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Land Certification and Schooling in Rural Ethiopia*

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Abstract

This paper investigates the impact of a rural Ethiopian land certification program on schooling. Our hypothesis is that formal property rights facilitate land inheritance, reducing the net benefit of schooling for children who will inherit the land. Formal rights also decrease the need for activities to secure continued access to the land, reducing the cost of schooling for all children. The results suggest a positive overall effect on school enrollment. However, grade progress of oldest sons, who are most likely to inherit the land, worsens. Our complementary analysis on child labor suggests a differential impact in the two zones studied.

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1 Introduction

The number of land certification programs around the world has been growing over the last couple of decades. These programs have been inspired by theories that predict that increased land tenure security will increase incentives to invest, allow for easier access to credit (if land can be used as collateral), and facilitate the development of land markets (Besley, 1995; de Soto, 2000; Joireman, 2008). Empirical findings, however, have been mixed; the results are likely to depend on the informal institutions that prevailed before the program as well as on the details of the program (Brasselle et al., 2002; Fenske, 2011; Jacoby and Minten, 2007; Place, 2009). In this paper, we investigate the impact of a land certification program in the rural Amhara region of Ethiopia on children's schooling and labor. Previous studies have found positive impacts of various rural land certification programs in Ethiopia on investments in the land and on land rental markets (Holden et al., 2011; Holden and Tefera, 2008; Holden et al., 2009). In the case of the Amhara program specifically, Deininger et al. (2011) found positive investment, land rental market development, and tenure security impacts of the program, and Bezabih et al. (2012) found that especially women dared to rent out land more often as a result of the program.

Very few studies have analyzed the effects of land titling programs on children's activities and, to the best of our knowledge, the few that exist have all studied urban programs in Latin America. Field (2007) and Moura et al. (2009) study urban land titling programs in Peru and Brazil, respectively, and find that child work decreases as a result of the programs. Similarly, Galiani and Schargrodsky (2010) find increased schooling of 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.

While the abovementioned studies provide insight into the potential effects of land titling on child activities, there are grounds to believe that the effects may be different in a rural context as opposed to an urban one. This could be the case for several rea-

sons, most of which are related to the fact that rural land is typically used as an input to production. Therefore, the effects on marginal productivity of child work on the land will matter. The studies in urban Latin America suggest that child time is freed when adults do not need to engage in activities to safeguard their land rights. Similar effects are possible in a rural context, but increased investments could also increase the marginal productivity of labor on the land. Furthermore, the program can affect the perceived future benefits of education and learning by doing at the field and therefore alter parents' and children's incentives to invest in education and work experience. A formal model explores this last mechanism and the mechanism where activities to secure continued access to the land is less needed.

The Amhara land certification program was the joint product of the Amhara region and donors. It 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* (village). 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. We have annual individual level information on school enrollment and school progress as well as household level information 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. School progress, conditional on being in school is negatively affected for oldest sons, but unaffected for other children in the household. Hours of child labor at the household level decrease in East Gojjam and increase in South Wollo. To the best of our knowledge our study is the first to evaluate the impact of land certification on child schooling and labor in a rural context. Though the studied land certification program has been shown to have many positive effects for rural households, and though school enrollment appears to be positively affected also in our rural context, education of oldest sons is

potentially negatively affected. If parents and sons believe that formal education will pay off less and learning by doing in the field to pay off more after land certification, this is a rational response. Further, land certification appears to increase the household supply of child labor in South Wollo, however not to the point that school enrollment is affected.

The remainder of the paper is structured as follows: Section 2 describes the land certification program and provides the educational context; 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 Background

In Ethiopia all land is state-owned. There have been periodic redistributions of households' rights to farm the land, the last major one in 1997. The 1995 Constitution and the 1997 Federal Land Law allow leasing, sharecropping and inheritance of land rights; practices which used to be illegal. The land certification program in Amhara provides households with a legally binding document of plots and boundaries, and ascertains the rights provided in the 1997 Federal Land Law. Since 2002, as part of its effort to reduce poverty in Amhara National Regional State (ANRS) in Ethiopia, the Swedish International Development Cooperation Agency (SIDA) has financed the program to provide the farming community of the region with certificates of their land holdings.[1] This project is a component of a large program called the SIDA-Amhara Rural Development Program (SARDP) which includes other activities targeting: (*i*) economic diversification, (*ii*) infrastructures and social services, (*iii*) decentralization and action

[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, hydropower and commercial fisheries. 90% of the population lives in rural areas and is engaged in agriculture.

on issues such as gender and HIV-AIDS prevention program.[2]

2.1 The land certification program in Amhara

The land certification program was included in SARDP in June of 2002, and subsequent work on the project began in two pilots villages: Adishena Gulit in East Gojjam and Gerado Endodber in South Wollo. By 2010, the registration activities were completed in nearly all *woredas* (districts) in the two zones. The land certification program in Amhara consists in several activities punctuated with the issuance of three documents, each related to a different level of information about user rights to land. The overall result of the process is the award of certificates confirming individuals' property rights to land through the boundary delimitation of the plots occupied by the residents and a resolution of latent conflicts with neighbors.

