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Land Certification and Schooling in Rural Ethiopia*

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Abstract

This paper investigates the impact of a rural land certification program on schooling in two zones of the Amhara region of Ethiopia. Using the variation in the timing of the arrival of the program at the local level, we investigate the link between land tenure security, schooling and child labor. The results show a positive effect of improved land rights on school enrollment for all children in one of the zones studied, and for oldest sons in the other. Grade progress of oldest sons, who are most likely to inherit the land, worsens.

Keywords: Schooling; Child labor; Land administration; Property rights; Ethiopia.

JEL Classification: J22, O15, Q15.

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1 Introduction

Land certification programs, which formalize land rights through systematic land registration activities, have been growing in numbers over the last decades. Inspiration for these programs is often credited to theories predicting that improved land tenure security increases investment, allows for easier access to credit when land can be used as collateral, and facilitates the development of land markets (see Besley, 1995; Besley and Ghatak, 2010; de Soto, 2000; Goldstein and Udry, 2008; Joireman, 2008). While empirical studies have found mixed support for the impacts of land rights on investments (see Brasselle et al., 2002; Fenske, 2011; Jacoby and Minten, 2007; Place, 2009), a new strand of literature (Field, 2007; Galiani and Schargrodsky, 2010; Moura and Bueno, 2014) has consistently reported a positive impact on child welfare for squatters in urban settings in Latin America. Field (2007) and Moura and Bueno (2014) find that child work decreases as a result of land tiling programs in Peru and Brazil, respectively. Similarly, Galiani and Schargrodsky (2010) find increased schooling for children resulting from a program in suburban Buenos Aires, and suggest that land titling programs have substantial poverty alleviation potential via increased human capital investment. These studies all suggest that formalization of land rights freed adults from staying at home to safeguard from eviction, which reduced incentives to make children work to complement household income. In this paper we investigate the relationship between land tenure security and children welfare and the impact of the land certification program on children's schooling and participation to agricultural activities in the rural Amhara in Ethiopia.[1] Since land is to a larger extent productive in rural areas, the effect might differ from in an urban context.

All land in Ethiopia was nationalized in 1975. Following this reform, every household was entitled to a piece of land conditional on self-cultivation and permanent physical presence in a location (Crewett and Korf, 2008). To enforce these rules, peasant as-

[1] Ethiopia is a federal country with 11 States and Amhara is the second largest State of the Country. The region is characterized by rugged mountains, extensive plateaus and scattered plains separated by deep gorges. Water is plentiful in the region and the rivers have a high potential for irrigation, hydro-power and commercial fisheries. 90% of the population lives in rural areas and is engaged in agriculture.

sociations (PA) were created at the village – *kebele* – level. To accommodate demand from landless households and maintain an egalitarian land distribution they carried out periodic land redistributions. Hence, in rural Amhara, fear of losing an uncultivated plot provided households with an incentive to cultivate their land in order to safeguard their land rights. Though this system of land tenure reduces incentive to migrate towards better opportunities (see for instance de Janvry et al., 2015; Valsecchi, 2014, in Mexico), labor supply of adult members is not diverted from productive activities as found in Latin America. Children are thus not forced into productive activities to substitute adult labor supply and the effect of the formalization of land rights on participation of children in farming activities is unclear.

Formalization of land rights, however, provides legal recognition of household land rights, and shifts enforcement of these rights from the individuals and the peasant association to the state (Bezabih et al., 2016). Moreover, it limits the ability of the peasant association to redistribute land and allows households to bequeath their land. As parents can no more rely on future land redistributions to accommodate future land demand of their children, they are faced with two strategies. They can either divide their landholding across their children, or bequeath all the landholdings to an heir and compensate the remaining children in some other way. Thereby, the land certification program alters parents and children's incentives to invest in education and work experience. We develop a formal model to further explore this mechanism.

The land certification program in Amhara is a broad program with an aim to register all land in the region. Due to capacity limitations, the program was gradually rolled out, creating variation in the timing of the arrival of the program to the *kebele*. We have panel data from 14 *kebeles* in two zones (East Gojjam and South Wollo), and use the variation in timing of the arrival of the program to identify effects of the program on school enrollment, on grade progress, and on child labor. Fixed effects control for time-constant differences between the kebeles. To test the parallel trends assumption, we perform a placebo test using the data from before the onset of the land certification program. We have annual individual-level information on school enrollment and school progress as well as household-level information by gender on child labor for the period preceding the data collection for the four waves of the panel. Since the data on schooling outcomes contain more variation than that on child labor we focus our analysis on schooling outcomes, with a complementary child labor analysis.

We find that the program has a positive effect on school enrollment in general in East Gojjam, and for oldest sons in South Wollo. School progress, conditional on being in school, is negatively affected for oldest sons, but unaffected for other children in the household. We find mixed results for participation of children in agricultural activities. As a results of the land certification program, total child labor at the household level has decreased in East Gojjam but has increased in South Wollo; however not to the point that school enrollment is affected.

To the best of our knowledge our study is the first to evaluate the impact of land certification on schooling and child labor in a rural context. Though the Amhara land certification program has been shown to have many positive effects for rural households, and though school enrollment appears to be mostly positively affected also in our rural context, education of oldest sons is potentially negatively affected.

The remainder of the paper is structured as follows: Section 2 describes the land certification program; Section 3 provides the theoretical foundations of the study (a formal model is in Appendix-I); Section 4 describes the data, and Section 5 the empirical approach; schooling results are in Section 6, Section 7 contains the child labor results, robustness checks of our main schooling results are in Section 8; and Section 9 discusses and concludes.

2 The land certification program in Amhara

All land in Ethiopia is state-owned, and there have been periodic redistributions of households' rights to farm the land. The last major redistribution occurred in 1997 after the adoption of the 1995 Constitution and the passing of the 1997 Federal Land Law. These legal changes allow leasing, sharecropping and inheritance of land rights;

practices which all used to be illegal (Proclamation No. 89/1997). Several regions in Ethiopia subsequently enacted their own land administration laws based on the federal law. A number of regions began implementing rural land certification programs successively, starting with Tigray in 1998 (Deininger et al., 2011).

The process behind land certification in Amhara began in 2001 with the establishment of the Environmental Protection and Land Administration and Use Authority (EPLAUA). The program itself commenced in 2002, with support from the Swedish International Development Cooperation Agency (SIDA). The project was initially limited to two zones in the region: East Gojjam and South Wollo. Implementation of the program in each zone was initiated by *woreda* (district) officials, who in turn facilitated the process of land certification at the *kebele* (village) level. Due to capacity limitations, the program was not implemented uniformly but rather was gradually rolled out to the *kebeles*.

Within each *kebele*, meetings and awareness campaigns were held and farmers were informed about land demarcation and the advantages of holding a land certificate. A land administration committee (LAC) was elected, and farmers were then invited to apply for their holdings to be demarcated.[2] Once a land user applied for a certificate over a piece of land and this claim had been verified by the LAC in the kebele, a temporary certificate was issued. The parcels with temporary certificates were publicly debated for one month in order to verify that the neighbors would not claim the land registered. In case of agreement and after corrections when necessary, a primary certificate was issued (also called a green book) for each household registered.[3] A formal process of dispute resolution, often involving village elders, intervened in the case of disagreement over land claims. Though initial disagreement was not uncommon, the share of landholders who could at the end not be registered in the field was quite low; less than 2.5% as of 2006 (Deininger et al., 2008).

[2]The land administration committee consists of five to seven members elected by residents of the kebele. They are responsible for all the practical matters of land administration and use at *kebele* level. At least two members of the committees should be women. The members work on a volunteer basis.

[3]Also known as the book of holding and named after its green color, the green book serves as a land certificate and is a legal recognition that those named within it are the rightful users of the land described.

The primary certificate includes the names and addresses of the landholder (both husband and wife if the land is held jointly), their photographs, the names of their family members, a list of each land parcel, their estimated areas, the land use, and the names of the neighboring landholders.[4] The primary certificates also summarize the landholders' rights and obligations according to the law. In Amhara, these rights and obligations were stipulated in the Amhara National Regional State Proclamation No. 46/2000.[5] Amhara is considered to have one of the most liberal sets of land use rights in Ethiopia: landholders are allowed to lease their entire plot to other farmers or investors for a period of up to 25 years, and land use rights can be bequeathed to family or, in the case that there are no family members interested in obtaining these rights, to any other farmer in the region. The landholder may also gift their land use rights to a family member living in the Amhara region, and landholders may exchange user rights. There is no mention in the proclamation of a landholder's right to mortgage their land use rights. Finally, the landholders are obligated to protect the land they hold and to engage in soil and water conservation activities.

Table 1: Arrival of the land certification program to the *kebeles*.

2003	2004	2005	2006	2007
Adishena Gulit	Amanuel	Kebi	Kete	Wolkite
Gerado Endodber	Telma	Sekla Debir	Godguadit	
Yamed	Amba Mariam	Chorisa	Addis Mender	
	D. Elias			

Source: Authors.

Overall, by December 2009, the land certification project had registered 4.9 million parcels in both East Gojjam and South Wollo, and 890,000 households received their primary certificates. Table 1 provides an overview of when the land program arrived in each *kebele*, i.e. the year in which the invitation to apply for a certificate began. Table 2 shows responses to a number of questions on the perceived usefulness of the

[4]The primary certificates do not include precise information about the geographical coordinates of the parcels. Using modern surveying techniques and equipment, a survey is then carried out and adds to the green book the geographical coordinates of the parcels. These boundaries are marked by permanent corner stones during the process. Maps of the area are then created and a second certificate is distributed to landholders.

