation to remedy some of the perceived shortcomings of existing systems, in particular to strengthen customary land rights, recognize occupancy short of full title, improve female land ownership, and decentralize land administration. Advances in information technology and remote sensing have revolutionized the way in which land is administered in other regions and reduced the cost of doing so, providing tools for implementation that were not available earlier. Second, increased prices for food, fuel, and fiber are capitalized in land values and, together with emerging demand for land by investors, add to pre-existing pressures on land via urban expansion all over Africa. Clearly defined property rights (at the individual or group level) and a well-governed system of land administration will be essential to avoid that these lead to socially undesirable outcomes and conflicts.

Yet, although the importance of formalizing property rights has also been emphasized by other scholars (de Soto 2000), surprisingly little seems to have happened on the ground. Progress with implementation of new laws has often been slowed by institutional wrangles. The lack of experience led even respected scholars to view interventions to register land as paradigmatic examples of a long discredited top-down approach to development rather than ways to empower land users (Easterly 2008). Although it is recognized that the 'title-no title' dichotomy may be 'the wrong answer to the wrong question' (Bromley 2008), it tends to continue in the empirical debate in the literature.

Against this backdrop, this paper aims to quantify the economic impacts of recent land certification in Ethiopia, arguably the largest land administration program carried out over the last decade in Africa, and possibly the world. The program departs from traditional titling interventions in a number of ways, in particular by (i) issuing non-alienable use right certificates rather than full titles; (ii) aiming to promote

gender equity via joint land ownership by spouses and inclusion of their pictures on certificates; (iii) using a participatory and highly decentralized process of field adjudication; and (iv) constraining needs for spatial information to a minimum to reduce costs. This could potentially provide a basis for a rapid and large-scale approach to avoid the shortcomings that reduced the sustainability and poverty impact of past land registration programs and help provide a response to the emerging challenges.

To assess whether Ethiopia's experience holds lessons for others, we assess the impact of the program as implemented in the Amhara region on perceived tenure security, land-related investment, and land market participation. Limited capacity at the *woreda* level led to a phase-in of the program that, together with a four-round panel household survey, allows us to implement a difference-in-difference strategy to identify early program impacts. Evidence points not only towards significant positive program effects on the outcomes of interest but also a very positive benefit-cost ratio. A number of steps to ensure sustainability of benefits or to increase them are suggested and study of differentiated impacts, as well as channels through which they materialize, will be desirable. At the same time, there are clear lessons that could help other countries in confronting some of the secular challenges they face in the area of land policy and administration.

The paper is structured as follows. Section two reviews evidence on impacts of land-related programs as well as characteristics of the Ethiopian effort that are used to formulate hypotheses on program impact. Section three presents descriptive data for the entire sample and for treatment and control groups and discusses the modalities of program implementation and their implications for the estimation strategy. Section four provides estimates of certification impacts on the key variables of interest and section five concludes with a number of implications for Ethiopia and other countries in the region.

2. Background and approach

To set the stage, we discuss how and why measures to strengthen land rights or improve the way in which they can be enforced will affect owners' incentives to make land-related investment, transfer land to more efficient uses through market transactions, and use it as collateral for credit. These predictions are contrasted with empirical evidence from different settings, especially in Africa. Key characteristics of the program and policy environment in Ethiopia are then used to review expected impacts, identify proxies to measure them empirically, and formulate hypotheses that can be subjected to statistical tests.

2.1 Evidence from the literature and implications for Africa

The literature identifies three channels through which higher security and better enforcement of property rights can, in principle, affect economic outcomes. First, clearly defined property rights to land and the ability to draw on the state's enforcement capacity will reduce the risk of eviction, increase incentives for

land-related investment (Besley 1995) and reduce the need for land owners to expend resources to stake out or defend their claims. The latter can be of particular importance for groups, e.g., women, whose access to land was traditionally discriminated against (Joireman 2008).

Positive impacts of more secure land tenure on investment and land values in rural areas have been demonstrated in China (Jacoby *et al.* 2002), Thailand (Feder *et al.* 1988), Latin America (Deininger and Chamorro 2004, Field *et al.* 2006, Bandiera 2007, Fort 2007), Eastern Europe (Rozelle and Swinnen 2004), and Africa (Deininger and Jin 2006, Goldstein and Udry 2006). In urban areas, efforts to enhance tenure security have led to higher levels of self-assessed land values (Lanjouw and Levy 2002), increased investment in housing (Galiani and Schargrodsky 2005) and female empowerment (Field 2005). Receipt of titles allowed former squatters, especially females, to join formal labor markets instead of staying at home to guard their land, thereby increasing their income and reducing child labor (Field 2007). Joint titles helped reduce fertility (Field 2003), increased investment in children's human capital (Galiani and Schargrodsky 2004) and improved educational outcomes (Galiani and Schargrodsky 2005). The way in which property rights to land could be exercised affected governance and corruption (Lobo and Balakrishnan 2002) and performance of local institutions (Deininger and Jin 2008).

The size of tenure-security and investment effects will depend on the attractiveness of investment opportunities and the reduction in enforcement efforts, i.e., it will be larger where tenure has been very insecure or the level of conflict high. A key policy issue, especially in Africa, is not only whether expected benefits are large enough to justify the cost but also whether a process can be implemented in an equitable manner and the institutions required can be sustained over time. Emphasis on individual title has often been associated with a failure to recognize the wide spectrum of joint and communal rights as well as local institutions that may have had more effective local presence than a distant state. As a result, efforts to improve tenure security may have weakened or extinguished some rights, displaced institutions without providing alternatives, and in doing so disempowered certain groups and increased rather than reduced conflict. Adoption of a sporadic rather than systematic approach and lack of safeguards such as wide dissemination of information and a transparent and public adjudication process with possibility for appeal have often set off a speculative clamor for land which, if not checked, may have led to interventions reinforcing or exacerbating pre-existing inequalities, with little positive impact on growth. Finally, failure to ensure that the cost of first-time registration as well as updating of registry records, in relation to land values, is commensurate the benefits, has often made it difficult to either complete first registration or keep the registry up to date. A combination of these issues has limited the effectiveness of or benefits from efforts at land registration in many African contexts (Pinckney and Kimuyu 1994, Bruce

and Migot-Adholla 1994, Jacoby and Minten 2007) and it will be important to check whether the case at hand was able to address some of these.

Being able to access reliable information on individuals' land ownership at low-cost through a public registry will also reduce the cost of exchanging land in markets for rental or sales. Rental allows land owners to tap new sources of income while still maintaining land as a means of insurance or old-age protection while those who remain in farming can consolidate and cultivate larger areas. Having a certificate can allay fears that land that has been rented can be lost, either to the government through redistribution, or to the tenant who will not vacate it upon termination of the lease period. This could be useful in contexts where migration will require land owners to be temporarily absent or if the number of transactions increases beyond the level that can be handled by informal mechanisms at the local level in a transparent way. In China, rental contributed to occupational diversification and was estimated to have increased productivity by about 60% (Deininger and Jin 2008). In Vietnam, award of certificates is estimated to not only have prompted investment in perennials (by 7.5% compared to no certificates) but also an 11-12 week expansion of the time households spent in non-agricultural activity, an effect that was particularly pronounced for the poor (Do and Iyer 2008).

Key benefits from possession of formal land title for land sales are the ability to exchange land with strangers and the associated ability to use land as collateral for credit (de Soto 2000).[1] The reason is that, if a reliable land registry provides a formal and low-cost way to identify land ownership without the need of physical inspection or inquiry with neighbors, land is ideal as collateral. At the same time, for credit effects from formal registration to materialize, households will need to have otherwise bankable projects, be credit-worthy, and willing to take the associated risk (Boucher *et al.* 2008). Moreover, land markets need to be sufficiently liquid to make a sale feasible within a given time if needed, implying that land rights are fully transferable and neither legal provisions nor social conventions limit foreclosure. While credit effects of land titling are reported in the literature (Feder *et al.* 1988), positive impacts were often limited to larger land owners (Mushinski 1999, Carter and Olinto 2003) and studies fail to find credit effects even in settings where such an effect was expected (Field *et al.* 2006, Fort 2007). Even if profitable projects exist, legal restrictions on land sales (Sundet 2004), limited commercial value of the land under question (Galiani and Schargrodsky 2005, Payne *et al.* 2008) and social or political considerations to limit foreclosure (Field and Torero 2006) may jeopardize realization of credit effects and imply that such effects may be less readily realized than sometimes suggested by their protagonists.