Woreda officials were in charge of implementing the program. Due to capacity limitations, the program was gradually rolled out to villages/*kebeles*. Within each village, farmers were informed about land demarcation and the advantages of holding a land certificate. A land administration committee (LAC) was formed, and then farmers were invited to apply for their holdings to be demarcated.[3] Once a land user has applied for a certificate over a piece of land and this claim has been verified by the LAC in the kebele, a temporary certificate is issued. This temporary certificate can be seen as a claim to a piece of land, and it is valid until another land user contests it.

The parcels with temporary certificates are publicly debated for one month in order to verify that the neighbors will not claim the land registered. In case of agreement and after corrections when necessary, the results of the public hearing allow for the issuance of a green book for each household registered.[4] The green book or primary

[2]The ultimate objective of SARDP, funded since 1993 by SIDA, is to contribute to the poverty reduction effort in Amhara by improving the food security condition of the rural population in 30 *woredas* of East Gojjam and South Wollo zones.

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

[4]Also known as the book of holding and named after its green color, the green book is a tool introduced by the land administration authorities as a legal recognition and acceptance that those named

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. The primary certificates also summarize the landholders' rights and obligations according to the law.

With the issuance of the primary certificates, the households can already enjoy some basic rights and obligations. However, 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.

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

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

Source: Authors.

Overall, in December 2009, the SARDP 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, the actual issuance of certificates might have started later. Table 2 show responses to a number of questions on the perceived usefulness of the certificates. The results indicate that people express a belief that the program should reduce conflicts, makes it easier for children to inherit the land, and increase the likelihood of compensation if the land is taken away. The fact that few people believe that having a certificate will encourage migration indicates that respondents do not automatically affirm to questions.

within are the rightful users of the land described in the book. It serves as land certificate.

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.

2.2 Education in Ethiopia and the study area

Primary school enrollment increased tremendously in Ethiopia during the time period of our study, albeit from a very low level. In the early 1990s Ethiopia had the lowest primary school enrollment rate in the world. Literacy and years of schooling are very low for adults in our data: the literacy rate for household heads is 42% and that of spouses 18%. The number of students in primary education has risen from 3.8 million in 1994/95 to 14 million in 2005/06 and 16.9 million in 2011/12 (Ministry of Finance and Economic Development and United nations Country Team Ethiopia, 2012). The

change started with the 1994 Education Reform, followed by, so far, four Education Sector Development Programs. Since then school fees have been abolished, decision-making has been decentralized and community involvement in schools has been encouraged, many new schools have been built – between 2000 and 2004 the number of primary schools increased by about 50%, the largest increase taking place in rural areas – and the government budget share for education has increased from 13.8% in 2000/01 to 19% in 2004/05. Donors have also contributed financial resources to construction of schools. As a result, enrollment rates have steadily increased at all stages of education; the primary school gross enrollment rate (GER) rose from 34.0 in 1994/95 to 91.3 in 2005/2006, and 94.25 in 2011/12.[5] Net enrollment (NET) rose from 36.0 in 1999/2000 to 77.5 in 2006/07, and 85.4% in 2011/12. enrollment has increased the most for the first years of basic education (Grade1-4), and somewhat less for the later years of primary education (Grade 5-8). Furthermore, though enrollment is still higher for boys than for girls, the gender gap has been narrowed; the gender parity index decreased from 0.6 in 1997/98 to 0.84 in 2005/2006, and 0.93 in 2011/12.[6]

SARDP included construction of primary schools in some *kebeles*. Between 2004 and 2010 the number of primary schools in East Gojjam and South Wollo increased from 743 to 1180. SARDP contributed to the construction of 241 out of the 437 new schools that were built. This might raise concern that school construction was correlated with the expansion of the land certification program. However, the process which sometimes resulted in construction of primary schools was completely separate from the expansion of the land certification program. SARDP contributed to the construction of primary schools as part of its aim to improve infrastructure. Funds were allocated to local areas and the community decided which investments where most needed. The local community also had to contribute 25% of the cost, usually in the form of labor or

[5]The rate of the number of pupils enrolled in primary school to the number of people in primary school age.

[6]However, in spite of large-scale construction of schools and hiring and training of teachers, number of teachers and classrooms have not increased at speed with number of pupils, thus increasing pupils per teacher and classroom and raising concerns about reduced quality of teaching (Ministry of Finance and Economic Development and United nations Country Team Ethiopia, 2012; Oumer, 2009; World Bank, 2005). In recent years, however, both pupils per teacher and per classroom have started to decline again (Ministry of Finance and Economic Development and United nations Country Team Ethiopia, 2012).

materials. Funds were allocated, and the local process of identifying the best use initiated, simultaneously at all places (SARDP, 2010). Hence, where SIDA has financed construction of schools, this process has been completely separate from the roll out of the land certification program.

Though education is steadily improving in rural areas, so far, returns to education for people who remain in the rural areas of Ethiopia appear to be small. Bigsten et al. (2003) show that primary education is more important in improving welfare in urban than in rural areas. Similarly, a World Bank report found that having more than a couple of years of education yield high returns in cities but not in rural areas (World Bank, 2005). Weir and Knight (2004) show that better educated rural households adopt fertilizers sooner, but that less educated households imitate.

3 Theoretical foundations

3.1 On land inheritance

According to Headey et al. (2014), in order to inherit land it is required that inheritors should be family, regional residents, willing to engage in agriculture, and that 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. Generally farm size is 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, e.g. different agro-climatic zones, lack of infrastructure, in more disease prone areas (malaria, tse-tse).

