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Abstract

We estimate the effects of changes in cotton adoption on children's schooling and child labor in rural Burkina Faso. Cotton adoption increases household's income, leading to increased demand for schooling and reduced child labor. On the other hand, because children are productive on cotton farms, cotton adoption increases the opportunity cost of child time and the demand for child labor. Using time and spatial variation, we find evidence of a strong effect on school enrollment and child labor for girls but no detectable effect on boys. We provide suggestive evidence showing that boys are more productive than girls on cotton farms. Therefore, the income effect from cotton adoption was larger than the wage effect for girls, hence the positive effect on enrollment.

1 Introduction

Low levels of human capital, particularly those of education, health and nutrition, have direct welfare implications. In addition, inequality in human capital outcomes, apart from being of interest per se, has both direct and indirect impacts on income inequality. Education is crucial in augmenting individual earnings and improving the prospects of economic growth in general. Thus, a better understanding of how poor households make decisions about educating their children can provide useful insights into how poverty can be effectively addressed. Furthermore, to answer operational questions regarding the design of appropriate education policies, micro-level household responses to changes in the economic environment need to be well understood.

In addition to low education levels, gender inequality in educational attainment is a pressing issue. Over the past three decades, girls' education has received increasing attention in the developing world, primarily because of the relationship between female education and child health and nutrition at the micro level as well as the overall impact on economic growth (e.g., Klasen, 2002). This makes investing more in girls' education even more crucial in environments where the initial gender disparity in education is relatively large (Schultz, 2002).

Recently, efforts to increase enrollment and reduce the gender gap have taken different forms. Demand side interventions include school feeding and cash transfers among others. For example, school feeding programs have been designed to attract more girls to school. Kazianga et al. (2013) reports such interventions in Burkina Faso, where girls receive a ration of food to take home. Similarly, conditional cash transfers can also be designed to provide higher incentives to increase the enrollment of girls (e.g., Akresh et al., 2013; Baird et al., 2011; Paul Schultz, 2004). Supply side interventions include the construction of "girl–

friendly" schools, where the school overall environment is made more appealing to girls. Examples of these types of interventions include the National Policy for Education of Girls at the Elementary Level in India (e.g. Meller et al., 2014; Wu et al., 2007) and the "girl-friendly" schools in Burkina Faso (Kazianga et al., 2013). This paper contributes to this strand of literature by examining the effects of a large-scale agricultural policy reform on girls' education in rural Burkina Faso.

Historically, production technology has been a key determinant of how households allocate child time between labor and education. In particular, for farming households, agricultural technology has been shown to influence education and child labor. Rosenzweig and Evenson (1977) found that the Green Revolution in India led to a reduction in child labor and an increase in school attendance. These initial findings have been supported by subsequent research (e.g., Foster and Rosenzweig, 1996, 2004). Because both agricultural technology and education play a central role in many development policies, understanding how they interact can provide useful insights into how resource-constrained households make decisions regarding educating their children, particularly in the context of a rapidly changing agricultural landscape.

Broadly speaking, poverty has been the main cause of child labor in predominantly agrarian economies, which are also characterized by limited access to quality education and adult labor, inadequate agricultural technology, high hazards and risks, and traditional attitudes toward children's participation in agricultural activities. In the context of family farming and livestock husbandry, the participation of children in non-hazardous activities can positively contribute to the inter-generational transfer of skills and children's food security.

We investigate the extent to which crop choice—in the form of cotton adoption—affects education outcomes at the household level in rural Burkina Faso. We use micro data from

Burkina Faso to ask whether and to what extent differences in the evolution of school enrollment and child labor across regions can be ascribed to changes in cotton adoption. The main contribution of this paper is to document an agricultural policy with an unusually (and unintended) large effect on girls' enrollment in school in rural Burkina Faso. It exploits a unique feature of the policy reform (which varied across space and time) to credibly identify the effects of cotton adoption on school participation.

Cotton is by far the major cash crop in Burkina Faso, and the adoption of cotton is presumed to have a substantial impact on household income. Farmers who adopt cotton are more likely to enjoy a substantial income increase, which in turn should lead to an increased demand for education and a reduced demand for family child (Basu and Van, 1998; Behrman and Knowles, 1999; Edmonds, 2005). These households, however, also face increased opportunity costs for child time because child labor is more productive in the farming of cotton than other crops (Collins and Margo, 2006; Levy, 1985).