[5]Subsequently revised in the Amhara National Regional State Rural Land Administration and Use Proclamation No. 133/2006.

certificates. The results indicate that people express a belief that the program should reduce conflicts, make it easier for children to inherit the land, and increase the likelihood of compensation if the land is taken away. Responses to such questions should of course be interpreted with caution, but the fact that few people believe that having a certificate will encourage migration indicates that respondents do not automatically affirm to questions.

Table 2: Opinion about the land certification program.

	Obs	Mean	Std. Dev.
Have you ever been concerned about land related conflicts?	1,756	0.216	0.412
Do you believe that having your land surveyed and then obtaining a land use certificate will reduce the number of conflicts related to inheriting land to children?	1,755	0.861	0.346
Do you believe that having your land surveyed and then obtaining a land use certificate will reduce the incidence of land related conflicts other than inheritance?	1,755	0.901	0.298
Have you ever attempted to undertake soil and water conservation works or plant trees on your land?	1,755	0.885	0.319
Do you think that having your land surveyed and then obtaining a land use certificate will encourage you to undertake more soil and water conservation measures on your land?	1,757	0.906	0.293
Do you think that having your land surveyed and then obtaining a land use certificate will provide you incentives to plant more trees on your land?	1,758	0.904	0.294
Do you feel that having a certificate will increase the possibility of obtaining compensation in case the land is taken?	1,757	0.892	0.311
Do you believe that having a land certificate improves the position of women?	1,757	0.875	0.331
Do you think having a certificate encourages people to migrate?	1,756	0.266	0.442
Do you think that having a certificate will encourage soil conservation by the *kebele* on common property?	1,563	0.801	0.399
Do you think that demarcation of public and community land will reduce problem of encroachment on common property resources?	1,746	0.763	0.425

Source: Authors.

3 Theoretical foundations

3.1 On the theoretical model

For simplicity of exposition, let's assume that land certification works in one of two ways.[6] The first is by increasing the probability that the oldest son inherits user rights for the family land, and thus remains on the farm as an adult. The model does not rest on the assumption that certification leads to perfectly enforced user rights, but rather the assumption that certification increases the (perceived) probability that user rights are enforced. The second way land certification is assumed to work is by reducing the cost of securing property rights. Though the context is different in Amhara, this is conceptually akin the mechanism explored in other studies (Field, 2007; Galiani and Schargrodsky, 2010; Moura and Bueno, 2014). Households signal continued need for their land via their land use and cultivation. [7]

The assumption that oldest sons are the primary inheritors of the family land is supported by a discussion of inheritance practices in the next section, and the fact that an overwhelming majority of survey respondents express the belief that land certification will make inheritance easier, as seen in Table 2. A further assumption in this case is that the returns to schooling in terms of future productivity are lower when the child remains on the family farm as compared to engaging in other work. We do not assume that education does not increase the productivity of farm work, but rather that the optimal amount of schooling is somewhat lower in the case of farm work as opposed to other forms of work. This assumption is supported by empirical results from rural Ethiopia, which find significantly higher returns on schooling for full-time non-farm employment as compared to full-time farming (Bigsten et al., 2003; Verwimp, 1996; World Bank, 2005), and by evidence that households perceive that returns to schooling

[6] A detailed version of the model is presented in Appendix-I.

[7] While there are other mechanisms through which strengthened property rights could impact child activities, they are less relevant in the context of Amhara. For instance, even though increased agricultural investment could raise the marginal productivity of farm labor and reduce demand for child labor, Deininger et al. (2011) find little evidence for an impact of the formalization of land rights on agricultural investment in Amhara. Likewise, we do not investigate the credit channel, as land cannot be used as collateral in our setting.

are highest for individuals employed in the formal sector (World Bank, 1998). There is evidence that schooling does have a significant positive impact on agricultural productivity, even in the case of traditional farming (Krishnan, 1996), but that this positive effect reaches a maximum after only a few years of schooling (Weir, 1999). Weir and Knight (2004) show that better educated rural households adopt fertilizers sooner; however, the initial disadvantage faced by less educated households is reduced over time as these households imitate the behavior of the better educated households.

Finally, we assume that the returns to own-farm child labor in terms of future productivity are higher when the child remains on the family farm as compared to engaging in other work. Rosenzweig and Wolpin (1985) demonstrate the usefulness of farm specific knowledge in agriculture in India. Therefore, if land certification is perceived by the household to strengthen their user rights and make it more likely that the oldest son can continue to work the family land, our model predicts that land certification should result in households allocating less of the oldest son's time to schooling and more to child labor. However, the schooling and child labor effects do not depend on each other, i.e. there is no automatic trade-off between the two activities unless child leisure is fixed.

Since the fragmentation of the household landholding among children make each child relatively poorer than their parents, not all children are likely to inherit. Parents maximize the prospects of their other children by investing more in their education when inheritance rights for the oldest son become stronger. A similar mechanism has been observed for girls in rural India, for example, after a change in inheritance laws (Roy, 2015). Consequently, land certification is likely to improve investment in education for most children, with mixed effects for the oldest son and an indeterminate effect on total demand for child labor at the household level.

The model does not make any strong predictions as to the magnitude of the predicted effects, as this depends on the initial levels of schooling, child labor, and (perceived) strength of user rights. Further, the model allows for children to be exclusively in school, exclusively in child labor, a combination of the two, or engaged in neither activity. As noted above, schooling has been found to have a significant positive impact on agricultural productivity, but with a rapidly diminishing marginal benefit. Therefore, we expect that many households will choose to send their children to school, even in the case where the child is expected to remain on the family farm. Further, the ILO (2008) argues that Ethiopian cultural values promote the idea that children should participate in work from an early age in order to develop skills and assist their parents. Therefore, it is likely that in many households, children will be involved in some forms of labor regardless if they are expected to continue working on the farm as adults. Hence, schooling and child labor are not mutually exclusive; in many cases, children combine the two activities. This also implies that a change in the time devoted to schooling does not necessarily affect child labor, and vice-versa. In general the literature on the effects of child work on schooling find negative effects on school attendance, grade progress and continuation, but the substitution is far from one-to-one (de Hoop and Rosati, 2014; Dumas, 2012; Khanam, 2008; Lancaster and Ray, 2004; Ravallion and Wodon, 2000; Ridao-Cano, 2001).

3.2 On land inheritance

According to Headey et al. (2014), inheritors to land in Ethiopia following the 1997 land law should be family, regional residents, and willing to engage in agriculture. Moreover, minimum farm size requirements should be met. Minimum plot size is dictated by irrigation status. Average farm size in Amhara is 1.09 ha, and 33% of households have less than 0.5 ha. Farm size is generally smaller for the young, controlling for other factors such as family size. Population increase has made it difficult to supply land to all young, which has contributed to the establishment of programs of voluntary resettlement into less populous areas. These programs are often not attractive, however, due to undesirable characteristics of the less populous areas.[8]

Both the current Civil Code and the Constitution provide equal inheritance rights

[8]For example, different agro-climatic zones, lack of infrastructure, in more disease prone areas.

to women and men. These rights, however, are often not applied in practice, with very few women owning or inheriting property and land (Ashenafi and Tadesse, 2005; Crummey, 2000; Gibson and Gurmu, 2011). Ashenafi and Tadesse (2005) argue that this is in part due to the fact that the 1995 Constitution endorses customary laws, and that this influence is most apparent in cases of property inheritance and land management, as well as marriage. Therefore, we expect sons to be the primary inheritors of the family land.

Inequality does not only exist along gender lines; Gibson and Gurmu (2011) find evidence that families in the Oromia region of Ethiopia are increasingly favoring elder sons in terms of inheritance, and argue that this development is related to changes in land tenure. They also find that competition between male siblings over resources is greater in households that have undergone land reform than households that have not. It is often not possible to distribute land equally among sons, even if the parents would like to, due to minimum plot size requirements. Further, there is evidence that disputes over land between fathers and sons, which previously had been uncommon, are increasing in frequency, as are disputes between siblings (Crewett and Korf, 2008). Therefore, the emerging evidence seems to indicate a shift towards the favoring of eldest sons in terms of land inheritance.

Parental decisions to bequeath land to their children are also likely to be influenced by expectations as to which children will take a lead role in providing old age support, as parents will most likely want these children to have the means to establish a productive household of their own (Quisumbing, 2007). This in turn is also likely to favor oldest sons in terms of land inheritance.

4 Data

The data comes from the Ethiopian Environmental Household Survey (EEHS), collected by the Ethiopian Development Research Institute (EDRI) in cooperation with University of Gothenburg and, during the last round, the World Bank. Four rounds of data have been collected to date, in 2000, 2002, 2005, and 2007. Interviews were conducted in April/June, and coincide with the end of the Ethiopian school year, which starts in September and ends in June of the following year.