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

3.2 On the theoretical model

A simple model of the household decision to allocate children's time to schooling and/or work is presented in Appendix I. In our model, we assume for simplicity that land certification works in one of two ways: by increasing the probability that the oldest son is able to inherit user rights for the family land, and thus remain on the farm as an adult, or by reducing the cost of defending property rights.

The first assumption is supported by the discussion of inheritance above, and the fact that an overwhelming majority of survey respondents express the belief that land certification will make inheritance easier, as seen in Section 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. 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 (Verwimp, 1999), and by evidence that households perceive that returns to schooling are highest for individuals employed in the formal sector (World Bank, 1998). 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. 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.

In the second case, we assume that the household allocates some of the child's time to protecting the household's claim to the land. While adult time might be more efficient in securing land rights in the short-run, the presences of children at the land could be crucial to secure the households' continued access to the land in the long run. The amount of time allocated to this activity depends on the strength of perceived property rights: when perceived property rights are weak, the household allocates more of the child's time to protective activities and vice versa. Therefore, the model predicts that land certification will allow for children to allocate their time away from protective activities towards productive activities, including schooling.

The model does not, however, 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. Importantly, we should not expect children to do either or, neither before or after the land certification program. 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). 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 International Labour Organization 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 (International Labour Organization, 2008). 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. Moreover, even if the amount of time the child devotes to schooling changes, child labor is not necessarily affected, and vice versa. In general the literature on the effects of child work on their schooling do find negative impacts of child work on school attendance, grade progress and continuation, but the substitution is far from one-to-one and there are many who combine school and work without a significant negative impact on schooling outcomes (de Hoop and Rosati, 2014; Dumas, 2012; Khanam, 2008; Lancaster and Ray, 2004; Ravallion and Wodon, 2000; Ridao-Cano, 2001).

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, which is at the end of the Ethiopian school year, starting in September and ending 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, 2006).

The original twelve *kebeles* in the sample were chosen randomly, 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). While all 14 *kebeles* are used in the school outcome analysis, only the original 12 *kebeles* can be used in the child labor analysis. 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.

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

Pattern	Freq.	Percent	Cum.
1111	6,684	75.79	75.79
1000	10	0.11	75.90
1100	19	0.22	76.12
1110	49	0.56	76.68
0111	583	6.61	83.29
0110	8	0.09	83.38
0011	966	10.95	94.33
0001	500	5.67	100.00
Total	8,819	100.00	

"1111" identifies household members that were present at the four rounds of the panel. Likewise, "1110" identifies individuals that were not surveyed in 2007 but were successfully surveyed in 2002 and 2005.

Most of the information on children's education was collected in the fourth round,

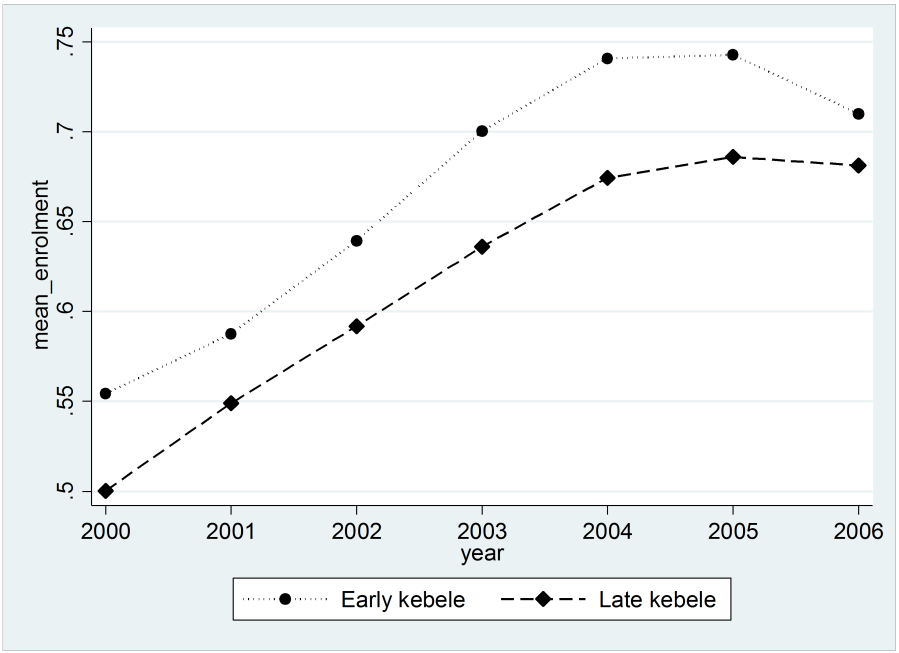
where respondents were asked about the schooling history of all household members age 6 to 24. This data was used to create an annual panel on school enrollment and annual grade progress. The school enrollment dummy is 1 if the child is enrolled during a particular school year and 0 otherwise. Grade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

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 seems 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.