The paper is related to a strand of literature that documents the interaction between agricultural technology and crop choice on the one hand, and education and child labor on the other. In India, enrollment rates in primary school increased in areas that experienced a larger increase in agricultural yields during the Green Revolution (Foster and Rosenzweig, 1996). More specifically, the increase in enrollment was attributed to increased returns to primary education, following the introduction of new high yielding crop varieties. The overall result, however, suggested a pro-male bias: on average, investments in education were significantly larger for boys than for girls (Boserup, 1990).

For the specific case of cash crops and cotton, Levy (1985) reports that children are better suited for cotton weeding and picking than tasks related to cultivating other crops, and child labor does not have a good enough substitute in cotton-related activities. As a

result, in Egypt, the shift in cropping pattern away from cotton played a role in curbing child labor. Along the same lines, Collins and Margo (2006) argues that the emphasis on cotton in nineteenth-century southern USA partially explains the education gap between Blacks and Whites, given that child labor was more productive in the cotton fields in the South, rendering it less likely for children to attend school[1]. Dammert (2008) found that, in Peru, children living in regions where coca engaged more in market work after coca production shifted to Columbia. Schooling outcomes, however, were not affected by the increase in working hours.

We find that the cotton policy reform increased girls' participation in school and reduced girls' participation in farm labor in the new cotton region relative to the non-cotton region. Using our preferred specifications, girls enrollment rate increased by 3.9 percentage points and number of years of education completed increased by 0.15 years. These point estimates imply a change of 32 percent in enrollment and 40 percent in years of education completed compared to the baseline outcomes in the comparison group (the non-cotton region). Girls participation in farm labor decreased by 0.22 percentage points. Our findings hold for alternative specifications and for a number of robustness checks. Hence the changes in education and child labor that we detect are unlikely due to other factors than the cotton policy reform.

2 The policy reform: cotton expansion

Cotton is one of the main economic resources of Burkina Faso and the main source of foreign exchange, accounting for 50 to 60 percent of exports. The country's share of world cotton

[1]There is some anecdotal evidence in the news that links cotton farming to child labor, http://www.businessweek.com/news/2012-01-23/child-labor-for-victoria-s-secret-cotton-examined-by-u-s-.html

exports has tripled since the mid 1990's. Cotton provides about 700,000 jobs – mainly for members of farmers' households – or about 17 percent of the population.

Cotton has been commercially grown in Burkina Faso since the 1920s (e.g., Hauchart, 2010)[2], and was a mandatory crop intended for export. The colonial administration imposed about 4 ha for 100 inhabitants. This policy intensified cotton production until the 1929 famine, which led the then Upper Volta to a food shortage. As a result, cotton farming was given up. Cotton farming was eventually revived owing to the establishment of the French Company for Textile Development (CFDT) in 1949. CFDT distributed inputs and supervised producers, and played a central role in the improvement of farming techniques (e.g., Schwartz, 1993). CFDT was replaced by a new parastatal organization named SOFITEX (Société des Fibres Textiles) in 1979. SOFITEX was a joint venture between the government and CFDT, hence the basic state-led model remained unchanged (Kaminski et al., 2011).

SOFITEX operated as a monopoly in the cotton sector until the mid-1990's, and was the only agency in charge of input distribution, output marketing and extension services in the sector. The relationship between SOFITEX and cotton producers was akin to contract farming whereby SOFITEX provided services farmers (e.g., improved seeds, farmer education, fertilizers, loans, and marketing services) to farmers against the exclusive rights to purchase cotton output. SOFITEX also managed to introduce new production techniques and high yield varieties.

The policy reform we focus on was implemented in two stages in the 1990's. The first stage targeted a farmers' organizations that undermined cotton production and lowered credit repayment rates. To improve farmers' social capital and production incentives, a new legislation was passed to allow the formation of farmer organizations based on voluntary

[2]Note that there are numerous varieties of cotton grains in Africa, some of which are indigenous and have been traced back to the tenth and thirteenth centuries (Gardi, 2003).

participation as opposed to farmer groups that are determined by residency in a given village. This reform affected only the region that was already farming cotton.

The second stage of the reform coincided with the devaluation of the local currency (CFA Franc) in late 1994. New cotton companies were allowed to provide the same services as SOFITEX, but in different regions of the country, namely in the central and eastern provinces. We refer to this region as the new-cotton region. The stated objective was to extend cotton farming to new areas to reach a target of 300,000 tons. This paper is primarily concerned with the second stage of the reform, that is, the effect of cotton expansion on regions that did not grow cotton before the policy reform[3].