[1] The large differences in the ratio of credit to GDP across countries is used as a key argument to justify interventions to formalize land rights that could then allow greater use of land as a collateral to access credit (de Soto 2000, Besley and Ghatak 2008).

2.2 Hypotheses on program impact and outcome variables

The extent to which any of the above effects of land certification materialize will depend on the policy environment, modalities of program implementation, and owners' confidence that certificates will be respected and change behavior. Before formulating hypotheses, we discuss these three elements in turn.

Three factors contributed to low levels of tenure security in Ethiopia (Amhara) and thus considerable potential for certification. First, in 1997, Amhara implemented, a redistribution of land that was largely politically motivated and generated considerable conflict (Ege 1997) that may be addressed in the context of land certification. Moreover, land in Ethiopia remains state owned and the constitution affirms the right of every adult to access land while empowering government to resort to land redistribution to achieve this goal, with high levels of bureaucratic discretion, if necessary.[2] Discussion of this topic has recently intensified as Tigray region passed and started implementing a proclamation to take away land of rural residents who had left their village for more than two years. Finally, urban expansion as well as award of land to investors by the government is proceeding apace and in both cases possession of a certificate can provide at least a basis for demanding and determining levels of compensation. Also, as land in Ethiopia is state property that can neither be sold nor mortgaged, we would expect no credit effects from land certification. Moreover, with the exception of Amhara, all regions restrict the amount of land that can be leased out to 50% of any holding, suggesting that—beyond Amhara—certification impacts on land rental markets may be limited.

The literature has many examples where differential access to information in the course of implementing land registration programs led such interventions to exacerbate rather than reduce pre-existing biases by wealth or gender. In Ethiopia, the tendency of land certification to encourage encroachment on communal lands by the powerful was particularly important. The only way to reduce this tendency was to identify such lands before any individual plots were demarcated in a public and participatory process (Gebre and Keneaa 2008). Both a process that is perceived to be unjust and failure to honor certificates on the part of officials can undermine the credibility of the whole process and thus any impact which one would expect certificates to have. Indeed, case studies report great skepticism among farmers who initially believed that certification was just another politically motivated campaign and only started changing their view as they participated in the process and realized the potential usefulness of the certificates (Adal 2008).

While qualitative evidence on process characteristics can provide a first assessment of economic impacts from certification, our quantitative outcome variables focus on three areas, namely perceived tenure

[2] The proclamation (law) in Amhara provides for land redistribution but makes it the responsibility of local communities and requires that it be supported by research to eliminate potentially adverse effects on land fragmentation and productivity. Tigray has recently started redistributing the land of anybody who had been absent from the village for more than 2 years and earned more than a certain amount (US $ 100 per month).

security; land-related investment; and rental market participation. First, the high level of tenure insecurity before the program, and the fact that certification would be expected to affect this variable quickly, imply that the perceived level of land tenure security is a useful indicator. We use the response to the question of whether the household expects a change (increase or decrease) of land holdings through administrative action over the next 5 years and note that, as the question format was identical in all the four survey rounds, concerns about potential halo effects are unfounded. Second, theory suggests that higher levels of tenure security will lead to higher levels of voluntary land-related investment, possibly with some lag. We use a dummy for whether households constructed new soil conservation structures (e.g., terraces, bunds made of soil or rocks, and hedgerows) or repaired existing ones at the plot level, as well as the number of hours spent on this, to measure such investment. Unfortunately, this variable is only available for the last two survey rounds. Finally, at least in the case of Amhara, possession of a certificate should make it easier to rent out land but, except for general equilibrium effects at the village level, not affect the extent of renting in and we use a dummy for the type or net rental market participation and the amount of land transacted through such markets as the relevant indicator to ascertain impacts of land certification on participation, noting that other impacts, e.g., those on allocative efficiency and overall productivity, transcend the scope of this paper and should be the subject of separate investigation.

2.3 Program characteristics and qualitative evidence on impact

In what is one of the largest programs of land registration in the world, three of Ethiopia's four main regions have, over the last 5 years, registered more than 20 million parcels of rural land by some 6 million households.[3] Despite the rapid speed, the quality of the certification process—measured by the share of cases where conflict could not re resolved, thus precluding issuance of a certificate—was high; certificates could not be issued in only 5% of cases, compared to 20% in other titling projects. Moreover, at less than US $ 1 per parcel (Deininger *et al.* 2008b), the cost of Ethiopia's certification program is an order of magnitude lower than what is reported in the literature which puts the cost of traditional titling at between US $ 20 and 60 per parcel (Burns 2007). In fact, even low-tech approaches that issue only certificates in West Africa are estimated to have cost some US$ 7-10 per parcel (Lavigne-Delville 2006).

Under the general process that was adhered to with some regional variations certification is initiated by a team of experts from the *woreda* level that accompanies the process through a village meeting, followed by election of an independent village land use and administration committee (LAC),[4] which then assumes

[3] Tigray had implemented a similar program in 1998. The size of the program is similar to 11 million of certificates awarded in Vietnam from 1993 to 2000 and issuance of 8.7 million titles in Thailand during 1980-2005. It also compares favourably to accomplishments by other land administration programs such as the 2.7 million titles (1.2 million urban and 1.5 million rural) issued in Peru from 1992 to 2005 and 1.8 million titles in Indonesia since 1996.

[4] The fact that the LAC is directly elected in a democratic fashion rather than being part of the (often politicized) administrative structure was highlighted repeatedly as an important merit in interviews with groups as well as individual villagers.

responsibility for systematic adjudication of rights in the field in a public process with presence of neighbors. While LAC members repeatedly emphasized the demanding nature of this task, it is critical to ensure transparency, e.g., in identification of communal areas, and reduces the scope for error that could arise from use office records that may not be up to date. The field adjudication process, which may rely on assistance by elders to resolve conflicts, concludes with the issuance of a preliminary registration certificate that identifies sizes and the adjoining neighbors for all of a holder's plots. Results are then displayed in public, followed by their entry into registry books, copies of which are to be kept at *kebele* and *woreda* level. Thereafter, certificates with holders' pictures (husband and spouse in case of couples where joint ownership is mandated), are issued. While these include space for maps, spatial information is not included except in pilot locations in view of the cost and is expected to be added in a 'second stage'.

Qualitative evidence suggests that decentralized, participatory, and transparent implementation, issuance of certificates rather than titles, and a focus on gender equality, helped the program avoid some of the problems raised in the literature on land titling in Africa. A nation-wide survey highlights that access to information or certificates was neither biased against females nor the poor. Moreover, the process was generally implemented as planned; in particular (i) public meetings were held before and during the certification process; (ii) land use committees (LACs) were elected and represented most of the sub-*kebeles*; and (iii) adjudication relied on village elders to resolve disputes and involved demarcation in the field with neighbors' presence. As the time allowed for the field process was long enough to sort out conflicts locally, the program could adapt to local conditions while still making rapid overall progress.

An overwhelming majority of households nation-wide pointed to positive impacts of certification on gender relations, land-related investment, rental market participation, and the perceived ability to receive compensation in case of land taking. More than 80% were willing to pay for replacement of lost certificates as well as addition of a map (Deininger *et al.* 2008b). Case study evidence points into a similar direction; as registration involved identification of borders and systematic conflict resolution, it led to a significant drop in land conflict which, according to local government reports, accounts for 80% of rural crime. In one site, the volume of court cases is reported to have reduced from 20 to at most 2 per week (Adal 2008). In some cases, widows were able to win court cases to hold on to their land rather than, as dictated by local tradition, having it revert back to the husband's lineage at the point of his death. In polygamous settings, the requirement to have separate certificates for any spouses beyond the first one is linked to a reduction in (reported) polygamy and even male farmers acknowledge that joint titling led to increased willingness to work and invest on the part of their wives who are now officially co-owners. Households in areas where urban expansion is imminent are reported to be particularly eager to get certificates that could help them substantiate their claims for compensation once their land is subject to

urban expansion. In fact, observers link the ability to use certificates to insist on compensation to the emergence of innovative in-kind compensation arrangements in a number of peri-urban areas.

3. Data, descriptive evidence, and econometric approach

This section describes the data underlying our empirical evidence and the sequence in which the program was implemented in treatment and control villages as a basis for tracking key indicators for hypothesized program impacts. This provides a pipeline comparison group that allows us to apply a difference-in-difference method to estimate the impact of land certification on the outcome variables of interest.