The data is from two zones in the Amhara region: East Gojjam and South Wollo. Though the zones border each other they are very different, and belong to two different agro-climatic zones. East Gojjam is fertile, while South Wollo is drier and has been hit by several droughts and famines. Land pressure has increased in both zones, but has been worse in South Wollo. Moreover, there has been forced resettlement from South Wollo starting in the early 1980's and continuing for almost a decade, i.e. there is an experience of people losing their right to the land completely. An ongoing voluntary resettlement program currently covers South Wollo. Further, the *kebeles* in South Wollo were all exposed to the Productive Safety-Net Programme (PSNP), while the *kebeles* in East Gojjam were not. The PSNP started in 2005 and targeted food-insecure households in food-insecure *woredas* (Kebede, 2008).

The original sample included twelve randomly chosen *kebeles*, six from East Gojjam and six from South Wollo, with two more *kebeles* added in the third round (one from East Gojjam and one from South Wollo). Within each *kebele* 120 households were randomly selected. On average an interview took 1.6 days to complete. When a household was not located in a follow-up survey it was replaced with another, randomly selected, household. Household attrition was, however, low: 94.9% of the households in the first round were still in the sample in the fourth round.

Table 3 show the pattern of attrition of household members across rounds. For as many as 75.59% of members, information was collected in all four rounds.

Most of the information on children's education was collected in the fourth round, where respondents were asked about the schooling history of all household members age 6 to 24. This data was used to create an annual panel on school enrollment and annual grade progress. The school enrollment dummy is 1 if the child is enrolled during a particular school year and 0 otherwise. Grade progress is defined only for children

Table 3: Pattern of attrition of household members across rounds.

Round 1	Round 2	Round 3	Round 4	Frequency	Percentage	Cumul
●	●	●	●	6,684	75.79	75.79
●	○	○	○	10	0.11	75.90
●	●	○	○	19	0.22	76.12
●	●	●	○	49	0.56	76.68
○	●	●	●	583	6.61	83.29
○	●	●	○	8	0.09	83.38
○	○	●	●	966	10.95	94.33
○	○	○	●	500	5.67	100.00
				8,819	100.00	

Note: This table shows the attrition pattern of households across rounds.
"●" represents a household member that was successfully surveyed at the designated round. "○" represents a household member that was not observed during the designated round. Hence, "● ● ● ●" identifies household members that were present at the four rounds of the panel. Likewise, "● ● ● ○" identifies individuals that were not surveyed in 2007 but were successfully surveyed in 2002 and 2005.

who are enrolled during a particular year, taking a value of 1 if the child manages to complete a grade during the school year and 0 otherwise. Figure A-1 in Appendix-II shows average enrollment by age for the time period covered by our study. The highest rates of enrollment are found among ten and eleven-year olds, at just under 80 percent. Among six year olds, less than 20 percent are enrolled.

Information was collected about all household members, whether currently residing in the household or not. In the analysis we use information on whether a boy is the oldest son or not, since oldest sons seem to be the main inheritors of land. A boy is classified as the oldest son if he is the oldest son for whom data was collected, i.e. if he is the oldest son considered by the respondent to belong to the household. Since there might be older sons who are not considered part of the household anymore, our oldest son variable is likely to contain measurement error.[9]

Child labor is measured at the plot level and aggregated at the household level. It rep-

[9] We discuss and address this potential problem in a robustness check in subsection 8.7.

resents the number of person-days worked by individuals less than 15 years old in any activity (pre-planting, planting, weeding, harvesting and threshing). It combines the number of mobilized children and the number of worked days. However, since the number of person-days worked pools all children of the same gender in the household together, it is not possible to observe how the demand for labor varies along with the individual characteristics of each child. Further, the child labor data are not available annually but rather were collected for each round, and are therefore not directly comparable to the schooling data. Due to these differences, all 14 *kebeles* are used in the school outcome analysis, while only the original 12 *kebeles* can be used in the child labor analysis. As a result, we choose to focus our attention primarily on the schooling outcomes, with child labor outcomes serving as complements to the main analysis.

5 Empirical strategy

The roll out of the certification program proceeded from one *kebele* to the next, generally starting in the more accessible *kebeles* and moving toward the more remote ones. Conditional on time-constant accessibility, the timing of the arrival of the program to the *kebele* was independent of schooling and child labor decisions. Hence, we define treatment at the *kebele* level. We use a binary treatment variable, $\tau_{k,t}$, which is equal to 1 if the land certification program came to *kebele* k before the start of school year t. This implies that $\tau_{k,t}$ will be equal to 0 for all *kebeles* in the first year. After switching to 1, it remains 1 for the *kebele* in question. Hence we estimate an impact which is immediate, and remains constant once it has occurred. We also treat all households in a given *kebele* as treated, regardless of whether they have yet received their certificate or not. We believe this to be a reasonable assumption in our case since the land certification program is universal, i.e. once the program arrives everyone knows that their land is going to be registered, even though the exact borders might be uncertain for some households. Moreover, the households do not require physical possession of a certificate in order to adjust the behavior we are interested in (as opposed to for example participation in rental markets, which could be conditional on having received a certificate). Since the program proceeds from one *kebele* to another, it is possible that it arrived earlier to some neighboring *kebele*, so that some might have anticipated the program even before its arrival. Therefore, our estimates produce a conservative estimate of the true effect of the land certification program.

We use household fixed effects to control for time-constant differences between households and, importantly, the *kebeles* in which they live. Since fixed effects and recent methods of inference with few clusters are easiest to incorporate into linear models we will use the linear probability model. Linear approximations are increasingly appreciated for their robustness also when the true model is non-linear (Angrist and Pischke, 2008). To be precise we estimate the within household estimator

$$\mathbf{y}_{i,t} - \bar{\mathbf{y}}_h = \beta_1\left(\tau_{k,t} - \bar{\tau}_h\right) + \beta_2\left(\mathbf{os}_{i,t} - \overline{\mathbf{os}}_h\right) + \beta_3\left(\tau_{k,t} \times \mathbf{os}_{i,t} - \overline{\tau_k \times \mathbf{os}_h}\right) + \beta_x\left(\mathbf{x}_{i,t} - \bar{\mathbf{x}}_h\right) + \beta_t\left(\psi_{k,t} - \bar{\psi}_h\right) + \epsilon_{i,t} \quad . \tag{1}$$

where $\mathbf{y}_{i,t}$ is either school enrollment or grade progress of child i during school year t, $\mathbf{os}_{i,t}$ is a dummy which equal 1 if child i is the oldest son in regressions on boys (oldest daughter in regressions on girls), $\mathbf{x}_{i,t}$ is a set of age dummies, and $\psi_{k,t}$ a set of zone-specific year dummies.[10] The h subscript is for households.

Our ability to make casual interpretation relies on the parallel trends assumption, i.e. the timing of the arrival of the land certification program should neither be correlated with differences in pre-existing trends in enrollment and grade progress nor with possible differences in such trends between eldest children and younger siblings. Table A-2 in the appendix tests for endogenous timing of the arrival of the land certification program by regressing the main outcome variables, school enrollment and grade progress, on year of arrival of the program, controlling for *woreda* fixed effects and households characteristics.[11] The robustness section includes placebo tests where we pretend that the expansion of the land certification program began in 2000.

[10] The year dummies are zone-specific in order to better capture weather variations, which differ between the zones given the agro-climatic zone difference, and to capture the introduction of the PSNP in South Wollo.

[11] The 14 *kebeles* of our study belong to 8 different *woredas*.

Our treatment is at *kebele* level and we have data from 14 *kebeles*, which is too few for inference based on conventional clustered standard errors (Liang and Zeger, 1986). Estimation of clustered standard errors relies on large-sample asymptotics, requiring a large number of clusters for correct inference (Cameron et al., 2008; Cameron and Miller, 2015). In our main estimations we rescale the cluster robust standard errors by $\sqrt{\frac{N-1}{N-K} \times \frac{G}{G-1}}$ to reduce small sample bias, and use the t-distribution with G-1 degrees of freedoms for inference, where G is the number of clusters. An advantage of this simple procedure is that it is used in *Stata* when invoking the *vce(cluster)* option after the command *regress*. To estimate a within-household model, we transformed the data into deviations from household means. The procedure has repeatedly been demonstrated to substantially improve inference with few clusters in comparison to conventional clustered standard errors (Bell and McCaffrey, 2002; Brewer et al., 2013; Cameron et al., 2008; Cameron and Miller, 2015; Imbens and Kolesar, 2016). According to Brewer et al. (2013), the procedure ensures correct test size (i.e. there is no over rejection of the null hypothesis) with as few clusters as six and under a wide range of error processes. However, it does not work well if the treatment variable is skewed, i.e. if the number of treated groups differs substantially from the number of control groups (Brewer et al., 2013; Mackinnon and Webb, 2017).

In an influential paper Cameron et al. (2008) suggest the wild cluster bootstrap, in which resampling is done over cluster weighted residuals. Usually a two- point weight distribution is used, where the so called Rademacher weights [-1,1] have been shown to have good properties (Davidson and Flachaire, 2008). With very few clusters, i.e. less than 11, one problem is, however, that only a limited number of possible combinations of clusters can be sampled. Mackinnon and Webb (2017) show that there will only be 2^{G} possible unique t-values from the resampling, where G is the number of cluster. This implies that the p-value cannot be point identified. In practice the midpoint of the possible range has then been used. Webb (2014) suggest the use of a 6-point distribution [-1.5, -1, -0.5, 0.5, 1, 1.5] when there are 11 or fewer clusters, and show that it has good properties with as few as five clusters. Cameron and Miller (2015) also suggest the 6-point distribution when there are few clusters (10 or fewer). As a robustness check we estimate wild cluster bootstrap p-values, using both Rademacher weights and the six-point weight distribution suggested by Webb (2014). In simulation studies, the wild cluster bootstrap procedure often outperform the simpler procedure used in the main estimations and in particular it is robust to a skewed distribution of the treatment variable (Brewer et al., 2013; Imbens and Kolesar, 2016; Mackinnon and Webb, 2017).