From an agronomic perspective, cotton cultivation needs long frost-free periods and moderate annual rainfall of about 700–1300 millimeters (e.g., Krishna, 2014). In drier regions, precipitation of about 650 millimeters might support production in addition to irrigation techniques (e.g., Krishna, 2014). Cotton farming in Burkina Faso is essentially rain fed and there is no evidence of irrigated cotton farms. Figure 1 provides a summary of rainfall distribution in Burkina Faso. From the figure, it is apparent that all the southern and southwestern regions and parts of the central, southeastern and eastern regions are suited for cotton farming. In contrast, the northern region, with less than 600 millimeter of annual rainfall, was never suited for cotton farming.

Prior to the policy reform the only cotton company was based in Bobo-Dioulasso (in the southern region). Prices and transportation costs at the time implied that it was not economically viable to expand into the central and eastern regions. As a result, cotton

[3]There are two main reasons why we do not focus on the old cotton region. First, it is because producers shifted away from cotton in the late 1980's and the early 1990's (Kaminski and Serra, 2011), it is plausible that cotton expansion observed in this region is driven by these farmers shifting back to cotton. Second, it is not clear whether it is the first stage of the reform or the second stage that would be driving cotton expansion in the old cotton region.

cultivation were mainly limited to the southern and the southwestern regions. After 1994, new cotton companies were established in the central and eastern regions, and hence made the commercial farming of cotton a viable economic activity for residents. This paper focuses on the expansion of cotton farming in the central and eastern and southeastern regions where cotton was not commercially farmed before the second stage of the policy reform.

3 Survey and Descriptive Statistics

The paper uses data from three rounds of the national priority surveys conducted in 1994, 1998, and 2003. The three surveys are similar in the scope of information collected, sampling design, and coverage. The surveys are closely related to the World Bank LSMS (e.g., Grosh and Glewwe, 2000) and possess national representativeness. All three surveys use a two-stage stratified random sampling. The analysis focuses on rural households while the sub-sample of urban households is used for robustness checks.

The surveys collected information on household and individual characteristics, employment status, expenditures and income. Information on school enrollment status and participation in various activities was collected for every school age child, i.e. aged between 6 and 15. Table 1A summarizes the data for the 1994 survey round, and Table 1B summarizes the combined data of 1998 and 2003 survey rounds. We report the rural sub-sample average at the child and household level for old cotton provinces (column 1), new cotton provinces (column 2) and non cotton provinces (column 3). We also present the mean difference test of the two first regions relative to the non cotton region (column 4 and 5).

At baseline (i.e. 1994), child education levels are very low with sizeable differences between boys and girls. Across the three regions, child total enrollment was around 18

percent and 26 percent, while the number of years of education completed was between 0.63 and 0.94 year, that is among school age children (7 to 15 years old), less than a quarter were registered in school at the time of the survey and they completed less than one year of education on average. In the new cotton region, there were 24 percent boys attending school against 15 percent of girls. Boys in this region completed on average 0.86 years of education against 0.53 years for girls. Education levels were higher in the old cotton regions than in the non-cotton region. There were no significant differences, however, between the new cotton region and the non-cotton region.

The follow up descriptive statistics (the 1998 and 2003 surveys) are summarized in Table 1B. Enrollment rates and years of education completed increased across all three regions. The difference between boys and girls, however, decreased faster in the new cotton region than in the other regions. Specifically, the gender difference in the number of year of education was cut in half in the new cotton region, while it changed only slightly for the old and non-cotton provinces.

Child labor is roughly the same across the three regions. We do not observe any detectable difference both at baseline and at follow-up. In 1994, girls participated more in child work than boys in both the old cotton region (42.4 percent vs 40.4 percent) and the new cotton region (43.4 percent vs 41.7 percent). In the 1998 and 2008 surveys, the noticeable change is in the new cotton region where girls worked slightly less than boys (52 percent vs 53.6 percent). The same pattern is also observed in participation in farm labor, with girls participating slightly less than boys at follow up.

Central to our identification strategy (discussed in more details below) is the adoption of cotton. At baseline, about 22 percent of households reported farming cotton in the old cotton region and 2.4 percent of households reported farming cotton in the new cotton region. In

the non-cotton region, about 3 percent households farmed cotton. After the policy reform (1998-2003), the percentage of households farming cotton increased to 40.3 percent in the old cotton region and to 11.3 percent in the new cotton region. The percentage of households who reported farming cotton decreased slightly in the non-cotton region. Stated differently, between 1994 and 1998/2003, the share of households who reported farming cotton increased by 84 percent in the old cotton region and by 385 percent in the new cotton region, while it remained constant in the non-cotton region. Hence, even if in absolute terms there were more cotton farmers in the old cotton region, it is unambiguous that cotton adoption was increasing at a faster rate in the new cotton region. We seek to assess the effect of this rapid change on education and child labor.