3.1 Data sources and modalities of program implementation

To test the above hypotheses, we use data from four waves of a panel survey of rural households that were conducted in 1999, 2001, 2004, and 2007 in East Gojjam zone of Amhara region in a number of villages all of which were supported by a SIDA-supported rural development project.[5] In each round, the survey, which was undertaken by the Department of Economics of Addis Ababa University in collaboration with Gothenburg University, EDRI, and the World Bank, includes information on some 900 randomly selected households and more than 4,000 plots operated by them.[6] The fact that the first 3 waves of the panel cover the period before certification started whereas some of the villages had been certified at the time of the 4th round allows us to use a difference-in-difference strategy together with a pipeline implementation strategy. This is possible as in some villages certification had been completed 12 months or more before implementation of the 4th round of our survey, thus affecting investment and land market participation decisions. As other project components were available in all villages, there is little concern about time-varying factors affecting villages differently and thus biasing our estimates. This is supported by the fact that, before the program, outcome variables moved in parallel in the villages.

Our strategy is conservative in two ways. First, as at the time of the 4th round of our survey all the villages had received information about the certification program, households in villages which we classify as 'non-certified' (some of whom had already received a certificate at the time the survey was implemented) may well have adjusted their behavior in anticipation of future program availability, implying that estimates of program impacts obtained here will be a lower bound of the true effect. Second, as we define the intervention at the village rather than the household level, our 'treated' category includes households who, for a number of reasons (mainly conflict that could not be resolved or delays in the issuance of

[5] The Gojjam zone was selected purposefully to represent surplus producing areas of the region. The districts and the villages in each district were also selected based on similar criteria while households in each village were selected randomly.

[6] Information for one of the sampled villages is available only for the last two rounds, as it was included in the sample during the third round. For production information, the reference period was the main agricultural season (*meher*, i.e., from June-February) of 1998/99, 2000/01, 2003/04 and 2006/07 agricultural years.

certificates due to delays or non-availability of pictures), did not receive a certificate, again exerting downward bias on the estimated effects of certification under reasonable assumptions.

Table 1 illustrates patterns of program implementation for the 7 villages (*kebeles*) in 3 districts (*woredas*) in our survey. First, we note a distinct phasing of program implementation which was undertaken by the *woreda* administration based on their discretion. With the exception of one control village (Telma), the program was introduced between February 2003 and February 2004 in our treatment villages, compared to the May 2005 to Sept. 2006 period in control ones. It then took an average of 11 months to complete registration and another 5 months for certificates to be issued. By comparison, 3 of the control villages had completed registration and two had started issuance of certificates at the time of the survey. In control villages that started certification, the process commenced some 15 months later than the treated ones and the delay in program introduction provides an identification strategy for our empirical analysis. Apart from the later start, the process implemented was identical as illustrated by the number of LAC members and village meetings which do not point to significant differences between the two groups of villages.

Household level evidence on process characteristics in the top panel of table 2 reinforces this; 85% in certified and 78% in control villages attended an average of 3.5 public information meetings and 85% and 68%, respectively, think they are well informed about the program. At the time of the survey, 87% of households in treatment villages had received a certificate, which they held for an average of 17 months, compared to 36% and 8 months in controls, with 77.5% in treatment and 2.3% in control areas having held certificates for a period longer than 12 months. Plot level data in the bottom panel of table 2 point towards some difference in implementation across villages; while almost all the plots (92%) in treated villages were measured (95% with rope) in the field with presence of more than half of neighbors in 60% of cases and between one third and half in 20% of cases, field measurement was done for less than two thirds of registered plots in control villages, 35% of these cases involved eye estimation only, and more than half or more than one third of neighbors were present only in 35% and 11% of cases.

To illustrate the evolution of key dependent variables, table 3 displays key household characteristics by participation status and year for the 356 and 477 households in treated and control villages, respectively. While there are few differences in heads' age or sex, systematic differences at the household level point towards the importance of controlling for household heterogeneity. For example, the treated villages have somewhat higher endowments of land per household (but not per capita), higher levels of human capital as proxied by literacy of the head, more livestock and other animals, and use higher amounts of fertilizer per hectare. Although the villages are some distance from each other, some time-varying factors (e.g., a drought in 2002) appear to have affected both of them in similar ways. Attributes for the 3,972 and 4,699 plots in treated and untreated villages, averaged over all periods, as reported in table 4, suggest that the

mean plot size measures some 0.3 ha and had been in the possession of its current owner for about 21 years. With 4%, irrigation is very rare in both villages and even though there are small differences in the subjective land attributes (land quality and incline), there are no statistically significant differences between villages in the share of flat and gently sloped as well as good and medium quality land together.

3.2 Outcome variables

Levels and changes over time in the outcome variables of interest, as displayed in table 5, provide a first check of our hypotheses. First, we note that in both treated and control villages perceptions of tenure insecurity in 1999 were indeed very high, with three fourths or more of land holders (78% in treated and 75% in control areas) expecting a change of land holdings due to administrative intervention, possibly as the 1997 redistribution was still fresh on their minds. Over the next 5 years, i.e., in the period before the certification program, these shares declined to 38% in both treatment and control villages. Between 2004 and 2007, i.e., during the period of program implementation, the trends diverge with a drop to 24% in treated areas that contrasts to a slight increase to 39% in control villages. Disaggregation reveals that the share expecting an increase dropped from 19% to 4% in treatment and to 11% in control areas, whereas the share of those expecting a decrease in their holdings remained unchanged in treatment areas while increasing from 19% to 28% in controls. As the generalized expectation of an increase in holding size could exert considerable pressure on policy-makers, both of these may be of relevance for tenure security. While less robust, a plot-level variable asking land owners whether they were concerned about land conflict, albeit introduced only in the last round, also points to significantly higher levels of tenure insecurity in the control (20%) as compared to the treatment group (14%) in a simple cross section.

Although the pre-program share of plots where investment or repairs were undertaken and the level of time spent on such investment were significantly higher in control as compared to treated villages, the difference in both narrowed significantly, and for construction of new structures even reversed, consistent with the hypothesis that certification did affect investment incentives in the expected direction. For example, a significant decline in the share of households who voluntarily engaged in construction of new or repair of existing structures and the number of hours spent (from 36% to 24% and 8.2 to 5.5 hours, respectively) in control areas contrasts with an equally large increase (from 12% to 25% and 2.3 to 4.4 hours) of this figure in treated ones. Similar narrowing or reversal is observed for the share of plots with any type of conservation structure (from 44% to 34% in control and from 22% to 32% in treatment areas) and the share of households who constructed new structures during the last 12 months (from 10% to 8% and 7% to 10% in control and treatment villages, respectively).

The share of landlords and mean area rented out had been consistently higher in treated as compared to control villages before land use certificates were distributed, a difference that narrowed from 2004. After

certification, we note a clear increase in rental market participation in both areas. While the increase in renting out (7% vs. 5%) is marginally higher in treated as compared to control group, the opposite is true for renting in, implying that more rigorous evidence will be needed to assess whether certification can be said to have had a significant impact on land market participation or whether, possibly as a result of the rather restrictive policy regime, no such impact materialized.

3.3 Econometric approach

To econometrically identify possible impacts of the certification program, we apply a difference-in-difference approach that compares the difference between pre- and post-program household and plot level outcome variables in certified and non-certified villages. This will provide us with an unbiased estimate of program effects if unobserved differences between treatment and control villages do not affect changes in outcome variables over time. This seems reasonable given that treated and control villages are located in the same zone, were exposed to the same set of interventions under a SIDA-financed rural development program, but entered the certification program at different points in time as a result of capacity limitations at the *woreda* level that implied a need for sequencing program start-up. The fact that other characteristics as well as outcome variables before the program evolved in a similar fashion on both sets of villages adds credence to this.