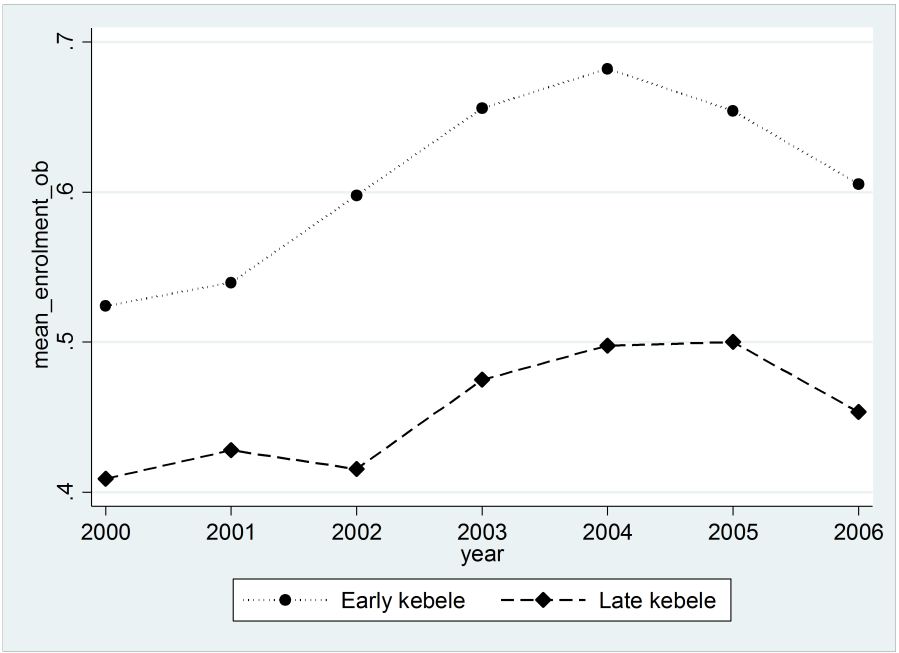
Child labor is measured at the plot level and aggregated at the household level. It represents the number of person-days worked by individuals less than 15 years old in any activity (pre-planting, planting, weeding, harvesting and threshing). It combines the number of mobilized children and the number of worked days. However, since the number of person-days worked pools all children of the 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. 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.

Figures 1a and 1b show annual school enrollment rates combining all years, for all children age 6-16 and for oldest sons age 6-16, respectively. The reason to show oldest sons separately is that they are the ones most likely to take over the land, and that their schooling might therefore respond differently. The figures show rates for children liv-

Figure 1: Average enrollment over time for children age 6-16



(a) All children



(b) Oldest brothers

Source: Author's illustration.

ing in *kebeles* where the land certification program arrived early – i.e. before the school year starting in 2004 or, alternatively, before the agricultural season preceding third round data collection – and *kebeles* where it arrived later. Enrollment rates increased until 2004, after which they seem to have stabilized. enrollment rates are higher in the

kebeles where the program arrived early, probably reflecting the fact that the program tends to have reached more urban locations earlier. The trend, however, is extremely similar in early and late *kebeles*. enrollment rates are lower for oldest brothers, with a larger difference between late and early *kebeles*. The trend is, again, very similar in early and late *kebeles*. Lower enrollment rates among oldest brothers could be explained by their perceived future more often being on the field.[7]. The larger difference in enrollment rates between oldest sons and other boys in late *kebeles* could then be explained by these places being more rural.

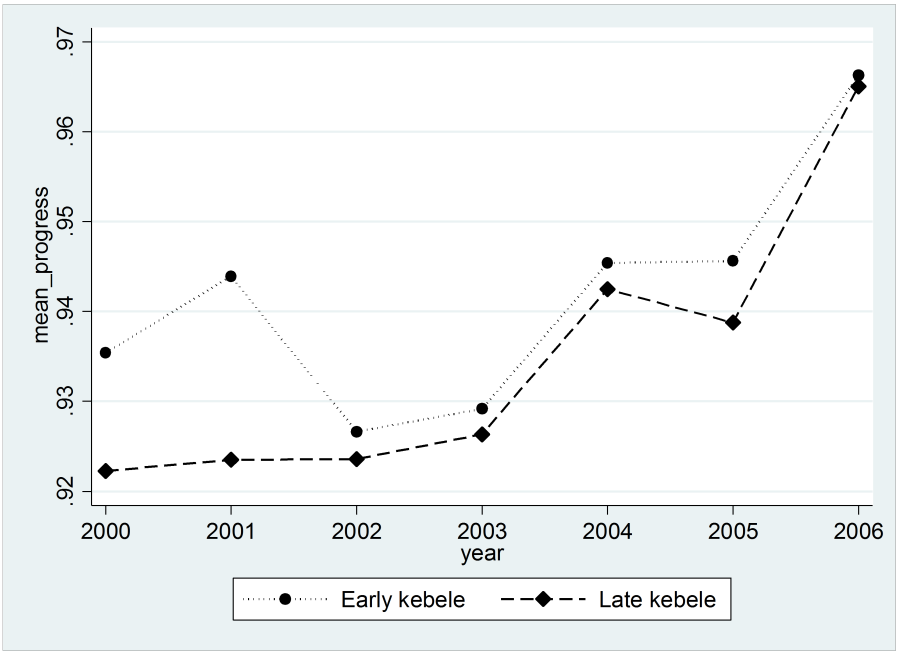
Figures 2a and 2b show the mean annual grade progress for all children who are enrolled and for oldest sons who are enrolled in school, respectively, depending on year of arrival of the land certification program. There does not appear to be any systematic trend difference between the *kebeles* who received the program earlier and those who received it later. For all children grade progress rates appear to have improved slightly over the years, while it is hard to detect any trend at all for oldest brothers.