Turning to the other crops, the statistics indicate that fewer households were growing millet in the old cotton region (67 percent) compared to the new cotton (86 percent) and non cotton region (87 percent). In the subsequent period, the number of household farming millet increased in the old cotton while it remained virtually the same in the new cotton region. The number of household farming sorghum remained almost the same over time across the three regions, without any notable difference at the baseline and follow up surveys. Overall, there was more adjustment in crop choice in the old cotton region than in the new cotton region, this makes it relatively easier to ascertain the effect of the policy reform in the new cotton region than in the old cotton region.

4 Identification Strategy

We use cotton expansion to identify the effects of cotton farming on school participation and child labor in the new cotton region. Cotton expansion into new region was decided

at the central government level, and therefore, was essentially given to local households. In particular, local decision makers were unable to initiate policies that would have induced the central government to expand cotton production in their areas. In practice, the National Cotton Board determined whether investing in the necessary physical and administrative infrastructure to start growing cotton in a region was a viable option, given the local agronomic and long-run rainfall conditions. We consider three regions: the southern and southwestern provinces that have always farmed cotton, the new cotton provinces that started growing cotton after 1995, and the rest of the country that did not grow cotton before or after 1995. For the remainder of this analysis, we focus on comparing the new cotton provinces with the non-cotton provinces. We also compare the old cotton provinces with the non-cotton provinces for robustness checks.

Figure 2 uses administrative data to illustrate the evolution of cotton production in a new cotton region and non-cotton region. It is apparent that cotton production surged in the new region after 1995, both in terms of quantity and acreage. By contrast, in the non-cotton region, cotton production remained unchanged. The identification strategy exploits these variations across time and space. Arguably, the policy reform induced some households, which would have not otherwise, to take up cotton farming. The crucial assumption is that the local population had no input in the decision to expand cotton, which was entirely up to the central government.

In Table 2, we use household-level data collected in 1994, 1998, and 2003 to confirm the trend observed in the aggregate data. Given concerns regarding serial correlation when difference-in-difference (DID) models are extend over several years (Bertrand et al., 2004), we divide the sample into pre- and post-reform periods (1994 versus 1998 and 2003). We estimate the following regression.

$$c_{ijk} = \alpha_1 + \alpha_2 T_i + \alpha_3 \text{postreform} + \beta_1 (\text{postreform} \times T_i) + \varepsilon_{ijk} \quad (1)$$

where c_{ijk} is a binary variable indicating whether household i in region j in year k cultivates a given crop (e.g., cotton, millet, sorghum, or maize). T_i is a dummy variable for whether household i lives in a cotton expansion (treated) region, *postreform* is a dummy variable for the period after the policy reform, that is, the 1998 and 2003 rounds of the survey. All regressions also control for child and household characteristics and survey months. The DID estimate of the policy reform for crop choice is denoted by β_1.

The regression results are shown in Table 2. The dependent variable in each column indicates whether a household farms each of the specified crops, that is, cotton, millet, sorghum, and maize, which together represent more than 70 percent of crop area in Burkina Faso in any given year. The DID estimate is the coefficient associated with the variable *Newcott X Postreform*. The variables *Newcott* and *Oldcott* are region dummies for the new cotton region in Panel A and old cotton region in Panel B. All regression results in this table and in subsequent tables report robust standard errors clustered at the province level.

Panel A shows the effect of the policy reform on cotton farming in the new cotton region. The estimate in column 1 indicates that, relative to the non-cotton region, the likelihood of cotton farming increased by 9.3 percentage points in the new cotton region after the policy reform. The policy reform did not, however, have any statistically significant effect on other crops (columns 2–4). In columns 5–8, we report estimation results that control for province fixed effects. The effect on cotton is slightly larger (10.2 percentage points) and none of the point estimates in columns 5–8 are significant. In 1994, only 2.4 percent of households were farming cotton in the new cotton region. Thus, the 10.2 percentage points correspond to a change of 425 percent in the proportion of households who farm cotton. Overall, the

results in Panel A demonstrate that, relative to the non-cotton region, more households began farming cotton in the new cotton region after the policy reform, a result which is consistent with the patterns observed in Figure 2.