To estimate program impacts on perceived tenure security, we use data from all four rounds to estimate

$$y_{it} = \lambda_t + \tau w_{it} + \mathbf{x}_{it}\boldsymbol{\gamma} + c_i + u_{it}, \qquad (1)$$

where y_{it} is a dummy variable that takes a value of one if household *i* expects an increase (or a decrease) of its landholdings due to administrative intervention in the five years following the survey; w_{it} is the policy variable of interest (1 for post-treatment period if household *i* resides in 'treated' village and 0 otherwise); $\mathbf{x}_{it}$ is a vector of household controls that include the head's age, gender, education, assets (number of oxen, value of other livestock, roof material) and relative land size, defined as the amount of owned land per adult equivalent relative to the median of this variable in the village; c_i captures household specific unobserved effects, λ_t is a full set of time dummies; and u_{it} is an *iid* error term. The null hypothesis that certification increases tenure security would imply that τ be negative and significant. Random effects probit model is appropriate if c_i is normally distributed with mean 0 and variance σ_u^2 and independent from all right-hand side variables. As this may be unrealistic, we also use Chamberlain's random effects probit (Chamberlain 1980, Wooldridge 2001) which relaxes this by allowing correlation between c_i and the means of time-varying covariates at the household level according to

$$c_i = \psi + \bar{\mathbf{x}}_i \boldsymbol{\xi} + a_i,$$

where $\bar{\mathbf{x}}_i$ is the vector of average of time-varying household covariates for household *i* over all periods and a_i is an error term. All that is required is that $\mathbf{x}_{it}$ and a_i are independently and normally distributed with mean zero and variance σ_a^2. Adding $\bar{\mathbf{x}}_i$ as an explanatory variables to (1) in each time period then allows estimation of the parameters λ, τ, $\boldsymbol{\gamma}$, ψ, $\boldsymbol{\xi}$ and σ_a^2 in a standard random effects probit model.

In contras to the household-level analysis in (1), impacts of certification on land-related investment are assessed at the plot level. Dependent variables for land-related investment take the value of 1 if the plot received soil or water conservation investment during the past 12 months or the number of hours spent in undertaking such investment during the past 12 months. Using the notation introduced above, the random effects probit or tobit (depending on the choice of the dependent variable) model for land-related investment on plot *j* by household *i* is specified as:

$$y_{jit} = \psi + \lambda_t + \tau w_{it} + \mathbf{x}_{it}\boldsymbol{\gamma} + \mathbf{p}_{jit}\boldsymbol{\delta} + \bar{\mathbf{x}}_i\boldsymbol{\xi} + a_i + u_{jit}, \quad (2)$$

where the only difference is the inclusion of $\mathbf{p}_{jit}$, a vector of plot level characteristics that includes size, soil quality, slope, and length of possession, and the addition of a plot specific error term u_{jit}. The hypothesis of certification increasing incentives for land-related investment translates into $\tau > 0$. As earlier rounds did not include comparable information, our analysis is limited to the last two rounds

Similar random effects probit and tobit specifications for participation on either side of the market and the amount of land transferred, respectively, are estimated for our rental market outcomes. As, for example due to non-convex transaction costs, rental market participation may be persistent over time (Holden *et al.* 2008), we also estimate a specification that allows for state dependence of rental market participation. The implied need to include the lagged dependent variable on the right-hand side of (1) gives rise to a nonlinear dynamic model that may suffer from the initial condition problem, i.e., the correlation between the unobserved effect and the initial observation of the dependent variable. To account for this, the distribution of the unobserved effect is modeled conditional on the initial observation in addition to the time-varying household level covariates (Wooldridge 2005). The reduced form equation to be estimated is

$$y_{it} = \psi + \lambda_t + \tau w_{it} + \mathbf{x}_{it}\boldsymbol{\gamma} + \rho y_{i,t-1} + \xi_0 y_{i0} + \bar{\mathbf{x}}_i\boldsymbol{\xi} + a_i + u_{it}, \quad (3)$$

where y_{it-1} is the lagged dependent variable and y_{i0} is the first realization of the dependent variable. The parameters in equation (3) are estimated using standard random effects probit or tobit, depending on the

type of the dependent variable. As this procedure requires data for at least for four periods, we are forced to drop one of the villages (A. Gulit) that was added to the survey during the third round. The hypothesis of a positive impact of certification on the propensity to rent out land translates into $\tau > 0$ in the probit and tobit equations for renting out or the area rented out.

4. Key results

Results corresponding to the three main hypotheses suggest that, despite the limited time elapsed since its completion, certification had a positive economic impact and improved tenure security, investment, and supply of land to the rental market. Even conservative estimates and a very rough calculation of monetary benefits point towards a positive and large cost-benefit ratio.

4.1 Tenure security

Results from probit estimation of (1) to identify determinants of higher perceived risk of land loss or gain through administrative redistribution in the next 5 years are reported in table 6 for the simple (col. 1 and 3) and Chamberlain specification (col. 2 and 4). In all cases, results suggest that households in treated villages have higher levels of tenure security, i.e., expect significantly less administrative intervention. Marginal effects suggest that, consistent across the two specifications, certification leads to a decrease of about 14 percentage points in the share of those expecting to gain and of about 9 percentage points in the share of those expecting to lose from land redistribution. Certification did not eliminate fears of land redistribution but helped to reduce it from levels that were very high even by global standards.

Coefficients on the time trend are highly significant and of large magnitude for gains but less significant for land losses, in line with descriptive evidence that points towards a reduction over time in the share of those who expect their holdings to increase rather than those who expect to lose land. Signs for coefficients on other variables are largely as expected. Older heads are more likely to expect land loss, consistent with the notion that administrative measure aim to redistribute productive assets among generations. A higher per capita land endowment, relative to the village median, increases the perceived likelihood of land loss and reduces the likelihood of gain, as expected in a system that aims to distribute a limited amount of overall land as equitably as possible among rural residents. The opposite is true for higher shares of good quality land, something that could suggest that officials are either not good at assessing land quality or do not take it into account in making their decisions. Higher endowments with non-land assets, oxen, education, or possession of an iron roof have—with the possible exception of the latter—little impact on the perceived threat of land loss or gain, suggesting that officials' objective is neither a general redistribution of assets nor a maximization of productivity (e.g., a desire to substitute for land markets in bringing land to better endowed households). The significance of coefficients on gender-

related variables such as the sex of the head and the number of adult males in the simple specification disappears once the Chamberlain method is used, suggesting that once we control for households' history these variables no longer affect tenure security. Interactions between the treatment dummy and variables such as the amount of land owned, total assets, and head's gender are consistently insignificant. While this may be a result of the limited number of observations, it provides little support to the notion of certification-induced tenure security effects being differentiated by wealth or gender.

4.2 Land-related investment

Table 7 reports coefficient estimates, as marginal effects, from probit and tobit models for new investment in or repairs of conservation structures during the last 12 months for the simple (col. 1, 2, 4 and 5) and Chamberlain specifications (col. 3 and 6). Results consistently point towards a statistically significant and economically meaningful certification impact with an estimated average treatment effect of some 30 percentage points on the propensity to invest in soil and water conservation measures and more than a doubling of the number of hours spent on such activities. Although from a low base and consistent with case study evidence, this is a large impact compared to other studies in the literature. Given that certification was only concluded recently, such investment will not have affected agricultural production as reported in our survey. To obtain a proximate measure of the size of the investment impact, we estimate a household-fixed effect production function with a dummy for presence of a functioning conservation structure (see appendix table 1 for results). Results suggest that such a structure increases output by about 9 percentage points, implying that, with a mean annual output of B 3,300, the investment-induced certification impact would amount to B 87 per hectare (0.29*0.09*3,330). Even if we assume that half of the investment actually involves repairs of existing structures and discount at 10%, our conservative estimate implies that the increment in output resulting from certification-induced investment in the first year post certification alone would be sufficient to entirely cover program cost (US$ 1 per plot or US$ 3.2 per hectare).

Coefficients on other variables suggest that the propensity to make land-related investment increases in plot size but decreases in overall holding size, consistent with the notion that presence of some fixed cost element increases payoffs from investment on larger fields but that, on larger holdings, there is increased competition among plots for investment. It also declines with time and gender the head but increases marginally with the number of dependents in the Chamberlain specification. The propensity to undertake investment is significantly lower on flat land, consistent with the fact that such plots are less prone to be affected by erosion and land degradation than hilly plots, implying less need to guard against these through adoption of soil conservation measures. As the investments considered do not involve any cash outlays, there is little reason to expect impacts to be differentiated by wealth, as indeed suggested

consistent lack of significance of the certification dummy's interaction of the with various measures of wealth (not reported) is insignificant throughout.