5 Empirical strategy

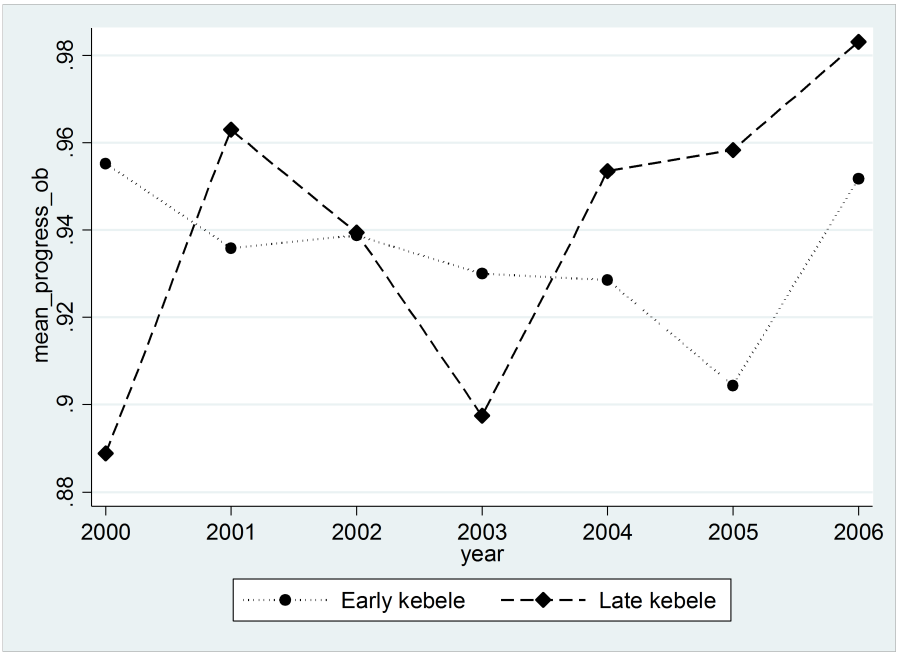
The roll out of the certification program proceeded from one *kebele* to the next, generally starting in the more urban and accessible *kebeles* and moving toward the more remote ones. Conditional on time-constant urbanity and accessibility, we, therefore, argue that the timing of the arrival of the 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 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 believe this to be a reasonable assumption since the land certifi-

[7]Older siblings might also receive less education because the families are on average poorer when they are school-age, or because their work is needed to support the families (Chesnokova and Vaithianathan, 2008). However, enrollment among older sisters is not lower than among younger sisters, speaking against this explanation. Another potential reason could be that older siblings have more often dropped out of school since they are on average older. However, delayed school entry at ages above 6 or 7 is more common than drop-outs before age 16 in the study area (see Lindskog, 2013).

Figure 2: Average grade progress over time for enrolled children age 6-16



(a) All children



(b) Oldest brothers

Source: Author's illustration.

cation 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. Since the program proceeds from *kebele* to kebele, it is likely to have arrived earlier to some neighboring kebele, so that some might have anticipated the

program even before its arrival. This would make it more difficult to estimate the impact of the program, and our estimates can therefore be seen as a lower bound to the true effects.

We use household fixed effects to control for time-constant differences between households and 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

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

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.[8] 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. Since primary schooling has expanded dramatically since 2000 we need to know that expansion of the land certification program do not follow the same pattern as the expansion of primary schools. In addition to financing of the land certification program, SIDA has financed construction of schools. However, as mentioned in Section 2, this process 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*,

[8]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.

school construction was the outcome of decisions within the community. Infrastructure funds were simultaneously allocated to all *kebeles*, who themselves identified local infrastructure needs (SARDP, 2010). As previously seen in Figure 1a, there was a steady improvement in school enrollment until 2004, with no difference between *kebeles* receiving the land certification program early and those receiving it later. And as seen in Figure 2a, grade progress trends were also similar across *kebeles*. The robustness section includes a placebo test where we pretend that the expansion of the land certification program began already in 2000, and followed its actual pattern.

Our treatment is at *kebele* level and we have data from only 14 *kebeles*, which is too little for inference based on conventional clustered standard errors. Like other "sandwich type" standard errors, 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).

Our main strategy for correct inference is the simple procedure described in Brewer et al. (2013): the cluster robust variance estimator is used on rescaled residuals, and the t-distribution with G-1 degrees of freedoms is used for inference, where G is the number of clusters. An important advantage of the procedure is that it is used in *Stata* when invoking the vce(cluster) option after regress (but not after other estimation commands). To estimate a within-household model with the regress command in *Stata*, we transform the data into deviations from household means. According to the results in 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. The one situation where it does not work well is if the number of treated groups differs substantially from the number of control groups.