In Panel B, we investigate the effect of the policy reform on cotton adoption. In column 1, the DID point estimate is -0.098 and significant at the five percent level, and the overall effect that combines both the DID estimate and the region dummy is positive. However, the positive effect disappears after we control for province fixed effects in column 5. Thus, it appears that the results in column 1 were mostly driven by the fact that most households were already growing cotton in the old cotton region, even before the policy reform.

Overall, both the aggregate data described in Figure 2 and the household data indicate that more households began growing cotton in the new cotton region after the policy reform. Since the household survey did not record farm area, we cannot investigate land allocation between cotton and the other crops. It is plausible that, at the intensive margin, land allocated to the other crops may have decreased, unless cotton expansion was initiated on previously uncultivated land. The conclusion one can draw is that that the policy reform induced more households to begin growing cotton, but did not have any detectable effect on household decisions to grow other crops, namely millet, sorghum, and maize.

5 Effects of cotton expansion on education outcomes

We now estimate the effect cotton expansion on enrollment and on number of years of education completed. We use specifications similar to regression 1, where the dependent variable is either a dummy variable indicating whether a child was enrolled in a school at

the time of the survey or the number of years of education completed[4]. We estimate the following regression:

$$y_{ijk} = \alpha_1 + \alpha_2 T_i + \alpha_3 \text{postreform} + \beta_1 \left(\text{postreform} \times T_i\right) + \varepsilon_{ijk}, \tag{2}$$

where y_{ijk} is either the enrollment status or years of education completed for child i in region j in period k; all other variables are as previously defined. We show estimates for the pooled sample and also disaggregate the results by gender.

Table 3 reports the first set of results. The enrollment status is in the first three columns and years of education completed in the last three. Beneath each column, we report the sum of coefficients for the treatment dummy and the coefficient of the interaction term. The estimates in columns 1 and 2 indicate that cotton expansion did not have a significant effect on enrollment for the pooled sample (boys and girls) or boys. In contrast, relative to the non-cotton region, girls' enrollment increased 3.7 percentage points in the new cotton region and the point estimate is significant at the five percent level. Columns 4–6 show the estimated effects of cotton expansion on years of education completed. The results corroborate the findings in columns 1–3. There is no significant effect on years of education completed for the pooled sample or the boys' sub-sample; however, years of education completed increased by about 0.13 years for girls who were exposed to the policy reform and the point estimate is significant at the five percent level. Adding the coefficient of interaction term and that of the treatment dummy, we find that the overall effect on girls is enrollment is 4.9 percentage points increase in enrollment and 0.17 years increase in years of education completed. The estimation results are robust to controlling for child age, household head's age and education,

[4]The highest grade completed coincides with years of education completed for children who did not repeat or skip grades.

and survey month dummies.

These estimates are small in terms of percentages points but represent significant changes considering that enrollment rates and number of years of education completed are low to start with. The estimated effect on enrollment corresponds to 42.6 percent increase starting from 11.5 percent enrollment rate in 1994 in the non-cotton region. The estimated effect on years of education corresponds to 51.5 percent increase starting from an average years of education completed of 0.33 years in 1994 in the non-cotton region.

Panel B of Table 3 reports the results for the old cotton areas and shows that the estimates for the policy impact are negative for school enrollment and years of education completed. For the first outcome, the point estimate is significant at the ten percent level for the pooled sample (column 1) and boys' enrollment (column 2), but not for girls' enrollment (column 3). The coefficient for years of education completed is significant at the ten percent level only for boys (column 5). The estimates of the interaction terms are negative, but the overall effect, that is, the sum of the interaction term and treatment dummy, is small in magnitude and not statistically significant. Overall, there is no evidence of change in school enrollment and years of schooling in areas that began cotton farming after the policy reform.

It is possible that geographic unobserved factors that affect enrollment are also correlated with the policy reform. This would be the case if, for example, the government tends to systematically invest more (or less) in public infrastructures (including schools) in the drier regions that never farmed cotton. We include province fixed effects in an attempt to control for such unobserved factors. Estimations that control for province fixed effects are shown in Table 4. The point estimates in Panel A are consistent with the results in Table 3. In column 3, relative to non-cotton regions, girls' school enrollment increased by 3.9 percentage points in cotton expansion areas and the coefficient is significant at the five percent level. In columns

1 and 2, the estimates of the enrollment status for the pooled sample and boys' sub-sample are of a smaller magnitude and not significant. There is evidence of increased enrollment only for girls. The results in columns 4–6 confirm those in columns 1–3. Girls gained about 0.15 additional years of education (column 6) and the point estimate is significant at the five percent level. The policy change did not have a statistically significant effect on the pooled sample (column 4) or the boys' sub-sample (column 5). These point estimates imply an increase of 32 percent in enrollment and 40 percent in number of years of education completed.