4.3 Rental market participation

To test whether, as predicted, certification affected the propensity to rent out but left the demand-side of the market unaffected, tables 8 and 9 present results from probit and tobit estimates of equation (3). In both cases, cols. 1-3 which contain, respectively the simple and the Chamberlain specification without dynamic effects, strongly support our hypothesis. While the treatment variable is weakly significant in the simple specification, the dynamic (col. 3 and 6 of both tables) suggest strong positive state dependence of participation decisions and the amount of land transacted on both sides of the rental market. Such path dependence implies that policy interventions that affect rental market participation will have effects on households' trajectories in the long term. Estimated marginal effects suggest that certification increases the propensity to rent out by 13 percentage points and the magnitude of land rented out by about 9 points or 1/10 of a hectare for the average farm in the sample. Estimated impacts for renting in are consistently insignificant. Socio-cultural norms and factor market imperfections make self-cultivation by female heads extremely rare, implying that they can either rent out their land or—often because of insecure tenure—leave it fallow (Adal 2005). To the extent that they allow productive use of plots that had been left uncultivated, certification-induced rental market effects would enhance productivity as well as equity. Higher levels of tenure security could affect productivity in a number of ways, e.g., by allowing landlords to enter longer term contracts or select more productive tenants who are not part of their immediate social network. As virtually all of the land is rented under sharecropping contracts, any such effects would translate directly into improved welfare for female landlords. Although beyond the scope of this paper, further study of this issue and of non-economic impacts, e.g., female empowerment, would be of interest.

Our results also point towards a significant impact of land endowments on renting out (positive) and renting in (negative) as would be expected if rental markets contribute to equalization of factor input ratios. Total owned area has a positive and significant effect in the leasing out regressions as compared to a negative and significant effect on the leasing in regressions. However, the absolute value of the marginal effect of total owned land on the amount of land rented out or in (table 9) is less than one, indicating that rental market participation allows only partial adjustment towards desired area of cultivated land (Bliss and Stern 1982). We note that, contrary to what is found in studies from other countries, but consistent with other evidence from Ethiopia (Deininger *et al.* 2008a), rental markets transfer land from relatively resource poor (mainly in terms of oxen power) who are often female-headed, to comparatively resource rich households. Consistent with the notion that imperfect labor markets,

together with social and cultural norms, make self-cultivation by female headed households difficult and that this effect is exacerbated by ill-functioning markets for draught animals, the gender of the household head and the number of oxen have a significant impact on the nature and magnitude of rental market transactions and that estimated to have very large and significant effects (which is smaller in the Chamberlain specification) that discourage renting out but encourage renting in. The significant coefficient on possession of an iron roof in the rent-in equation reinforces this notion, suggesting that there may also be imperfections in other financial markets that make renting in easier for those with higher levels of wealth. To the extent that the certification-induced higher propensity to rent out implies greater freedom in the choice of transaction partner, certification could, by allowing women to choose more able partners, have an impact not only on the productivity of rental transactions and land use in general but also on the welfare of a vulnerable group, something left for future research. At the same time, older households are more likely to rent out and literate ones rent our larger areas of land.

5. Conclusion and policy implications

This paper aimed to explore whether the land certification program in Amhara had positive economic impacts and could provide lessons for others. Despite its recent nature and clear gaps in the local policy environment, we find evidence of significant economic benefits, the magnitude of which exceeds program cost significantly. Follow-up research to assess non-economic effects from the program, especially on female empowerment, the channels through which specific program effects materialize, the path of their evolution over time, and how benefits are distributed across the population, would be of great interest. More immediately, our results give rise to a number of conclusions.

For Ethiopia, the evidence of clear benefits implies that completion of certification will be warranted, ideally based on review and possible adjustment with regard to institutional structure (EPLAUA vs. MOARD), specific rules for implementation (communal areas, women's participation, spatial records), and the policy framework (leasing). Second, while tenure security and investment benefits can further increase over time, especially as other factors that are needed for such effects to materialize (e.g., non-agricultural employment opportunities or better marketing channels) come into place, they can easily be undermined if beneficiaries' lose confidence in the value of certificates. Taking of land by government—whether for urban expansion, outside investors, or internal redistribution—without use of certificates to determine compensation levels or prompt award of compensation could jeopardize credibility of certificates. At a more technical level, failure to keep them up to date, e.g., because of deficiencies in record-keeping, would have the same effect and could result in them losing their value.

The evidence presented here suggests not only that implementation of a decentralized, transparent, and cost-effective process of land registration is possible, but also that failure to do so may in many situations

forgo significant economic and possibly social benefits. Assessment of impacts of similar programs in other contexts would not only be highly desirable and could provide a fruitful avenue for research that considers land titling as one of many avenues to secure and gradually formalize land rights.

Table 1: Program characteristics by village

	Certificates issued 12 months before survey?						
	No				Yes		
District (*Woreda*) name	Gozamin		Enemay		Machakel		Gozamin
Village (*Kebele*) name	Kebi	Wolkie	Telma	S. Debir	Amanuel	D. Elias	A. Gulit
Kebele area in ha	630	2670	1964	2560	4373	1790	2172
No of households	1094	1050	1464	1275	1151	906	890
Program introduced	May 2005	Sep. 2006	Oct. 2003	Jun. 2005	Feb. 2004	Feb. 2004	Feb. 2003
Competed registration	Dec. 2005	NC	Aug. 2006	Dec. 2006	Jun. 2004	Jul. 2004	May 2005
Start of certificate distribution	Aug. 2006	NS	Sep. 2006	NS	Feb. 2005	Feb. 2005	Jun. 2005
No. of LAC members	15	20	21	35	14	14	18
Training days to LAC members	3	5	8	8	9	4	6
Number of village meetings	4	4	6	2	5	3	3

Source: Own computation from AAU/Gothenburg/WB Survey
NC=Not completed at the time of the survey. NS=Not started at the time of the survey.

Table 2: Program characteristics at household and plot levels

	Certificates issued?	
	No	**Yes**
Household level data		
A member of the household attended public information meetings	0.78	0.85
Number of meetings attended	3.50	3.60
Well informed about the program	0.68	0.85
Has landholding certificate	35.55	87.47
Number of months since certified	8.07	17.15
Plot level data		
Plot area was determined in the field	0.64	0.92
Plot area was determined at *kebele* office referring to previous records	0.35	0.05
Plot measured using tape and rope, if determined in the field	0.65	0.95
Plot measured using eye estimation, if determined in the field	0.35	0.00
More than half of the neighbors were present when measured	0.35	0.59
Half or less than half of the neighbors were present were present	0.11	0.20
Plot has a certificate	0.30	0.75
Number of months since certified	8.19	16.93
Plot is jointly certified with head and spouse	0.83	0.77
Number of households	481	359
Number of plots	2369	2143

Source: Own computation from AAU/Gothenburg/WB Survey

Table 3: Household characteristics by treatment category over time

	No certificate				With certificate			
	1999	**2002**	**2004**	**2007**	**1999**	**2002**	**2004**	**2007**
Total owned land in hectares	1.34	1.35	1.61	1.47	1.57	1.59	1.89	2.06
Owned land per aeu in ha	0.36	0.34	0.36	0.32	0.37	0.34	0.36	0.38
Share of good quality land	0.36	0.32	0.31	0.44	0.36	0.33	0.28	0.39
Number of dependents	2.50	2.59	2.70	2.68	2.83	2.97	2.84	2.83
Number of adult male	1.24	1.41	1.65	1.79	1.41	1.54	1.71	1.95
Number of adult female	1.21	1.33	1.58	1.68	1.36	1.53	1.71	1.93
Number of oxen	1.20	1.20	1.17	1.29	2.22	1.98	1.99	2.06
Value of livestock (B)	1,628	1,670	1,771	1,962	2,883	2,839	2,888	3,081
Value of other animals (B)	857	924	1,026	1,124	1,432	1,309	1,591	1,737
Roof corrugated iron sheet	0.55	0.60	0.71	0.79	0.61	0.70	0.86	0.91
Age of household head (years)	44.17	45.66	48.08	49.81	44.87	46.67	48.72	50.46
Female headed household	0.13	0.12	0.15	0.17	0.10	0.07	0.17	0.19
Head can read and write	0.39	0.38	0.35	0.27	0.48	0.48	0.42	0.43
Value of crop output per ha (B)	1,926	634	2,596	3,283	2,564	880	2,187	2,804
Number of households	462	463	475	477	229	233	347	356

Source: Own computation from AAU/Gothenburg/WB Survey

Table 4: Plot Level Characteristics by Treatment Category

	No certificate 2004-2007	With certificate 2004-2007
Plot size in hectares	0.31	0.34
Number of years possessed	20.84	21.44
Good soil quality	0.38	0.35
Medium soil quality	0.37	0.43
Flat land	0.57	0.72
Gently sloped land	0.34	0.23
Irrigated land	0.04	0.04
Number of observations (plots)	4699	3972