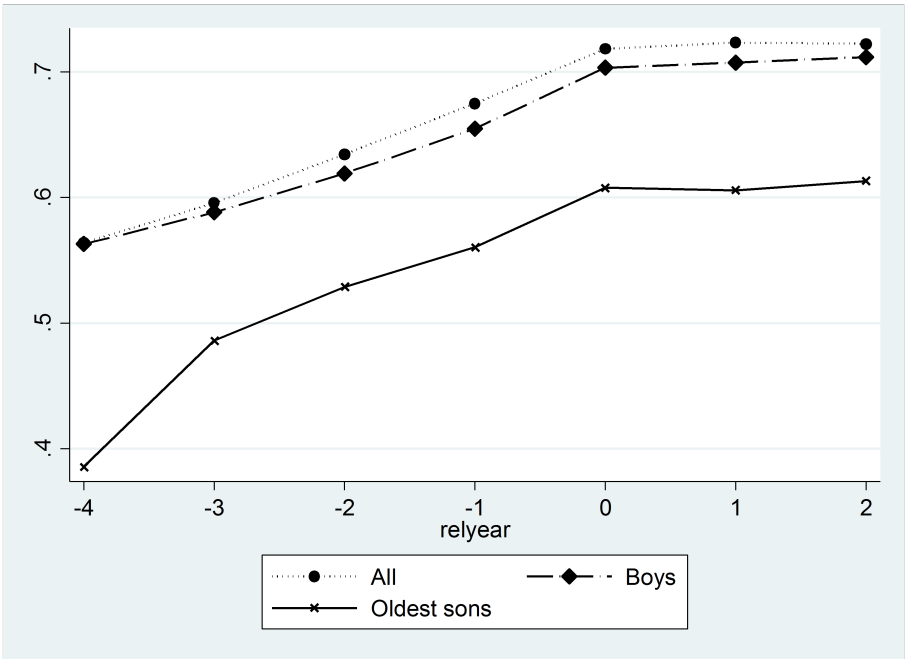
In an influential paper Cameron et al. (2008) suggest the wild cluster bootstrap t procedure, in which resampling is done over cluster weighted residuals. Usually a two-point weight distribution is used, where the so called Rademacher weights [-1,1] have been shown to have good properties (Davidson and Flachaire, 2008). In the analy-

sis of Brewer et al. (2013), the wild cluster bootstrap t procedure performs as well as their simpler procedure in most cases, and it outperforms their simpler procedure if the number of treated groups differs substantially from the number of control groups. With very few clusters, i.e. less than 11, a problem is that only a limited number of possible combinations of clusters can be sampled. Mac Kinnon and Webb (2014) 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. MacKinnon and Webb (2015) 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. As a robustness check we estimate wild cluster bootstrap t p-values, using both Rademacher weights and the six-point weight distribution suggested by MacKinnon and Webb (2015).

Both with the wild cluster bootstrap t procedure and the simpler procedure suggested by Brewer et al. (2013) true effects have to be sizeable for a reasonable probability to detect them, i.e. though the risk of Type I errors are small, the risk of Type II errors are large if the true effect is of limited magnitude.

Figures 3 and 4 below display a first indication of the relationship between the arrival of the land certification program and children's school enrollment and grade progress. However, we do not yet control for year, age and household effects. Time has been defined in relation to the introduction of the land certification program, and set to 0 the year in which the program came to the *kebele*. There is one line for all eligible children (age 6-16 for enrollment, and enrolled children for grade progress), one for boys, and one for oldest sons. The increasing enrollment trend seems to stop after the arrival of the land certification program. For oldest brothers there appears to be a reduction in grade progress starting already the year before the arrival of the program. Plausible reasons for an effect preceding the arrival of the program to the *kebele* is that the program might partially have affected schooling in the previous year (since the program arrived before the start of the school year in question, the exact timing of arrival is during the previous school year or during the summer break), or that people

Figure 3: Enrollment of children age 6-16 in relation to the time of the arrival of the land certification program



Note: Time equals zero the first school year starting after the land certification program arrived to the *kebele*.

Source: Author's illustration.

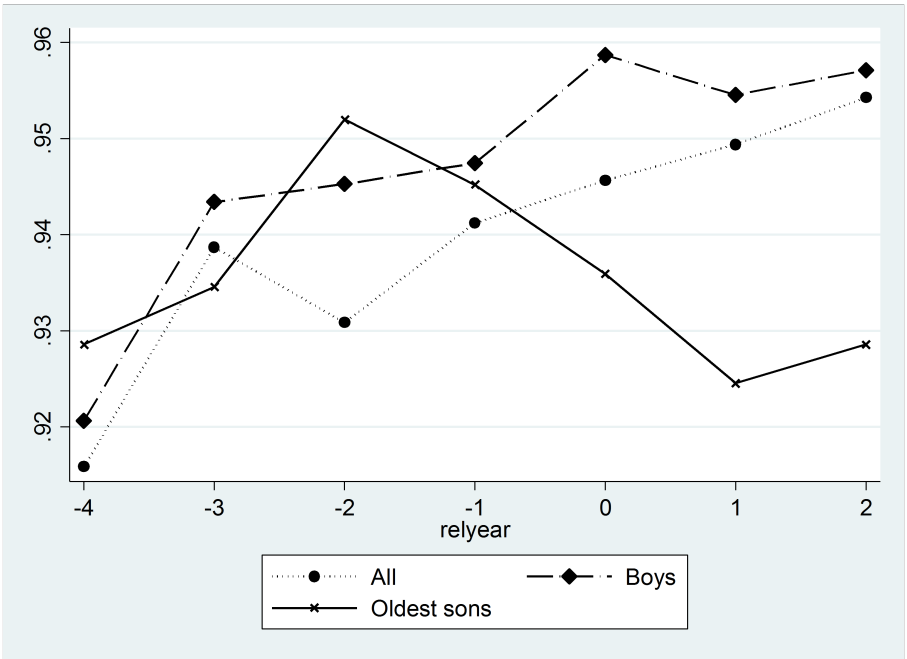
foresaw the arrival of the program since it had reached neighboring *kebeles*.