We investigate the effect of the policy reform in the old cotton regions in Panel B using specifications that control for province fixed effects. None of the point difference-in-difference estimate is statistically significant. In particular, the estimates for girls in column 3 and 6 are not statistically significant, a contrast to the results shown in Table 3. All remaining estimations include for province fixed effects to control for time invariant systematic differences across provinces.

5.1 Alternative specification

Cohort Analysis

We construct a counterfactual based on age and the timing of the policy reform (e.g., Duflo, 2001). We exploit the observation that older cohorts (i.e., children who were too old to enroll in primary school at the time of the policy reform) would not have been affected from the policy reform, regardless of the region of residence. On the other hand, children who were the right age would be directly affected by the policy reform only if they resided in the cotton expansion area. A DID can then be used to identify the impact of the policy reform on the outcomes of interest.

Officially, children in Burkina Faso attend primary school when they are 6–12 years old. In practice, because of delayed admissions and grade repetitions, children older than 12 years can also enroll in elementary school. We pool the 1998 and 2003 rounds of the survey and construct two cohorts. The young cohort comprises children who were observed in 1998 or 2003 and born between 1987 and 1996 (cohort1A). Of these, children who resided in cotton expansion areas would have been affected by the policy reform. The old cohort comprises individuals born between 1972 and 1981 and who were observed either in 1998 or 2003 (cohort2A). Formally, we estimate a regression as follows:

$$y_{ijk} = \beta_0 + \beta_1 \left(\text{cohort1A} \times T_i\right) + \beta_3 \text{cohort1A} + \beta_4 T_i + \varepsilon_{ijk} \tag{3}$$

where *young* indicates individuals who are born between 1987 and 1996; i, j, and k index households, regions, and the year, and T_i is a binary variable indicating whether household i resides in a new cotton region. In this regression, β_1 identifies the effect of the policy reform under the assumption that changes in education outcomes across cohorts and regions are constant in the absence of external shocks.

We show the estimates of regression 3 in Table 5. The layout is the same as that of the previous tables. The estimates in columns 1–3 indicate that for younger girls living in regions affected by the policy reform, enrollment increased by 4.6 percentage points as compared to girls of the same cohort who lived in the control areas; the point estimate is significant at the ten percent level. There is no detectable effect when boys and girls are pooled together or when boys are treated as a separate sample. Columns 4–6 display the results for years of schooling. Girls gained about 0.19 years of education, which is significant at the ten percent level, while there is no significant effect on the pooled sample (column 4) or for the boys' sub-sample (column 5). While the point estimates are marginally higher than those

reported in the fixed-effects specification (Table 4), it is comforting to find that the two different specifications led to the same qualitative conclusion, that is, the policy reform has a positive impact on girls' education but does not affect boys' education. In Panel B, the same exercise is repeated for old cotton areas and we find that none of the point estimates are statistically significant. Thus, the interaction of the policy reform with time does not significantly change the education outcomes in the old cotton region. Overall, the results of the cohort analysis are consistent with previous findings: relative to the non-cotton region, girls in the new cotton region were enrolled at higher rates and also had higher number of years of education completed.

Child Labor

One of our main arguments is that cotton adoption alters the opportunity cost of child time, which in turn affects school participation. To assess this argument, we test whether the policy reform affected child labor. The three survey rounds include questions on labor participation of all individuals who were at least 10 years old at the time of the survey. The survey asked whether an individual worked in the week before the survey and if they worked on the farm. We extract the sub-sample of individuals aged 10–15 years to assess the effects of the cotton policy reform on child labor.

The estimates are shown in Table 6. In Panel A, for the new cotton regions, the point estimates for girls in column 3 is -0.235 and is significant at the one percent level, that is, girls in these regions are 23.5 percentage points less likely to participate in any work than girls of a comparable age in the non-cotton regions. The point estimate in column 6, that is, girls' participation in farm labor is -0.223 and is significant at the five percent level. Taken together, the point estimates in columns 3 and 6 suggest that the reduction in child labor for

girls comes almost exclusively from the reduced participation in farm labor. The estimates in columns 1, 2, 4, and 5 are not statistically significant, indicating that the policy reform did not have a significant effect on labor participation for boys.