Source: Own computation from AAU/Gothenburg/WB Survey

Table 5: Outcome Variables by Treatment Category

	None				With certificate			
	1999	**2002**	**2004**	**2007**	**1999**	**2002**	**2004**	**2007**
Expectations of land redistribution in the next five years and of conflict								
Expect change in holdings	0.75	0.62	0.38	0.39	0.78	0.64	0.38	0.24
Expect an increase in holdings	0.55	0.45	0.19	0.11	0.55	0.36	0.18	0.04
Expect a decrease in holdings	0.20	0.17	0.19	0.28	0.23	0.27	0.19	0.19
Concerned about land conflict (p)				0.20				0.14
Land related investment over the last 12 months (plot level)								
Repaired structure / built new one			0.36	0.24			0.12	0.25
Number of hours spent			8.22	5.51			2.26	4.38
Constructed new structure			0.10	0.08			0.07	0.10
Plot has conservation structure			0.44	0.34			0.22	0.32
Participation in land rental market								
Rent-out land	0.24	0.21	0.29	0.34	0.17	0.15	0.26	0.33
Area rented out (ha)	0.20	0.21	0.28	0.34	0.14	0.16	0.32	0.45
Rent-in land	0.37	0.26	0.20	0.36	0.49	0.31	0.36	0.45
Area rented in (ha)	0.25	0.19	0.15	0.29	0.29	0.19	0.27	0.44
Number of households	462	463	475	477	229	233	347	356
Number of plots			2284	2415			1886	2086

Source: Own computation from AAU/Gothenburg/WB Survey. Empty cells imply that no data was available.
Note: Except where indicated in the table, all variables are at the household level.

Table 6: Impact of certification on perceived land tenure security: Marginal effects from probit model

	Expect an increase		Expect a decrease	
		Chamberlain		Chamberlain
Land use certificates issued	-0.135***	-0.135***	-0.093***	-0.095***
	(-4.12)	(-4.13)	(-4.34)	(-4.43)
Relative land size	-0.106***	-0.106***	0.040***	0.041***
	(-7.33)	(-7.31)	(4.11)	(4.26)
Share of good quality land	0.066**	0.070***	-0.055**	-0.055**
	(2.52)	(2.66)	(-2.33)	(-2.35)
Number of dependents	-0.011	-0.001	0.014**	0.019
	(-1.59)	(-0.05)	(2.38)	(1.57)
Number of adult male	-0.026**	0.008	0.018**	0.027
	(-2.47)	(0.38)	(2.15)	(1.51)
Number of adult female	-0.019*	-0.033	0.013	0.025
	(-1.70)	(-1.54)	(1.39)	(1.43)
Number of oxen	-0.004	0.001	0.011	-0.005
	(-0.49)	(0.08)	(1.63)	(-0.52)
Value of other animals x 10^{-3} (Birr)	0.006	0.008	-0.002	0.002
	(1.21)	(1.45)	(-0.72)	(0.52)
Roof corrugated iron sheet	-0.066***	-0.019	0.052***	0.031
	(-3.01)	(-0.56)	(2.90)	(1.04)
Age of household head (years)	-0.015***	-0.016***	0.006*	0.010***
	(-3.73)	(-3.70)	(1.77)	(2.62)
Age of household head squared	0.000***	0.000***	-0.000	-0.000
	(2.76)	(2.75)	(-1.30)	(-1.39)
Female headed household	-0.032	0.021	-0.049**	-0.062
	(-1.16)	(0.35)	(-2.13)	(-1.44)
Household head can read and write	-0.023	0.013	0.032*	0.019
	(-1.22)	(0.41)	(1.84)	(0.66)
Year = 2002	-0.093***	-0.098***	-0.012	-0.021
	(-4.85)	(-4.96)	(-0.57)	(-0.96)
Year = 2004	-0.243***	-0.253***	-0.049**	-0.070***
	(-14.70)	(-13.34)	(-2.38)	(-3.04)
Year = 2007	-0.320***	-0.333***	0.052*	0.012
	(-17.17)	(-15.53)	(1.92)	(0.38)
Number of observations	3042	3042	3042	3042
Number of households	882	882	882	882
Log lik.	-1467.109	-1461.588	-1510.578	-1502.232
Chi-squared	518.218	517.908	111.531	126.756
rho	0.070	0.070	0.049	0.046
sigma_u	0.274	0.274	0.227	0.220
Lik.-ratio test of rho=0	-1469.227	-1463.689	-1511.736	-1503.235
Chibar2	4.237	4.204	2.315	2.006

Note: The dependent variable is whether the household expects an increase or decrease in landholdings over the coming 5 years due to land redistribution and reallocation. The Chamberlain specification includes the mean value of the time-varying household level variables (Chamberlain 1980), coefficients for which are not reported. A constant term is included in all the regressions. Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Impact of certification on propensity and magnitude of investment in soil & water conservation: marginal effects

	Repairs and new investment last 12 months: porbit models			Hours spent on repairs and new investment last 12 months: tobit models[a]		
			Chamberlain			Chamberlain
Land use certificates issued	0.268***	0.302***	0.291***	1.279***	1.439***	1.347***
	(9.92)	(10.70)	(10.32)	(9.90)	(10.79)	(10.11)
Parcel size in hectares	0.019	0.057***	0.061***	0.205*	0.496***	0.523***
	(1.26)	(3.58)	(3.80)	(1.84)	(4.05)	(4.32)
Number of years possessed	-0.000	0.001	0.000	0.007*	0.011***	0.009**
	(-0.08)	(1.14)	(0.61)	(1.88)	(2.94)	(2.38)
Good soil quality	-0.014	-0.013	-0.013	-0.073	-0.051	-0.056
	(-1.18)	(-1.14)	(-1.15)	(-0.82)	(-0.58)	(-0.64)
Medium soil quality	-0.013	-0.012	-0.013	-0.090	-0.085	-0.098
	(-1.18)	(-1.17)	(-1.23)	(-1.06)	(-1.01)	(-1.19)
Flat land	-0.129***	-0.121***	-0.121***	-1.075***	-1.023***	-1.002***
	(-6.02)	(-5.92)	(-5.89)	(-8.44)	(-8.14)	(-8.09)
Gently sloped land	-0.025	-0.025*	-0.023	-0.261**	-0.245**	-0.213*
	(-1.54)	(-1.69)	(-1.57)	(-2.20)	(-2.09)	(-1.84)
Irrigated land	0.017	0.019	0.019	0.101	0.091	0.087
	(0.72)	(0.86)	(0.83)	(0.60)	(0.55)	(0.53)
Total owned land in hectares		-0.058***	-0.062***		-0.335***	-0.357***
		(-6.81)	(-7.24)		(-6.53)	(-7.06)
Value of livestock x 10^{-3} (Birr)		-0.003*	-0.003*		-0.017*	-0.012
		(-1.91)	(-1.86)		(-1.86)	(-1.01)
Corrugated iron roof		0.017	-0.035		0.122	-0.355*
		(0.92)	(-1.21)		(0.98)	(-1.91)
Number of dependents		0.009	0.024***		0.089***	0.248***
		(1.41)	(2.59)		(2.61)	(3.78)
Number of adult male		0.013	0.015		0.080*	0.038
		(1.62)	(1.26)		(1.76)	(0.42)
Number of adult female		0.001	0.018*		-0.032	0.093
		(0.17)	(1.66)		(-0.68)	(1.16)
Age of household head (years)		0.006	0.007		0.055**	0.038
		(1.38)	(1.50)		(2.32)	(1.54)
Age of household head squared		-0.000*	-0.000***		-0.001***	-0.001***
		(-1.65)	(-2.65)		(-2.64)	(-3.04)
Female headed household		-0.042**	0.068		-0.458***	0.510*
		(-2.05)	(1.47)		(-3.14)	(1.77)
Head can read and write		-0.010	0.010		-0.093	0.061
		(-0.67)	(0.56)		(-0.97)	(0.46)
Year = 2007	-0.067***	-0.065***	-0.053***	-0.350***	-0.357***	-0.260***
	(-6.08)	(-5.63)	(-4.41)	(-4.56)	(-4.45)	(-2.93)
Number of observations	8671	8671	8671	8671	8671	8671
Number of households	856	856	856	856	856	856
Log likelihood	-3662.079	-3625.047	-3596.866	-9747.794	-9713.545	-9686.255
Chi-squared	294.122	348.923	387.019	293.521	361.972	419.962
Rho	0.672	0.656	0.647	0.619	0.603	0.594
sigma_u	1.432	1.380	1.354	7.439	7.175	7.023
Lik.-ratio test of rho=0	-4760.517	-4613.590	-4555.439			
Chibar^2	2196.876	1977.085	1917.145			

Note: The Chamberlain specification includes the mean value of the time-varying household level variables (Chamberlain 1980), coefficients for which are not reported. A constant term is included in all the regressions. Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

[a]The dependent variable is log((number of hours spent on repairs and new investment last 12 months + 0.01)/0.01).