Bell and McCaffrey (2002) and Imbens and Kolesar (2016) suggest a more sophisticated, data driven, rescaling of residuals to reduce small sample bias and choice of the appropriate degrees of freedoms of the *t*-distribution used for inference. Though the approach requires assumptions about the correlation structure of residuals, their method performs extremely well in simulations, also when assumptions are not fulfilled and with very few clusters. Similar to the wild cluster bootstrap, the method is robust to a skewed distribution of the treatment variable. The method by Imbens and Kolesar (2016) is also used as a robustness check.

The literature on inference with few clusters has focused on the risk of Type I errors, but according to Brewer et al. (2013) the risk of Type II errors are larger if the true effect is of limited magnitude. Hence effects need to be sizeable

6 School results

Tables 4 and 5 display the main empirical results. Since East Gojjam and South Wollo differ so greatly with respect to agro-climatic conditions and land rights history, we perform separate estimations for the two zones in addition to estimations combining all *kebeles*.

Land certification appears to have increased school enrollment, although these results are primarily driven by East Gojjam. For boys in the combined and East Gojjam samples, the land certification program coefficient is statistically significant at the 10% and 1% level, respectively. The impact on oldest sons does not significantly differ from the

Table 4: The impact of the land certification program on children's school enrollment.

	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys			
Land certification	0.029*	0.066***	-0.008
	(0.016)	(0.017)	(0.014)
× *Oldest son*	0.025	-0.013	0.069*
	(0.023)	(0.023)	(0.030)
Oldest son	-0.098***	-0.127**	-0.076
	(0.028)	(0.044)	(0.040)
Enrollment rate	0.631	0.563	0.699
Number of observations	11,982	5,953	6,029
Number of children	2,526	1,265	1,261
Number of households	1,323	650	673
Panel B: Girls			
Land certification	0.016	0.038***	0.005
	(0.011)	(0.010)	(0.014)
× *Oldest daughter*	0.020	-0.015	0.045
	(0.023)	(0.031)	(0.039)
Oldest daughter	-0.030	-0.006	-0.058
	(0.023)	(0.032)	(0.032)
Enrollment rate	0.654	0.572	0.724
Number of observations	10,821	5,004	5,817
Number of children	2,258	1,068	1,190
Number of households	1,315	630	685

The table reports the coefficients of the within-household linear probability model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

main effect. For boys in South Wollo the main effect of land certification is not statically significant, while the oldest son interaction is significant at the 10% level. When the land certification has arrived in the kebele, boys in East Gojjam are 6.6 percentage points more likely to be enrolled in school and oldest sons in South Wollo are 6.9 percentage points more likely to be enrolled. In general, oldest sons appear to be disadvantaged with regard to school enrollment.[12] For girls, the land certification program coefficient is only statistically significant in East Gojjam, where it is significant at the 1% level. After the arrival of the land certification program girls in East Gojjam are 3.8

[12]This is in line with the findings in Lindskog (2013) who employed the same data.

percentage points more likely to be enrolled in school. There is no difference between oldest daughters and other girls.

Table 5: The impact of the land certification program on children's grade progress.

	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys			
Land certification	0.005	0.029	-0.012
	(0.014)	(0.017)	(0.018)
× *Oldest son*	-0.040***	-0.063***	-0.021**
	(0.014)	(0.018)	(0.008)
Oldest son	0.030**	0.025*	0.035**
	(0.011)	(0.012)	(0.014)
Graduation rate	0.947	0.946	0.948
Number of observations	4,006	1,781	2,225
Number of children	1,101	511	590
Number of households	777	363	414
Panel B: Girls			
Land certification	-0.001	0.005	-0.004
	(0.014)	(0.023)	(0.020)
× *Oldest daughter*	0.008	-0.020*	0.024
	(0.020)	(0.010)	(0.030)
Oldest daughter	-0.016	0.010	-0.028
	(0.016)	(0.009)	(0.020)
Graduation rate	0.936	0.945	0.930
Number of observations	3,957	1,491	2,466
Number of children	1,043	441	602
Number of households	770	347	423

The table reports the coefficients of the within-household linear probability model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

Conditional on school enrollment, the main effect of land certification on grade progress is not statistically significant. However, arrival of land certification seems to have worsened grade progress of oldest sons compared to other boys. The interaction term is statistically significant at the 5% level in both the combined sample and in South Wollo, and at the 1% level in East Gojjam. In East Gojjam oldest sons are 6.3 percentage points less likely to make progress, i.e. they are more likely to repeat a grade or drop out. In South Wollo the effect is smaller, at 2.1 percentage points. Note, however, that, according to the school enrollment results, the sample of oldest sons who are enrolled in school changes in particular in South Wollo, while this effect is less present in East Gojjam. To investigate further whether composition effects are likely to drive the worsened grade progress of oldest sons, in Table 6 we estimated our model on samples restricted to boys who were already enrolled either the year before or two years before.

Table 6: The impact of the land certification program on grade progress of boys already enrolled in previous years.

	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys who were enrolled the year before			
Land certification	0.000	0.015	-0.007
	(0.010)	(0.011)	(0.014)
× *Oldest son*	-0.027**	-0.046**	-0.014*
	(0.010)	(0.015)	(0.007)
Oldest son	0.024**	0.029*	0.021*
	(0.009)	(0.012)	(0.012)
Graduation rate	0.967	0.972	0.944
Number of observations	3,595	1,593	2,002
Panel B: Boys who were enrolled two years before			
Land certification	0.003	0.030 **	-0.014
	(0.013)	(0.012)	(0.016)
× *Oldest son*	-0.025	-0.052**	-0.006
	(0.018)	(0.018)	(0.021)
Oldest son	0.013	0.017	0.014
	(0.008	(0.015)	(0.012)
Graduation rate	0.965	0.966	0.965
Number of observations	2,889	1,283	1,606

The table reports the coefficients of the within-household linear probability model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

The effect remains in East Gojjam, but disappears in South Wollo, supporting the suspicion that worsened grade progress in South Wollo might depend mostly on a composition effect, while it is primarily driven by something else in East Gojjam. The grade progress of girls, whether oldest daughters or not, does not seem to be affected by land certification.

7 Labor results

In Tables 7 and 8 we consider the effect of the land certification program on child labor. Child labor is defined as the number of person days per hectare of land cultivated during the agricultural season by household members below 15 years old.[13] The land certification program had arrived to half of the *kebeles* before the agricultural season reported in the 2005 survey, and these are the treated *kebeles*. As the program had not started yet in 2002, the estimated 2002 effects serve as placebo checks. If trends in child labor are similar in *kebeles* where the program arrived earlier as in *kebeles* where it came later, the 2002 effect should not be statistically different from zero. We do not report the estimates in 2007 as the land certification activities have started in all the *kebeles* by then.Tables 7 and 8 report the mean of the activity in the absence of the land certification program, in addition to estimated changes due to the program.

Table 7 reports the estimated change in child labor supply following the arrival of the land certification program. Overall, we find evidence that the effect of land certification varies between regions. In East Gojjam, labor supply by boys and girls decreased: child labor per hectare decreased on average by 2 persons-days for boys and by 1 person-day for girls. This represents an average decrease of about 30% for boys and 32% for girls. In South Wollo, however, we find that child labor increased after the arrival of the land certification program, but only for boys. Our estimates indicate that labor supply by male children increased by 75 percent. We find no effect on labor supply of female children.[14] The increase in child labor in South Wollo may be related to the fact that South Wollo has a relatively hilly topography, and land certification has increased incentives to invest in soil conservation, often in the form of terracing (Deininger et al., 2011). Indeed, soil conservation is one of the obligations attached to the land certification process.

[13]Since we need the information on child labor collected in the first and second rounds to compute differences, the two *kebeles* added in the third round are not included in the child labor analysis.

[14]However, our estimate for labor supply by female children failed the placebo test. This implies that

Table 7: Land certification and child labor supply.

	Boys & Girls		Boys		Girls	
	mean	effect	mean	effect	mean	effect
Panel A: East Gojjam						
Year						
× 2002 (placebo)	6.384	0.133	4.310	-0.448	2.097	0.531
		(1.857)		(1.422)		(0.775)
× 2005 (treatment effect)	8.511	-2.594*	5.292	-1.581*	3.231	-1.046**
		(1.017)		(0.704)		(0.399)
Number of households	669		669		669	
Panel B: South Wollo						
Year						
× 2002 (placebo)	15.150	-3.633	10.543	-2.564	4.799	-0.984**
		(2.374)		(2.233)		(0.249)
× 2005 (treatment effect)	15.328	7.882**	8.031	6.073***	7.657	1.860
		(2.643)		(1.281)		(1.564)
Number of households	747		747		747	

The table reports the effect estimated using a difference-in-difference approach with a linear specification as described in Section 5. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

The changes in child labor can be driven by either a relative increase in the number of households making their children work (the extensive margin) or by a relative increase in the time allocated to agricultural activities by children who are already working (the intensive margin). To disentangle these mechanisms, we estimate the marginal effect on children's participation in agricultural activities. This is a dummy variable equal to 1 when the household engaged in child labor – the number of person days per hectare of land cultivated during the agricultural season by household members below 15 years old is positive – and 0 otherwise. The results are displayed in Table 8.