The estimates for the old cotton region are shown in Panel B. The estimates in columns 1–3 indicate that the participation of child labor decreased in these regions as well. Boys are about 7.3 percentage points (column 2) and girls about 8.5 percentage points (column 3) less likely to report child labor participation. The point estimates are significant at the five and ten percent levels. None of the estimates for farm labor (columns 4–6) are significant, suggesting that the effects on child labor detected in columns 1–3 are not driven by changes in child participation in farm labor.

Overall, the results in Table 6 demonstrate that cotton expansion decreased the participation of girls on farms in new cotton regions. The policy change, however, did not have a statistically significant effect on boys' participation on farms. These results are consistent with the findings for school participation[5].

6 Robustness checks

In this section, we perform three sets of analyses to check the robustness of our findings. The first set of regressions pools the the 1998 and 2003 rounds survey to run a DID similar to regression 3, where the sample is restricted to cohorts who were too old to begin schooling in 1995, when the cotton policy reform was implemented. The cotton policy change should

[5]When farming cotton is made available in a region (mainly because a cotton company starts servicing the region), farmers still have to decide whether to farm cotton or not. Hence, the various DID specifications (that we discussed) estimate the average effect, that is, including farmers who opt to farm cotton and those who decide not to, in response to to the policy change. In appendix A.1, we show estimates of the policy change for households who were induced to farm cotton precisely because of the policy reform. The point estimates are larger, but one should notice also that the first stage is relatively weak, using Stock and Yogo (2005)' s rule of thumb.

not have an effect on the education of these individuals. The cohorts include individuals who were born between 1972 and 1979 (cohort1B) and those born between 1959 and 1966 (cohort2B) observed in 1998 and 2003. These individuals all had turned 15 by the time the cotton expansion policy was implemented, and could not had started school in response to the 1994 policy reform. The estimates are reported in Table 7 and should be comparable with Table 5. In particular, the coefficients in Panel A for girls' enrollment (column 3) and years of education completed (column 6) in the cotton expansion areas are not significant in the placebo regressions. In addition, these point estimates are smaller in magnitude in comparison to those in Table 5. These estimates provide some supporting evidence that girls' education in non-cotton regions and new cotton regions followed the same trend before the policy reform.

Second, we re-estimate the effect of the policy reform (equation 2) using the urban households sub-sample. Arguably, most urban households are non-agricultural households and should not have been affected by the policy change. A significant effect of the policy reform on girls' education would suggest that there were other factors affecting girls' education when the policy reform was implemented and in the same areas, hence making our identification strategy questionable.

Estimations of these placebo regressions are shown in Table 8 and should be comparable with Table 4. None of the point estimates of the DID coefficient in columns 1–6 are significant in Panel A, that is, the new cotton regions. In particular, the DID estimates for girls in columns 3 and 6 are not statistically significant and are in fact negative. Therefore, there is no evidence that the policy reform affected girls' education in urban households. The results in Panel B corroborate those in Panel A. The results for the cotton expansion areas, however, are not statistically significant. Nevertheless, they provide additional confidence in

earlier findings. For non-agricultural households, there is no significant effect of the cotton policy change on school participation, only farmers who adopted cotton were more likely to enroll their daughters into schools.

Third, we examine the effect of the policy reform on child labor in urban areas. As we argued above for education outcomes, there is no *a priori* reason for child labor in urban areas to respond to the policy reform. We report the estimation results in Table 9. None of the point estimates for the policy reform are statistically significant at the ten percent level. This holds for both the new cotton region in Panel A and old cotton region in Panel B. In particular, the estimates for girls in columns 3 and 6 in the new cotton region (Panel A) are smaller in magnitude and not statistically different from zero. In sum, the robustness checks suggest that our analysis identifies the effects of the policy reform on education and child labor[6].

7 Discussions

In societies that favor males, policy reforms that benefit girls more than boys are rare. Conditional on our identification strategy, one could argue that the cotton expansion in rural Burkina has provided certain unusual outcomes. We propose three possible explanations for these puzzling results. First, these results may reflect the argument that in low-income settings, girls' human capital is a luxury and thus, is more income elastic than boys' human capital (e.g., Alderman and Gertler, 1997; Rosenzweig and Schultz, 1982). In this case,

[6]The other potential explanation would be a national program of school construction known as Basic Education Development Plan (PDDEB) that started in 2002. The program's activities included the construction and restoration of schools and several initiatives to promote education (Ki et al., 2006). Because PDDEB started one year before 2003, it could bias our estimates if PDDEB placement was somehow correlated with cotton regions. We have estimated the effect of the cotton policy reform using the 1994 survey (the baseline) and the 1998 survey, i.e. before PDDEB started. The results reported in Table A2 in the Appendix are consistent with our main findings. Hence, it is unlikely that PDDEB is driving our results.

the increase in income that results from cotton adoption would be more beneficial for girls' human capital than boys' human capital.