Table 8: Certification impact on rental market participation: marginal effects from probit models

	Rented-out			Rented-in		
			Chamberlain			Chamberlain
Land use certificates issued	0.097*	0.134**	0.126**	-0.002	-0.014	-0.010
	(1.82)	(2.35)	(2.38)	(-0.04)	(-0.32)	(-0.23)
Total owned land in hectares	0.062***	0.065***	0.055***	-0.099***	-0.103***	-0.091***
	(4.98)	(5.30)	(4.77)	(-5.75)	(-5.88)	(-5.81)
Share of good quality land	-0.001	-0.016	-0.032	-0.061	-0.050	-0.053
	(-0.03)	(-0.37)	(-0.74)	(-1.34)	(-1.14)	(-1.19)
Number of dependents	-0.007	-0.006	0.001	0.016	-0.029	-0.019
	(-0.66)	(-0.25)	(0.04)	(1.31)	(-1.17)	(-0.79)
Number of adult male	-0.025	-0.028	-0.031	-0.010	-0.061*	-0.044
	(-1.63)	(-0.78)	(-0.87)	(-0.62)	(-1.71)	(-1.24)
Number of adult female	0.024	0.006	0.021	-0.001	-0.015	-0.009
	(1.48)	(0.19)	(0.68)	(-0.05)	(-0.49)	(-0.27)
Number of oxen	-0.181***	-0.080***	-0.086***	0.134***	0.077***	0.089***
	(-9.93)	(-3.54)	(-3.87)	(7.76)	(3.39)	(3.91)
Value of other animals x 10^{-3} (Birr)	-0.018**	-0.002	0.003	0.014***	0.011	0.008
	(-2.50)	(-0.24)	(0.35)	(2.65)	(1.61)	(1.01)
Roof corrugated iron sheet	-0.088**	-0.057	-0.078	0.113***	0.104**	0.114**
	(-2.00)	(-0.87)	(-1.17)	(3.24)	(2.10)	(2.15)
Age of household head (years)	-0.005	-0.012*	-0.011*	-0.001	0.004	0.007
	(-0.75)	(-1.69)	(-1.65)	(-0.15)	(0.41)	(0.85)
Age of household head squared	0.000*	0.000*	0.000*	-0.000	0.000	-0.000
	(1.70)	(1.72)	(1.69)	(-0.92)	(0.02)	(-0.52)
Female headed household	0.373***	0.143	0.225**	-0.204***	-0.148**	-0.177***
	(5.87)	(1.39)	(2.19)	(-7.70)	(-2.53)	(-2.61)
Household head can read and write	0.067*	0.082	0.090	-0.019	0.019	0.038
	(1.81)	(1.41)	(1.54)	(-0.57)	(0.37)	(0.74)
Initial year participation as landlord			0.124***			
			(2.83)			
Lagged participation as landlord			0.332***			
			(7.51)			
Initial year participation as tenant						0.174***
						(5.30)
Lagged participation as tenant						0.273***
						(7.44)
Year = 2007	0.086***	0.067**	0.032	0.163***	0.163***	0.171***
	(2.74)	(2.09)	(0.90)	(5.09)	(4.76)	(4.65)
Number of observations	1424	1424	1302	1424	1424	1302
Number of households	736	736	736	736	736	736
Log lik.	-579.050	-554.254	-462.474	-657.789	-645.424	-553.642
Chi-squared	231.821	212.860	408.046	160.423	157.457	348.339
Rho	0.395	0.424	0.038	0.502	0.502	0.038
sigma_u	0.807	0.857	0.199	1.003	1.005	0.200
Lik.-ratio test of rho=0	-591.925	-568.202	-461.949	-680.949	-668.285	-553.291
Chibar2	25.749	27.896	1.050	46.319	45.722	0.701

Note: The Chamberlain specification includes the mean value of the time-varying household level variables (Chamberlain 1980), but not reported. A constant term is included in all the regressions. Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Certification impact on size of land rented: marginal effects from tobit models

	Land rented-out			Land rented-in		
			Chamberlain			Chamberlain
Land use certificates issued	0.073**	0.088***	0.092***	0.016	0.007	0.020
	(2.30)	(2.77)	(2.83)	(0.65)	(0.29)	(0.78)
Total owned land in hectares	0.086***	0.086***	0.074***	-0.059***	-0.061***	-0.051***
	(10.88)	(11.07)	(9.54)	(-6.24)	(-6.48)	(-5.45)
Share of good quality land	0.022	0.013	-0.002	0.003	0.008	0.006
	(0.82)	(0.50)	(-0.09)	(0.10)	(0.31)	(0.25)
Number of dependents	-0.010	-0.002	-0.003	0.008	-0.013	-0.017
	(-1.32)	(-0.10)	(-0.23)	(1.14)	(-0.96)	(-1.25)
Number of adult male	-0.013	-0.016	-0.027	-0.000	-0.041**	-0.039*
	(-1.33)	(-0.70)	(-1.18)	(-0.03)	(-2.00)	(-1.88)
Number of adult female	0.016	0.008	0.016	-0.001	-0.004	-0.003
	(1.53)	(0.41)	(0.83)	(-0.10)	(-0.20)	(-0.17)
Number of oxen	-0.152***	-0.094***	-0.095***	0.075***	0.041***	0.044***
	(-13.29)	(-6.24)	(-6.30)	(8.56)	(3.29)	(3.34)
Value of other animals x 10^{-3} (Birr)	-0.013***	-0.003	0.003	0.011***	0.009**	0.006
	(-2.69)	(-0.50)	(0.52)	(3.71)	(2.10)	(1.37)
Roof corrugated iron sheet	-0.055**	-0.054	-0.061	0.069***	0.063*	0.073**
	(-2.15)	(-1.38)	(-1.50)	(2.88)	(1.83)	(2.18)
Age of household head (years)	-0.006	-0.009**	-0.008*	-0.002	0.001	0.002
	(-1.40)	(-2.29)	(-1.79)	(-0.43)	(0.24)	(0.47)
Age of household head squared	0.000***	0.000**	0.000**	-0.000	0.000	-0.000
	(2.61)	(2.32)	(1.99)	(-0.67)	(0.34)	(-0.04)
Female headed household	0.191***	0.076	0.096*	-0.166***	-0.119**	-0.122**
	(5.47)	(1.42)	(1.68)	(-6.41)	(-2.36)	(-2.47)
Household head can read and write	0.051**	0.063*	0.088**	-0.002	0.002	0.016
	(2.10)	(1.69)	(2.25)	(-0.13)	(0.08)	(0.51)
Initial value of rented-out land in ha			0.035			
			(1.57)			
Lag of rented-out land in hectares			0.082***			
			(3.48)			
Initial value of rented-in land in ha						0.112***
						(6.34)
Lag of rented-in land in hectares						0.137***
						(8.37)
Year = 2007	0.052***	0.047**	0.039*	0.078***	0.082***	0.077***
	(2.61)	(2.34)	(1.81)	(4.23)	(4.13)	(3.50)
Number of observations	1424	1424	1302	1424	1424	1302
Number of households	736	736	736	736	736	736
Log lik.	-980.509	-960.667	-819.983	-1001.082	-987.542	-863.362
Chi-squared	481.280	523.044	538.654	306.883	329.675	442.059
Rho	0.307	0.326	0.188	0.283	0.289	0.000
sigma_u	0.600	0.606	0.442	0.507	0.506	0.000

Note: The Chamberlain specification includes the mean value of the time-varying household level variables (Chamberlain 1980), but not reported. A constant term is included in all the regressions. Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix table 1: Determinants of value of crop output: household fixed effect estimates

	Value of crop output (log)
Plot has soil and water conservation structures	0.091***
	(5.60)
Plot size (hectares)	0.276***
	(23.56)
Male adult labor (days)	0.334***
	(21.84)
Female adult labor (days)	-0.001
	(0.09)
Hired labor (days)	0.023
	(1.16)
Oxen (days)	0.128***
	(10.96)
Chemical fertilizer (kg)	0.155***
	(14.54)
Manure (kg)	0.027**
	(2.27)
Dummy female family labor[a]	-0.011
	(0.31)
Dummy hired labor[a]	-0.087**
	(2.33)
Dummy chemical fertilizer[a]	0.125***
	(3.40)
Dummy manure[a]	0.213***
	(2.92)
Number of year possessed	-0.000
	(0.02)
Good soil quality	0.185***
	(9.55)
Medium soil quality	0.110***
	(6.12)
Flat land	0.031
	(0.97)
Gently sloped land	0.055*
	(1.70)
Irrigated land	0.138***
	(3.47)
Year = 2002	-0.884***
	(42.02)
Year = 2004	0.383***
	(18.25)
Year = 2007	0.671***
	(32.09)
Constant	4.259***
	(40.46)
Number of observations	11689
Number of households	844
R^2	0.554

Note: Absolute value of t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.
[a]The value of the dummy is 1 if the input is not used, and the value is 0 if the input is used. All inputs are in logs.