We find no indication that the land certification program has changed the proportion of households that engaged in child labor. This suggests that the increase in child labor observed in South Wollo and the decrease observed in East Gojjam are mostly driven

the treatment effect of female labor supply is not well identified and should be interpreted with caution.

Table 8: Land certification and participation of children to farm work.

	Boys & Girls		Boys		Girls	
	mean	effect	mean	effect	mean	effect
Panel A: East Gojjam						
Year						
× 2002 (placebo)	0.337	-0.046	0.231	-0.025	0.213	-0.050
		(0.043)		(0.041)		(0.055)
× 2005 (treatment effect)	0.428	-0.015	0.321	-0.007	0.251	-0.024
		(0.027)		(0.028)		(0.033)
Number of households	669		669		669	
Panel B: South Wollo						
Year						
× 2002 (placebo)	0.396	-0.072	0.309	-0.037	0.252	-0.042
		(0.052)		(0.053)		(0.036)
× 2005 (treatment effect)	0.451	0.019	0.346	0.013	0.319	-0.006
		(0.051)		(0.046)		(0.037)
Number of households	747		747		747	

The table reports the effect estimated using a difference-in-difference approach with a linear specification as described in Section 5. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

by time allocation of male children who were already involved in farming activities.

8 Robustness checks

8.1 Using the wild cluster *t* bootstrap procedure for inference with few clusters

As discussed above, if the number of treated and comparison clusters differ substantially the wild cluster *t* bootstrap is the preferred one for inference with few clusters. In our schooling specifications 30.61% of the *kebele* years are treated, while 69.39% are not. While the combined sample has 14 *kebeles*, the separate East Gojjam and South Wollo samples have only 7 *kebeles* each. Hence, we estimate the *p*-values from the wild cluster *t* bootstrap procedure using both the 2 – point Rademacher – and the 6 point weight distribution (see Table 9). We estimate the enrollment equation for boys and girls, and the grade progress equation for boys (grade progress is not estimated for girls since there were not statistically significant results in the main estimations) The same coefficients that were statistically significant in the main analysis remain so.

Table 9: p-values from wild cluster t bootstrap.

		All *kebele*	E. Gojjam	S. Wollo
Panel A: Boys				
Dependent variable: Enrollment (Table 4)				
Simple term	2 point Rademacher weights	0.020	0.000	0.545
	6 point weight distribution	0.030	0.020	0.466
Interaction term	2 point Rademacher weights	0.637	0.282	0.034
	6 point weight distribution	0.511	0.320	0.031
Dependent variable: Grade progress (Tables 5)				
Simple term	2 point Rademacher weights	0.693	0.250	0.557
	6 point weight distribution	0.705	0.166	0.549
Interaction term	2 point Rademacher weights	0.012	0.134	0.024
	6 point weight distribution	0.014	0.016	0.052
Panel B: Girls				
Dependent variable: Enrollment (Table 4)				
Simple term	2 point Rademacher weights	0.000	0.000	0.012
	6 point weight distribution	0.000	0.000	0.062
Interaction term	2 point Rademacher weights	0.462	0.194	0.320
	6 point weight distribution	0.392	0.418	0.106

The table reports p-values after correction of the standard errors for the small number of clusters.

8.2 Using Bell and McCaffrey's method for inference with few clusters

Below we use Bell and McCaffrey's method for inference with few clusters, suggested by Imbens and Kolesar (2016). In addition to the coefficients and standard errors, Table 10 reports the degrees of freedom of the t-distribution used for inference. Standard errors are somewhat larger than in the main estimations. Significance levels are somewhat higher than in the main estimations, both because of the larger standard errors, and because t-distributions with fewer degrees of freedom are used for inference. Importantly, the main results still hold. Land certification increases enrollment for boys and girls in East Gojjam, and it decreases grade progress for boys in both East Gojjam and South Wollo.[15]

Table 10: The impact of the land certification program on children's school enrollment and progress using Bell and McCaffrey's method for few cluster inference.

	School enrollment			Grade progress		
	All *kebeles*	E. Gojjam	S. Wollo	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys						
Land certification	0.029	0.066**	-0.008	0.005	0.029	-0.012
	(0.017)	(0.018)	(0.016)	(0.016)	(0.020)	(0.021)
	[10.59]	[4.45]	[5.07]	[10.55]	[4.45]	[5.23]
× *Oldest son*	0.025	-0.012	0.069	-0.040**	-0.063**	-0.021*
	(0.024)	(0.0023)	(0.036)	(0.015)	(0.019)	(0.008)
	[10.59]	[4.79]	[5.05]	[8.31]	[3.58]	[4.24]
Oldest son	-0.098*	-0.122**	-0.074	0.030**	0.025	0.035*
	(0.029)	(0.042)	(0.040)	(0.012)	(0.012)	(0.015)
	[11.66]	[5.08]	[5.59]	[9.29]	[3.89]	[4.74]
Observations	11,982	5,953	6,029	4,006	1,781	2,225
Panel B: Girls						
Land certification	0.016	0.038**	0.005	-0.001	0.005	-0.004
	(0.012)	(0.013)	(0.015)	(0.015)	(0.026)	(0.022)
	[10.37]	[4.44]	[5.01]	[9.71]	[4.44]	[5.04]
× *Oldest daughter*	0.020	-0.015	0.045	0.008	-0.020*	0.024
	(0.025)	(0.031)	(0.047)	(0.021)	(0.011)	(0.032)
	[10.52]	[4.99]	[4.85]	[9.13]	[4.32]	[4.50]
Oldest daughter	-0.030	0.006	-0.058*	-0.016	0.010	-0.028
	(0.023)	(0.032)	(0.031)	(0.017)	(0.009)	(0.021)
	[11.93]	[5.56]	[5.51]	[9.42]	[9.42]	[5.23]
Observations	10,821	2,734	3,330	1,713	591	1,122

The table reports estimates of the impact of land certification on schooling outcomes of children using Bell and McCaffrey's procedure to adjust for few cluster inference (Bell and McCaffrey, 2002; Imbens and Kolesar, 2016). Adjusted standard errors are in parentheses and the adjusted degree of freedom is reported in brackets. Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

[15] Though not reported, for the sake of concision, our estimates of the effect of land certification on labour supply remain significant, at 10% percent, when the p-value is adjusted using Bell and McCaffrey's method for inference with few clusters. The results will be provided upon request.

8.3 Placebo tests

In Table 11 we present the results of a placebo test. We use the 2000 to 2003 data and simulate that the expansion of the land certification program began in 2000, and followed its actual pattern. We do not observe any significant effects of the placebo in either the main effects or the interactions.

Table 11: Placebo test of effect of land certification on school enrollment and progress.

	School enrollment			Grade progress		
	All *kebeles*	E. Gojjam	S. Wollo	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys						
Land certification	-0.031	-0.027	-0.033	0.019	0.029	0.013
	(0.018)	(0.022)	(0.030)	(0.022)	(0.020)	(0.035)
× *Oldest son*	0.032	-0.021	0.082	-0.022	-0.037	-0.014
	(0.037)	(0.057)	(0.046)	(0.030)	(0.038)	(0.040)
Oldest son	-0.123***	-0.131*	-0.111**	0.052	0.069*	0.044
	(0.033)	(0.062)	(0.034)	(0.032)	(0.035)	(0.044)
Observations	6,881	3,364	2,892	1,832	786	633
Panel B: Girls						
Land certification	-0.023	-0.001	-0.047	0.011	0.033	-0.002
	(0.022)	(0.025)	(0.031)	(0.013)	(0.031)	(0.015)
× *Oldest daughter*	0.025	0.033	0.018	-0.001	0.025	-0.018
	(0.033)	(0.024)	(0.053)	(0.021)	(0.037)	(0.028)
Oldest daughter	-0.037	-0.028	-0.044	-0.006	-0.016	0.004
	(0.032)	(0.034)	(0.049)	(0.016)	(0.035)	(0.016)
Observations	6,064	2,734	3,330	1,713	591	1,122

The table reports the coefficients of the within-household linear probability model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

8.4 Controlling for school expansion

Primary school enrollment increased tremendously in Ethiopia during the time period of our study, albeit from a very low level. Between 2004 and 2010 the number of primary schools in East Gojjam and South Wollo increased from 743 to 1180. This might raise concern that school construction was correlated with the expansion of the land certification program.[16] We have data on the availability of primary and secondary schools in the *kebeles* from 2002, 2005 and 2007. In 2002, 11 *kebeles* had primary schools and two *kebeles* had secondary schools. By 2007, 13 *kebeles* had primary schools and three *kebeles* had secondary schools. School expansion took place in only two *kebeles*: Yamed in South Wollo, which received a primary school either in 2002, 2003 or 2005, and Debre Elias in East Gojjam, which received both a primary and secondary school either in 2006 or in 2007.