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*.

Contrary to the impression from Figure 5, land certification appears to have increased school enrollment. For boys in the combined and East Gojjam samples, the land certification program coefficient is statistically significant at the 5% level. The impact on oldest sons is not statistically significant from the main effect. For boys in South Wollo the main effect of land certification is not statically significant, but the oldest son interaction is so at the 5% level. When the land certification has arrived in the *kebele*, boys in East Gojjam are 6.3 percentage points more likely to be enrolled in school and oldest

Figure 4: Grade progress of children age 6-16 who are enrolled in school in relation to the time of the arrival of the land certification program



Note: Time equals zero the first school year starting after the land certification program arrived to the *kebele*.

Source: Author's illustration.

sons in South Wollo are 7.2 percentage points more likely to be enrolled. In general oldest sons appear to be disadvantaged with regard to school enrollment.[9] For girls, the land certification program coefficient is statistically significant in all samples, at the 1% level in the combined and East Gojjam samples, and at the 5% level in South Wollo. After the arrival of the land certification program girls in East Gojjam are 5.4 percentage points more likely to be enrolled in school, and girls in South Wollo are 3.6 percentage points more likely to be so. There is no difference between oldest daughters and other girls.

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 East Gojjam and South Wollo, and at the 1% level in the combined sample. In East Gojjam oldest sons are 6.3 percentage

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

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	0.042**	0.064**	0.018
	(0.015)	(0.020)	(0.022)
× *Oldest son*	0.017	-0.029	0.072**
	(0.025)	(0.025)	(0.030)
Oldest son	-0.094***	-0.116**	-0.072
	(0.027)	(0.039)	(0.038)
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	0.040***	0.055***	0.036**
	(0.008)	(0.006)	(0.014)
× *Oldest daughter*	0.022	-0.028	0.064
	(0.025)	(0.029)	(0.034)
Oldest daughter	-0.029	0.011	-0.062*
	(0.023)	(0.031)	(0.032)
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.

points less likely to make progress, i.e. they are more likely to repeat a grade. In South Wollo the effect is smaller, at 2.3 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. Oldest daughters, as other girls, do not seem to be affected, except possibly in East Gojjam where the coefficient of the interaction term is significant at the 10% level.

While oldest sons where disadvantaged in terms of school enrollment, overall the grade progress of those who are enrolled seems to be higher than for other boys.

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	0.006	0.029	-0.010
	(0.013)	(0.017)	(0.015)
× *Oldest son*	-0.041***	-0.064***	-0.023**
	(0.013)	(0.017)	(0.008)
Oldest son	0.031**	0.025*	0.036**
	(0.011)	(0.012)	(0.014)
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	-0.002
	(0.013)	(0.022)	(0.019)
× *Oldest daughter*	0.008	-0.021*	0.025
	(0.020)	(0.011)	(0.029)
Oldest daughter	-0.016	0.011	-0.029
	(0.016)	(0.009)	(0.020)
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.

7 Labor results

In Tables 6 and 7 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.[10] The land certification program had arrived to half of the *kebeles* before the agricultural season reported in the 2004 survey, 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 villages where the program arrived earlier as in villages where it

[10]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.

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 villages by then. The Tables report the mean of the activity in the absence of the land certification program, in addition to estimated changes due to the program.

Table 6: 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.

Table 6 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 from one region to another. In East Gojjam, labor supply by boys and girls decreased: child labor by hectare decreased on average by 2 persons-days for boys and by 1 person-days 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, especially 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.[11]

These changes 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 working anyway (the intensive margin). To disentangle those mechanisms, we estimated the marginal effect on children's participation in agricultural activities. This is a dummy variable equal to 1 when the household made their children work – 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 7.

Table 7: 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.

We find no indication that the land certification program has changed the proportion

[11] However, our estimate for labor supply by female children failed the placebo test. This implies that the treatment effect of female labor supply is not well identified and should be interpreted with caution.

of households that made their children work. This suggests that the increase in child labor observed in South Wollo and the decrease observed in East Gojjam are mostly driven by an increase of time allocated to farming activities by male children.

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 8). 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.

8.2 Placebo tests

There are no signs of differential pre-treatment trends in school enrollment or grade progress between *kebeles* who got the land certification early versus late in Figures 5 and 6. In Table 9 we present the results of a placebo test. We use the 2000 to 2003 data and pretend that the expansion of the land certification program began in 2000, and followed its actual pattern. To save space we do not report coefficients of the age- and year dummies and the constant. In line with the suggestive evidence in Figures 3 and 4, there are no statistically significant effects of the placebo program.

Table 8: *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.

8.3 Controlling for weather shocks

Still, 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 hit all of East Gojjam or all of South Wollo. In Table 10 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 2003, 2004 and 2006. 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.