References

Adal, Y. 2005. "Rural women's access to land in Ethiopia." . Addis Ababa: Forum for Social Studies.

Adal, Y. 2008. "Rural Land Certification in Ethiopia." Working Paper. Addis Ababa: Institute of Development Research.

Bandiera, O. 2007. "Land Tenure, Investment Incentives, and the Choice of Techniques: Evidence from Nicaragua." *World Bank Economic Review 21* (3): 487-508.

Besley, T. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana." *Journal of Political Economy 103* (5): 903-37.

Besley, T. and M. Ghatak. 2008. "Creating Collateral: The de Soto Effect and the Political Economy of Legal Reform." Working Paper. London: London School of Economics.

Bliss, C. J. and N. H. Stern. 1982. *Palanpur: The Economy of an Indian Village*. Oxford: Clarendon Press.

Boucher, S., M. R. Carter and C. Guirkinger. 2008. "Risk rationing and wealth effects in credit markets: Theory and implications for agricultural development." *American Journal of Agricultural Economics 90* (2): 409-23.

Bromley, D. W. 2008. "Formalizing property relations in the developing world: The wrong prescription for the wrong malady." *Land Use Policy forthcoming*.

Bruce, J. W. and S. E. Migot-Adholla. 1994. *Searching for land tenure security in Africa*. Dubuque, IA: Kendall/Hunt Publishers.

Burns, T. A. 2007. "Land Administration: Indicators of success and future challenges." Agriculture & Rural Development Department. Washington: World Bank.

Carter, M. R. and P. Olinto. 2003. "Getting Institutions "Right" for Whom? Credit Constraints and the Impact of Property Rights on the Quantity and Composition of Investment." *American Journal of Agricultural Economics 85* (1): 173-86.

Chamberlain, G. 1980. "Analysis of Covariance with Qualitative Data." *Review of Economic Studies 47* 225-38.

de Soto, H. 2000. *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere else* New York: Basic Books.

Deininger, K., D. A. Ali and T. Alemu. 2008a. "Assessing the Functioning of Land Rental Markets in Ethiopia." *Economic Development and Cultural Change 57* (1): 67-101.

Deininger, K., D. Ayalew, S. Holden and J. Zevenbergen. 2008b. "Rural land certification in Ethiopia: Process, initial impact, and implications for other African countries." *World Development forthcoming*.

Deininger, K. and J. S. Chamorro. 2004. "Investment and Income Effects of Land Regularization: The Case of Nicaragua." *Agricultural Economics 30* (2): 101-16.

Deininger, K. and S. Jin. 2006. "Tenure Security and Land-Related Investment: Evidence from Ethiopia." *European Economic Review 50* (5): 1245-77.

Deininger, K. and S. Jin. 2008. "Securing property rights in transition: Lessons from implementation of China's rural land contracting law." *Journal of Economic Behavior & Organization forthcoming*.

Do, Q. T. and L. Iyer. 2008. "Land Titling and Rural Transition in Vietnam." *Economic Development and Cultural Change 56* (3): 531-79.

Easterly, W. 2008. "Institutions: Top down or bottom up?" *American Economic Review, Papers and Proceedings 98* (2): 95-9.

Ege, S. 1997. "The Promised Land: The Amhara Land Redistribution of 1997." SMU-rapport 5/97. Dragvoll, Norway: Norwegian University of Science and Technology, Centre for Environment and Development.

Feder, G., Y. Chalamwong, T. Onchan and C. Hongladarom. 1988. *Land Policies and Farm Productivity in Thailand*. Baltimore and London: Johns Hopkins University Press.

Field, A. J., E. Field, and M. Torero. 2006. "Property rights and crop choice in rural Peru, 1994-2004." MTID Discussion Paper 100. Washington, DC: International Food Policy Research Institute.

Field, E. 2005. "Property Rights and Investment in Urban Slums." *Journal of the European Economic Association 3* (2-3): 279-90.

Field, E. 2007. "Entitled to Work: Urban Property Rights and Labor Supply in Peru." *Quarterly Journal of Economics 122* (4): 1561-602.

Field, E. and M. Torero. 2006. "Do Property Titles Increase Credit Access Among the Urban Poor? Evidence from a Nationwide Titling Program."

Field, E. M. 2003. "Fertility responses to land titling: The roles of ownership security and the distribution of household assets." . Cambridge MA: Harvard University.

Fort, R. 2007. *Property rights after market liberalization reforms: land titling and investments in rural Peru*. Wageningen, NL: University of Wageningen.

Galiani, S. and E. Schargrodsky. 2004. "Effects of Land Titling on Child Health." *Economics and Human Biology 2* (3): 353-72.

Galiani, S. and E. Schargrodsky. 2005. "Property Rights for the Poor: Effects of Land Titling." Documento de Trabajo 06/2005. Buenos Aires: Universidad Torcuato Di Tella, Centro de Investigacion en Finanzas.

Gebre, A. and Z. Keneaa. 2008. "Situational assessment on land dispute resolution in four regional states of Ethiopia (Amhara, Tigray, Oromia, and SNNPR)." Study Report submitted to the Ethiopia land tenure and administration program (ELTAP). Addis Ababa: University of Addis Ababa.

Goldstein, M. and C. Udry. 2006. "The profits of power: Land rights and agricultural investment in Ghana." Economic Growth Center Working Paper 929. New Haven, CT: Yale University.

Holden, S., K. Deininger, and H. Ghebru. 2008. "Low-cost land certification and land rental market participation in Tigray, Ethiopia." Working Paper. Aas, Norway: Norwegian University of Life Sciences.

Jacoby, H. and B. Minten. 2007. "Is land titling in Sub-Saharan Africa cost effective? Evidence from Madagascar." *World Bank Economic Review 21* (3): 461-85.

Jacoby, H. G., G. Li and S. Rozelle. 2002. "Hazards of Expropriation: Tenure Insecurity and Investment in Rural China." *American Economic Review 92* (5): 1420-47.

Joireman, S. F. 2008. "The mystery of capital formation in Sub-Saharan Africa: women, property rights and customary law." *World Development forthcoming*.

Lanjouw, J. O. and P. I. Levy. 2002. "Untitled: A Study of Formal and Informal Property Rights in Urban Ecuador." *Economic Journal 112* (482): 986-1019.

Lavigne-Delville, P. 2006. "Registering and administering customary land rights: PFRs in West Africa." Paper presented at the Conference on 'Land Policies & Legal Empowerment of the Poor'. Washington DC: World Bank.

Lobo, A. and S. Balakrishnan. 2002. "Report card on service of bhoomi kiosks: An assessment of benefits by users of the computerized land records system in Karnataka." Working Paper. Bangalore: Public Affairs Centre.

Mushinski, D. W. 1999. "An Analysis of Offer Functions of Banks and Credit Unions in Guatemala." *Journal of Development Studies 36* (2): 88-112.

Payne, G., A. Durand-Lasserve, and C. Rakodi. 2008. "Social and economic impacts of land titling programs in urban and peri-urban areas: International experience and case studies of Senegal and South Africa." . Oslo and Stockholm: SIDA and Norwegian Ministry of Foreign Affairs.

Pinckney, T. C. and P. K. Kimuyu. 1994. "Land Tenure Reform in East Africa: Good, Bad or Unimportant?" *Journal of African Economies 3* (1): 1-28.

Rozelle, S. and J. F. M. Swinnen. 2004. "Success and Failure of Reform: Insights from the Transition of Agriculture." *Journal of Economic Literature 42* (2): 404-56.

Sundet, G. 2004. "The Politics of Land in Tanzania." . Oxford, UK: Oxford University.

Wooldridge, J. M. 2001. *Econometric analysis of cross section and panel data*. Cambridge, MA: MIT Press.

Wooldridge, J. M. 2005. "Simple Solutions to the Initial Conditions Problem in Dynamic, Nonlinear Panel Data Models with Unobserved Heterogeneity." *Journal of Applied Econometrics 20* (1): 39-54.