Table 12: Impact of the land certification program on children's school enrollment and progress, controlling for school expansion.

	School enrollment			Grade progress		
	All *kebeles*	E. Gojjam	S. Wollo	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys						
Land certification	0.035*	0.066**	-0.002	0.009	0.029	-0.006
	(0.017)	(0.017)	(0.018)	(0.014)	(0.017)	(0.018)
× *Oldest son*	0.024	-0.013	0.068*	-0.042***	-0.063**	-0.023**
	(0.022)	(0.0023)	(0.030)	(0.013)	(0.018)	(0.007)
Oldest son	-0.097***	-0.122**	-0.074	0.031**	0.025*	0.036**
	(0.028)	(0.041)	(0.038)	(0.011)	(0.012)	(0.014)
Observations	11,982	5,953	6,029	4,006	1,781	2,225
Panel B: Girls						
Land certification	0.017	0.038**	0.003	0.002	0.004	-0.001
	(0.013)	(0.011)	(0.018)	(0.014)	(0.022)	(0.021)
× *Oldest daughter*	0.020	-0.015	0.045	0.008	-0.018*	0.023
	(0.023)	(0.031)	(0.039)	(0.019)	(0.009)	(0.030)
Oldest daughter	-0.030	0.006	-0.058*	-0.015	0.009	-0.027
	(0.023)	(0.032)	(0.032)	(0.016)	(0.009)	(0.020)
Observations	10,821	2,734	3,330	1,713	591	1,122

The table reports estimates of the impact of land certification on schooling outcomes controlling for school expansion. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

[16] SIDA contributed to the construction of 241 out of the 437 new schools that were built, and also contributed to the land certification program. However, the process which resulted in construction of primary schools was completely separate from the expansion of the land certification program. As opposed to the land certification program, which was exogenously brought to the kebeles, school construction was the outcome of decisions within the community. Funds were allocated to local areas and the community decided which investments were most needed. The local community also had to contribute 25% of the cost, usually in the form of labor or materials. Infrastructure funds were simultaneously allocated to all kebeles, who themselves identified local infrastructure needs (SARDP, 2010).

In Table 12, we assume that the new primary school in Yamed was already available in 2003 and that the primary and secondary schools in Debre Elias were operating starting in 2006. The results are qualitatively the same as the main results in Tables 4 and 5. Further robustness checks where the primary school is assumed to come to Yamed in 2004 or 2005 respectively yield nearly identical results.[17] The results also hold to the outright exclusion of these two *kebeles* (available on request).[18]

8.5 Controlling for weather shocks

We might be concerned that the arrival of the land certification program just happened to coincide with shocks that affected educational investment. In particular, weather shocks are likely to be important determinants of agricultural labor input, and also to be correlated at the *kebele* level. Note that the zone-specific year dummies will control for all shocks that affect all of our *kebeles* in East Gojjam or all of our *kebeles* in South Wollo.

In Table 13 we also control for household level self-reported environmental shocks (primarily floods and droughts, but also hailstorms and animal pests). Unfortunately, we do not have annual information on shocks, but only know if a household was hit by a shock between rounds. Hence, if, for example, a household reports a shock between the 2nd and 3rd rounds of data collection the dummy is equal to 1 for school years 2002, 2003 and 2004.

This limitation and the potential selection due to self-reporting are the reasons not to include weather shocks in the main analysis. The main results are not affected by the inclusion of environmental shocks.

[17] As we do not have data for the completed school year 2007, assuming that the new schools came to Debre Elias in 2007 rather than 2006 would have no impact on our baseline results.

[18] Our estimates of the effect of land certification on labour supply remain robust when the *kebeles* Yamed and Debre Elias are not included in the analysis. These results will be provided upon request.

Table 13: Effect of land certification on school enrollment and progress after controlling for weather shocks.

	School enrollment			Grade progress		
	All *kebeles*	E. Gojjam	S. Wollo	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys						
Land certification	0.030*	0.067***	-0.007	0.005	0.028	-0.011
	(0.016)	(0.017)	(0.016)	(0.015)	(0.017)	(0.020)
× *Oldest son*	0.025	-0.016	0.072*	-0.043***	-0.069***	-0.022*
	(0.023)	(0.024)	(0.030)	(0.014)	(0.015)	(0.008)
Oldest son	-0.102***	-0.130**	-0.076	0.031**	0.025*	0.037*
	(0.029)	(0.042)	(0.040)	(0.011)	(0.012)	(0.014)
Shock	0.002	-0.000	0.002	-0.012	0.010	-0.031*
	(0.017)	(0.027)	(0.018)	(0.011)	(0.015)	(0.015)
Observations	11,760	5,817	5,943	3,930	1,742	2,188
Panel B: Girls						
Land certification	0.016	0.040**	0.004	-0.002	-0.001	-0.005
	(0.011)	(0.012)	(0.014)	(0.014)	(0.023)	(0.021)
× *Oldest daughter*	0.019	-0.020	0.046*	0.012	-0.015	0.027
	(0.025)	(0.036)	(0.038)	(0.021)	(0.012)	(0.031)
Oldest daughter	-0.030	0.007	-0.058*	-0.020	0.005	-0.030
	(0.024)	(0.037)	(0.031)	(0.016)	(0.011)	(0.020)
Shock	-0.002	-0.019	0.016	-0.003	0.023	-0.016
	(0.013)	(0.023)	(0.014)	(0.011)	(0.021)	(0.012)
Observations	10,594	4,830	5,764	3,862	1,425	2,437

The table reports the coefficients of the within-household linear probability model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

8.6 Using the fixed effects logit

Though the linear approximation is a robust approximation independent of the true functional forms (Angrist and Pischke, 2008), the linear probability model does have its well-documented short-comings, and there is no consensus on the practical importance of these. In particular, the linear probability model leads to predicted probabilities below 0 or above 1. When many predicted probabilities are outside of the unit range, the estimator is biased and inconsistent (Horrace and Oaxaca, 2006). Since we use data transformed into deviations from household means, predictions are centered around 0 and the implications of probabilities outside of the unit range are unclear.

Regardless, we can compute predicted probabilities, and these are almost never outside of the unit range: in the enrollment estimations 99.95% of boys' and 99.98% of girls' predicted probabilities are within the unit range; in the grade progress estimations 99.84% of boys' and 99.98% of girls' predicted probabilities are within the unit range. Nevertheless, as a robustness check we use the fixed effects logit. However, inference with few clusters is a problem in these estimations. Furthermore, computation of marginal effects is not straight forward since the household effects are never estimated. Instead of making some assumption to be able to compute marginal effects we report odds ratios in Table 14. The general picture is the same as in the main results.

Table 14: Effect of land certification on odds of school enrollment and progress.

	School enrollment			Grade progress		
	All *kebeles*	E. Gojjam	S. Wollo	All *kebeles*	E. Gojjam	S. Wollo
Panel A: Boys						
Land certification	1.063	1.478*	0.705***	1.097	1.700	0.766
	(0.160)	(0.239)	(0.076)	(0.513)	(1.245)	(0.463)
× *Oldest son*	1.369	0.919	2.414***	0.313***	0.307*	0.398*
	(0.325)	(0.217)	(0.705)	(0.119)	(0.218)	(0.199)
Oldest son	0.309**	0.240**	0.369**	1.690	1.536	1.844
	(0.082)	(0.076)	(0.157)	(0.838)	(0.983)	(1.538)
Observations	8,535	4,362	4,173	902	449	453
Panel B: Girls						
Land certification	1.146	1.144	1.173	0.821	1.064	0.609
	(0.146)	(0.196)	(0.222)	(0.311)	(0.630)	(0.357)
× *Oldest daughter*	1.196	0.966	1.572	1.323	0.758	1.792
	(0.326)	(0.302)	(0.787)	(0.691)	(0.285)	(1.437)
Oldest daughter	0.633*	0.688	0.591	0.540	0.912	0.473
	(0.148)	(0.183)	(0.258)	(0.838)	(0.983)	(0.278)
Observations	7,521	3,630	3,891	1,140	318	822

The table reports the coefficients of the within-household specification using a conditional logit model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

8.7 Excluding boys with shifts in oldest son status

In Table 15 we have excluded boys who are not consistently coded as either being the oldest son or not being oldest son, i.e. boys whose status shifts between rounds. This is only done for boys and oldest sons, since being the oldest daughter or not does not appear to be of importance for the girls. In all, 77.31% of boys have a consistent status. Since we lose observations we might expect a loss of precision. On the other hand, our data is likely to include less measurement error, which should increase precision. Results remain qualitatively the same, but there are no statistically significant effects in South Wollo.

Table 15: Effect of land certification on school enrollment and progress for children with consistent oldest son status.

	School enrollment			Grade progress		
	All kebeles	E. Gojjam	S. Wollo	All kebeles	E. Gojjam	S. Wollo
Panel A: Boys						
Land certification	0.015**	0.045**	-0.016	0.007	0.030	-0.008
	(0.013)	(0.014)	(0.014)	(0.013)	(0.020)	(0.015)
× *Oldest son*	0.016	-0.011	0.049	-0.038**	-0.062**	-0.018
	(0.023	(0.025	(0.029	(0.015)	(0.021	(0.015)
Oldest son	-0.121***	-0.166***	-0.071	0.031**	0.025	0.035*
	(0.034	(0.041	(0.045	(0.013)	(0.013)	(0.017
Observations	10,171	5,110	5,061	3,375	1,510	1,865

The table reports the coefficients of the within-household linear probability model. All models also include age dummies, zone-specific year dummies and a constant. Standard errors are in parentheses and clustered at the kebele level using the few clusters procedure in Brewer et al. (2013). Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.