Table 9: 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 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 is by nature heteroscedastic, and the linearity assumption is likely to be invalid and lead to predicted probabilities below 0 or above 1. Furthermore, 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. Nevertheless, we can compute predicted probabilities, and these are almost

Table 10: 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	0.043**	0.064**	0.019	0.007	0.029	-0.009
	(0.016)	(0.020)	(0.024)	(0.014)	(0.017)	(0.017)
× *Oldest son*	0.018	-0.033	0.077**	-0.045***	-0.070***	-0.023**
	(0.026)	(0.026)	(0.029)	(0.014)	(0.014)	(0.007)
Oldest son	-0.098***	-0.123**	-0.075	0.032**	0.025*	0.037**
	(0.028)	(0.039)	(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)	(0.012)	(0.015)	(0.015)
Observations	11,760	5,817	5,943	3,930	1,742	2,188
Panel B: Girls						
Land certification	0.041***	0.055***	0.037**	-0.001	-0.000	-0.000
	(0.009)	(0.006)	(0.014)	(0.013)	(0.022)	(0.019)
× *Oldest daughter*	0.019	-0.039	0.065*	0.012	-0.012	0.027
	(0.026)	(0.034)	(0.032)	(0.021)	(0.012)	(0.031)
Oldest daughter	-0.029	0.014	-0.062*	-0.020	0.006	-0.030
	(0.025)	(0.036)	(0.031)	(0.016)	(0.010)	(0.020)
Shock	-0.003	-0.020	0.016	-0.003	0.023	-0.016
	(0.013)	(0.023)	(0.013)	(0.011)	(0.020)	(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.

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 remains 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 11. The general picture is the same as in the main results.

Table 11: 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	1.315**	1.608***	0.992	1.097	1.700	0.766
	(0.171)	(0.223)	(0.199)	(0.513)	(1.245)	(0.463)
× *Oldest son*	1.282	0.914	2.267**	0.313***	0.307*	0.398*
	(0.314)	(0.226)	(0.782)	(0.119)	(0.218)	(0.199)
Oldest son	0.318***	0.239***	0.392**	1.690	1.536	1.844
	(0.086)	(0.076)	(0.169)	(0.838)	(0.983)	(1.538)
Observations	8,535	4,362	4,173	902	449	453
Panel B: Girls						
Land certification	1.526***	1.420***	1.702***	0.821	1.064	0.609
	(0.178)	(0.135)	(0.332)	(0.311)	(0.630)	(0.357)
× *Oldest daughter*	1.158	0.863	1.768	1.323	0.758	1.792
	(0.320)	(0.266)	(0.866)	(0.691)	(0.285)	(1.437)
Oldest daughter	0.646*	0.716	0.598	0.540	0.912	0.473
	(0.086)	(0.076)	(0.169)	(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.

8.5 Excluding boys with shifts in oldest son status

In Table 12 we have excluded boys who are not consistently coded as either being or not being oldest son, i.e. their status shifts between rounds. 77.31% of boys have a consistent status. 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. 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.

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

Table 12: 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	0.033**	0.043**	0.018	0.010	0.032	-0.005
	(0.014)	(0.017)	(0.022)	(0.013)	(0.021)	(0.012)
× *Oldest son*	0.001	-0.040	0.051	-0.040**	-0.064**	-0.020
	(0.025)	(0.026)	(0.028)	(0.015)	(0.020)	(0.015)
Oldest son	-0.114***	-0.160***	-0.069	0.031**	0.025	0.036*
	(0.033)	(0.039)	(0.046)	(0.013)	(0.013)	(0.018)
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.

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 of the program may differ in this setting. Land certification could affect children's activities through a range of mechanisms. 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. Conversely, if child labor is used to secure the household's claim to the land, then a strengthening of user rights may free some of children's time to pursue other activities, such as schooling. Further, since certification means that children are not required to be present on the field in order to secure the household's continued access to the land, land certification facilitates migration on the part of the children. This in turn may 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 very different agro-climatic conditions: East Gojjam and South Wollo. East Gojjam is characterized by fertile land, while South Wollo is prone to regular drought, and has therefore been subject to forced as well as voluntary resettlement programs. We argue that these differences are likely to make farming somewhat less attractive and inhabitants' perceived land rights less

secure in South Wollo.

On the whole we find that land certification has a positive impact on children, also in our rural context. Overall school enrollment increases as a response to the land certification program. However, in East Gojjam the results suggest a similar effect for oldest sons and other boys, while in South Wollo increased enrollment applies in particular to the oldest son. We believe 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 might to a larger extent have felt obliged to keep their oldest son on the land to secure continued access to the land, 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. In East Gojjam where land is more productive, on the other hand, staying on the land might be perceived as the most profitable option for the oldest son, and therefore there is no particular effect of the program on school enrollment for these children.

Though school enrollment seems to increase as a response to the land certification program, school progress is generally unaffected except in the case of oldest sons', whose school progress seems to worsen. In East Gojjam 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.

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 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 who are not oldest sons. The increase in child labor in South Wollo does not appear to negatively affect their 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. Child labor was initially lower in East Gojjam than in South Wollo; which may possibly be related to the differences in agro-climatic conditions and land right history. 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. In the meantime it is reassuring that rural land certification also appears to be mostly beneficial for children.

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I Appendix: 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 where it is assumed that each household contains 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 has become an adult and may or may not continue to live in the family household, but for simplicity it is assumed that their income and consumption remain part of the household total. 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:

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

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.