9 Discussion

We have studied the impact of a land certification program in rural Amhara, Ethiopia, on children's schooling and work. To the best of our knowledge, earlier studies have only considered the impact of urban land certification on children's activities. Since land is productive in rural areas there are reasons to expect that the effects differ in this setting. Land certification could affect children's activities through a range of mechanisms. We have focused on the land inheritance channel. If the program leads to a higher probability that a child takes over the land, and farming is considered profitable, then schooling could be seen as a less attractive alternative while learning by doing at the field could be seen as more attractive for these children. Not all children are likely inheritors, however. In rural Ethiopia the oldest son is the most likely heir of the land and parents may compensate their other children through increased investment in schooling. Conversely, if household labor is used as a signal to secure the household's claim to the land, then a strengthening of user rights may free time to pursue other activities, including children's schooling. Further, when land inheritance rights are weak, children that are meant to remain on the land might have to be present on the field in order to secure the household's continued access to the land. Land certification can then free up time for these children in particular and provide added incentive for children from low productivity households to attend school in order to widen their future options.

We have data from two zones in the Amhara region with different agro-climatic conditions and history of tenure security: East Gojjam and South Wollo. East Gojjam is characterized by fertile land and gentle slopes, while South Wollo is steeper, prone to regular drought, and has been subject to forced as well as voluntary resettlement programs. Based on anecdotal evidence, these differences make farming less attractive and inhabitants' perceived land rights less secure in South Wollo.

On the whole we find that the effect of land certification on children's activities differs depending on the zone in which it is implemented. In East Gojjam school enrollment increases for both boys and girls, and the results suggest a similar effect for oldest sons and other boys. In South Wollo school enrollment increases only for the oldest son. We argue that this difference between the zones is related to the difference in land rights history as well as the difference in agro-climatic conditions. With land rights being perceived as less secure in South Wollo, parents have been more inclined towards keeping their oldest son on the land to secure continued access, for themselves when they grow older as well as for him. Safer land rights, which include the possibility to rent out the land, in combination with low agricultural productivity, could create the opportunity for the oldest sons to gain employment in non-farm activities as adults. In this sense, the results in South Wollo are similar to the results found in the previous studies focused on urban areas.

The general increase in school enrollment in East Gojjam could be explained by alternative mechanisms. One possibility is that household time in general is freed up, allowing increased schooling of children. Another one is that children who will not inherit the land are compensated with more schooling when the oldest sons' inheritance is more certain. The fact that land cannot be used as collateral speaks against a credit channel. While we cannot rule out wealth effects, we believe the fact that our treatment is based on the arrival of the program in the *kebele* makes them less likely to explain our results. It would probably take some time before wealth effects could be observed. Another possibility is that the fact that both spouses' names are on the certificate has increased women's bargaining power. If women prioritize children's schooling higher than men, this could explain an increase in enrollment. However, it is then difficult to explain why the increased enrollment is concentrated to East Gojjam.

School progress is generally unaffected except in the case of oldest sons', whose school progress seems to worsen. In East Gojjam, where farming is relatively more profitable, this may be due to the oldest son and his parents choosing to focus less attention on schooling when his probability of taking over the farm increases, however not to the point that enrollment is negatively affected. In South Wollo, oldest sons' school enrollment and grade progress move in opposite directions, and worse average school progress among oldest sons could be related to the fact that some oldest sons who previously did not attend at all now have the possibility to do so. Estimations on subsamples of boys who were already enrolled the previous year or two years ago suggest that such composition effects can explain the worsened grade progress in South Wollo, but not in East Gojjam.

The child labor data are less detailed since we only have information for the years preceding data collection and since we only have household level information. The impact of the program on child labor again appears to differ between East Gojjam and South Wollo. Child labor decreases in East Gojjam, while in South Wollo, boys' labor increases. This seems to be due to changes in the intensity of use of boys' labor in those households where boys already were working. In East Gojjam, the decrease in child labor seems to complement the general increase in school enrollment for boys. The increase in child labor in South Wollo could be a direct effect of improved investment in soil conservation through terrace building. Importantly, the increased child labor does not appear to negatively affect schooling (to the extent that this can be measured by enrollment and grade progress). Since children will typically have some leisure there is no one-to-one trade-off between child labor and their schooling. The contrasting impacts of the program on schooling and particularly child labor outcomes in East Gojjam and South Wollo are in line with the findings of previous studies that show that the effects of land certification will depend on initial conditions.

To the best of our knowledge this is the first study on the impact of rural land certification on children's schooling and labor supply, and more studies are needed before any general conclusions can be drawn. While there are many possible mechanisms through which land certification could affect children's activities, the fact that oldest son's schooling is affected differently from that of other children in the household does suggest the land inheritance channel to be important in rural areas.

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Appendix-I Theoretical model and results

A-1. Framework

The theoretical model developed here is based on the model presented in Bhalotra and Heady (2003), and is a two period model of a peasant household of one parent and one child. In the baseline model, we maintain the assumption that the parent always works and that their labor supply can be normalized to one. Further, the child does not bargain with its parent.

The first period household income, y_1, is given by:

$$y_1 = f\left(a\ ,\ k\ ,\ l_{p1}\ ,\ l_{c1}\right) \tag{2}$$

where, a and k are the (fixed) amount of land and productive capital held by the household, l_{p1} is the labor supplied by the parent while l_{c1} is the labor supplied by the child. The wage rate in the first period is the marginal product of own farm labor.

In the second period the child is an adult and for simplicity it is assumed that their income and consumption remain part of the family household. The child's second period wage is a function of the first period activity in which the child participated, i.e. work or school. This allows for a dynamic effect for the choice of activity in the first period. Second period household income is given by:

$$y_{2w} = f\left(a\ ,\ k\ ,\ l_{p2}\right) + w_2\left(l_{c1}, s\right) \times l_{c2} \tag{3}$$

in the case where the child does not remain on the farm as an adult and by:

$$y_{2f} = f\left(a\ ,\ k\ ,\ l_{p2},\ g\left(l_{c1}, s\right) \times l_{c2}\right) \tag{4}$$

in the case where the child remains on the farm in the second period. s measures time spent at school, $g\left(l_{c1}, s\right)$ and $w_2\left(l_{c1}, s\right)$ are respectively the total factor productivity and wage rate given past experience at farming and schooling.

This is the first point of departure for our model as compared to the model in Bhalotra and Heady (2003), which assumes that the impact of child labor and schooling on wage is the same, regardless of whether the child remains on the family farm or not. We assume that the returns to child labor in terms of productivity are greater when the child remains on the family farm as compared to engaging in other work. Similarly, the returns to schooling in terms of productivity are lower when the child remains on the family farm as compared to engaging in other work.

The household can either save or borrow in the first period, so that first period consumption is not bound by first period income. Further, the household is assumed to inherit some initial financial wealth (which can be either positive or negative) from period zero. First period net financial wealth, ω_1 , is thus given by:

$$\omega_1 = \omega_0 + y_1 - x_1 - c(s) \tag{5}$$

where ω_0 is initial financial wealth, $c(s)$ is the direct cost of schooling – it is equal to 0 if the child does not attend school – and x_1 is first period consumption (the price of which is normalized to unity). Second period net financial wealth is given by:

$$\omega_2 = y_2 - x_2 + \omega_1 \times (1 + r) \tag{6}$$

Wealth at the end of the second period is assumed to be $\omega_2 = 0$, yielding the corresponding second period budget constraint:

$$x_2 = y_2 + \omega_1 \times (1 + r) \tag{7}$$

The household now endeavors to maximize its utility function, which is assumed to be time separable and is given by:

$$u = u_1(x_1, l_{p1}, l_{c1}, s) + \delta \times u_2(x_2, l_{p2}, l_{c2}) \tag{8}$$

where $\delta \leq 1$ is the inverse of the time discount factor, ρ . The utility function is assumed to be a twice differentiable positive concave function of consumption and leisure, so that the marginal utility of consumption is positive while the marginal utility of labor and schooling is negative. Thus, the parent is faced with the following maximization problem:

$$\left| \begin{array}{ll} \max & u_1(x_1, l_{p1}, l_{c1}, s) + \delta u_2(x_2, l_{p2}, l_{c2}) \\ \text{s.t.} & \begin{cases} 0 = \omega_1 - \omega_0 - y_1 + x_1 + c(s) \\ \\ 0 = x_2 - y_{2i} - \omega_1 \times (1 + r) \end{cases} \end{array} \right. . \tag{9}$$

where $i \in \{w\ ,\ f\}$, depending on whether or not the child works for wages or remains on the farm in the second period.

A-2. Introducing property rights

A-2.1 Inheritance

In the original model it is implicitly assumed that the family can freely choose whether the child remains on the family farm or not, indicating that property rights are established. This is, however, not always the case. One way to introduce property rights into the model is to assume that stronger property rights increase the probability that the child can remain on the family farm. In this case, we can re-write the second period budget constraint for children with the possibility of remaining on the family farm as:

$$x_2 - \Big(\big(1-\gamma\big)\big(f\left(a\,,\,k\,,\,l_{p2}\right) + w_2\left(l_{c1}, s\right) l_{c2}\big) + \gamma f\left(a\,,\,k\,,\,g\left(l_{c1}, s\right) l_{c2}\right)\Big) - \omega_1\left(1+r\right) = 0$$

where $0 < \gamma \leq 1$ is the parameter measuring the strength of property rights – $\gamma = 1$ if the parents can freely allocate or transfer their landholding to their kids and 0 if they cannot do so.

By setting up a Lagrangian function Γ with multipliers λ_1 and λ_2, one can derive the first order conditions relevant to the child labor/schooling decision:

$$\frac{\partial \Gamma}{\partial x_1} = \frac{\partial u_1}{\partial x_1} - \lambda_1 = 0 \tag{10}$$

$$\frac{\partial \Gamma}{\partial x_2} = \delta \frac{\partial u_2}{\partial x_2} - \lambda_2 = 0 \tag{11}$$

$$\frac{\partial \Gamma}{\partial l_{c1}} = \frac{\partial u_1}{\partial l_{c1}} + \frac{\partial f}{\partial l_{c1}}\lambda_1 + \left(\gamma \frac{\partial f}{\partial g}\frac{\partial g}{\partial l_{c1}} + \left(1-\gamma\right)\frac{\partial w_{c2}}{\partial l_{c_1}}\right) \times l_{c2}\lambda_2 \leq 0 \tag{12}$$

$$\frac{\partial \Gamma}{\partial s} = \frac{\partial u_1}{\partial s} - \frac{\partial c}{\partial s}\lambda_1 + \left(\gamma \frac{\partial f}{\partial g}\frac{\partial g}{\partial s} + \left(1-\gamma\right)\frac{\partial w_{c2}}{\partial s}\right) \times l_{c2}\lambda_2 \leq 0 \tag{13}$$

According to Eq (12), the child will work if the first period wage plus the value of the increase in the second period wage due to wage work experience is equal to the marginal dis-utility of wage labor, while Eq (13) shows that the parent will send their child to school if the value of the increase in the second period wage due to schooling minus the marginal cost of schooling is equal to the marginal dis-utility of schooling. Therefore, there are four possible outcomes, summarized in Table A-1.

Table A-1: Possible outcomes.

Child activity	Conditions	
Child works but does not attend school	$\frac{\partial \Gamma}{\partial l_{c1}} = 0\,;\, \frac{\partial \Gamma}{\partial s} < 0$	(i)
Child attends school but does not work	$\frac{\partial \Gamma}{\partial l_{c1}} < 0\,;\, \frac{\partial \Gamma}{\partial s} = 0$	(ii)
Child works and attends school	$\frac{\partial \Gamma}{\partial l_{c1}} = 0\,;\, \frac{\partial \Gamma}{\partial s} = 0$	(iii)
Child neither works nor attends school (idle)	$\frac{\partial \Gamma}{\partial l_{c1}} < 0\,;\, \frac{\partial \Gamma}{\partial s} < 0$	(iv)

Source: Authors.

Assuming that $\frac{\partial f}{\partial g}\frac{\partial g}{\partial s} < \frac{\partial w_{c2}}{\partial s}$, then it is clear that children with the possibility of remaining on the family farm will devote less time to schooling than children who do not face this possibility. If we assume that $\frac{\partial f}{\partial g}\frac{\partial g}{\partial l_{c1}} > \frac{\partial w_{c2}}{\partial l_{c_1}}$, then this will have the additional effect of making child labor more attractive for children who remain on the family farm. The size of this effect in both cases will, however, depend on the value of γ.

A-2.2 Comparative statics

Suppose γ increases from γ_1 to γ_2. It is clear from Eq (12) and Eq (13) that an increase in γ will increase the likelihood that children devote time to work and reduce the likelihood that they allocate time to schooling. In the case of Eq (12), the change in time allocated to child labor can be expressed as $\left(\frac{\partial f}{\partial g}\frac{\partial g}{\partial l_{c1}} - \frac{\partial w_{c2}}{\partial l_{c_1}}\right)(\gamma_2 - \gamma_1)\, l_{c2}\lambda_2$, which is positive, given our assumption above. Similarly, in the case of Eq (13), the change in time allocated to schooling can be expressed as $\left(\frac{\partial f}{\partial g}\frac{\partial g}{\partial s} - \frac{\partial w_{c2}}{\partial s}\right)(\gamma_2 - \gamma_1)\, l_{c2}\lambda_2$, which is negative, given our assumption above. The magnitude of these changes will of course depend on how great the difference is in returns to child labor and schooling, respectively, between the two types of second period activities. Therefore, it is possible that an increase in γ only impacts one of these activities; work and schooling are not mutually exclusive, and there will only be a direct trade-off between the two in the event that child leisure is fixed. Further, it is possible that the wage function is not strictly concave in child labor and/or schooling, in which case there is a threshold level of child labor or schooling, beyond which the marginal return to an increase in this activity is zero. A change in γ has no effect on children with no chances of inheriting the right to use the family land.

A-2.3 Securing property rights

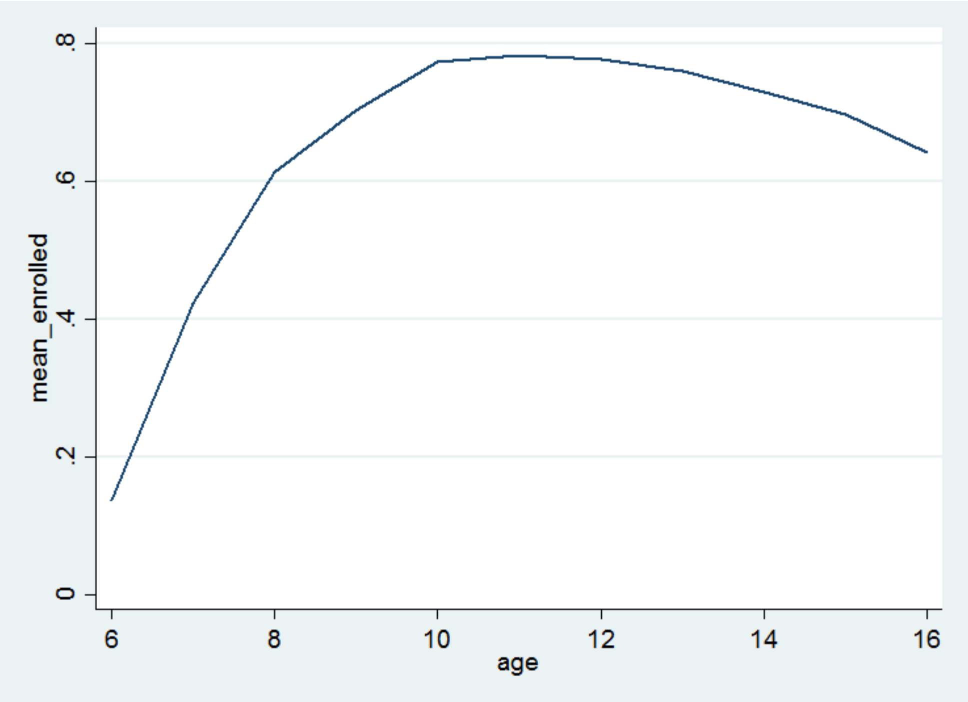
Assume now, for simplicity, that weak property rights lead households to allocate child time to activities intended to secure the household's claim to the land. Such activities are assumed to imply that that child's physical presence is required on the land. One way of modeling this, then, is via an increased direct cost of schooling when property rights are weak, as school attendance required the child to leave the farm for extended periods of time. We can rewrite the direct cost of schooling as $\gamma^{-1/2}c(s)$. Therefore, the direct cost of schooling becomes inversely related to the strength of property rights. We can then rewrite Eq (13) as:

$$\frac{\partial \Gamma}{\partial s} = \frac{\partial u_1}{\partial s} - \gamma^{-1/2}\frac{\partial c}{\partial s}\lambda_1 + \frac{\partial w_{c2}}{\partial s} \times l_{c2}\lambda_2 \leq 0 \tag{14}$$

It is clear from the above equation that an increase in the strength of property rights will, all else equal, make schooling more attractive for the household. Finally, it is possible that both the inheritance and the security aspects of property rights are relevant, in which case the effects of improved property rights on schooling are ambiguous.

Appendix-II Additional figures and tables

Figure A-1: Enrollment by age, average 2000-2006



Source: Author's illustration.

Table A-2: Testing for endogenous start of the land certification program.

Dependent variables	Boys	Girls
School enrollment	-0.031 (0.018)	-0.025 (0.019)
Observations	3,670	3,094
Grade progress	-0.015 (0.023)	0.018 (0.011)
Observations	833	714

The table reports the effect of the year in which the land certification arrived in the kebele on the main outcome variable between 2000 and 2002. All models include *woreda* dummies, age dummies, year dummies, number of siblings, oldest sister or brother dummy, female household head, literate household head, literate spouse, income in 2000 and share of income from off-farm activities in 2000. Standard errors are in parentheses and clustered at the *kebele* level using the few clusters procedure in Brewer et al. (2013).
Significance levels are denoted as follows: * p<0.10, ** p<0.05, *** p<0.01.