To investigate the income effect, we test whether the policy reform affected household income, which we proxy by household expenditures per capita. The results are summarized in Table 10. Columns 1 and 2 report the estimates for the new and old cotton areas, without controlling for province fixed effects. The point estimates indicate that households who were exposed to the policy reform have higher consumption expenditures, while those in the old cotton area, did not experience any significant change. In columns 3 and 4, we demonstrate that the estimates are robust to controlling for province fixed effects. Thus, our findings are robust to the additional province fixed effects in columns 1 and 2. In total, the policy reform unambiguously raised household expenditures (income) in new cotton regions. This can potentially explain the effects on the policy reform for girls' education if indeed investment in girls' human capital is more income elastic than investment in boys' human capital, as argued by Alderman and Gertler (1997) and Rosenzweig and Schultz (1982).

Second, in patrilinear societies, where boys inherit land, the introduction of cotton (the most valuable cash crop in the area) increases the value of bequest for boys (e.g., Quisumbing et al., 2001). Parents may increase investment in girls' education if they are concerned about equality among their offspring (e.g., Fafchamps and Quisumbing, 2005). This also would lead to a higher investment in girls' education if parents believe that education could compensate girls for the increased value of land that the boys would eventually inherit.

Third, gender difference in the amount of schooling received can be explained by the fact that the prominent economic activity, cotton farming, rewarded brawn more than skills (e.g., Pitt et al., 2012). Because boys have a comparative advantage in growing cotton, their opportunity cost of schooling compared to girls is relatively high. By contrast, girls tend to

resort to activities with higher returns to skill, where schooling has a high payoff. To this effect, it is plausible that farm work is divided along the lines of gender, such that boys work more than girls on cotton fields. This would be the case, for example, if crops are divided by gender (e.g., Duflo and Udry, 2004). We provide some indirect evidence for this explanation using data from a national agricultural survey, which collected information on labor at the plot level. The data allow for testing whether the number of boys and girls in the then households affects how intensive cotton plots are cultivated relative to other crops[7].

The estimation results are shown in Table 11. In all three columns, the dependent variable is the natural logarithm of labor (measured in man days) per hectare applied to each plot[8]. Across all three columns, the number of boys and girls consistently increases household labor supply at the plot level. In column 2, the main crop grown on the plot interacts with the number of boys (row 6) and girls (row 7). First, it is apparent from row 4 that (column 3) cotton plots are farmed more intensively than other crops. When interacting with the number of boys, the coefficient is .07 (significant at the one percent level), while that for girls is smaller in magnitude (.01; not statistically significant). By contrast, there is no significant differences when plots cereals interact with boys or girls in column 3. The main insight from this table is that the higher the number of boys in a household, the more intensively cotton plots are farmed[9]. No such gender difference was found on cereals plots.

[7]Hired labor is negligible such that the household composition essentially determines labor supply.

[8]The regressions also control for plot characteristics, plot owner characteristics, and the number of male and female adults.

[9]Note that crop choice is endogenous. For example, a household with a large number of boys could choose to farm cotton. This would be, however, consistent with the idea that boys contribute more than girls on cotton plots.

8 Conclusion

This study used variations in cotton expansion across time and space in Burkina Faso to estimate the effects of cotton adoption on education in rural Burkina Faso. The evidence suggests substantial gains for girls in the new cotton region relative to girls in the non-cotton region. Based on our preferred specification, enrollment rates for girls increased by 32 percent and years of education completed increased by 40 percent. Consistent with the gains in education, girls participation to farm labor decreased by 65 percent. In contrast, the cotton policy reform did not have any significant effect on boys' education.

This is a relatively large effect, especially when contrasted with interventions that were specifically designed to increase girls' enrollment. For instance, Kazianga et al. (2013) estimated that a large girl-friendly school construction program in Burkina Faso led to a gain of about 24 percentage points in girls' enrollment. Kazianga et al. (2012) estimated that a school feeding intervention (in the form of dried food and take-home rations) that targeted girls, increased enrollment by about 6 percent in northern Burkina Faso. It is worth highlighting the time horizon and the associated costs when comparing the effects of the cotton policy to more specific interventions. Nevertheless, the evidence strongly suggests that cotton expansion had some positive spillover effects on girls' human capital.

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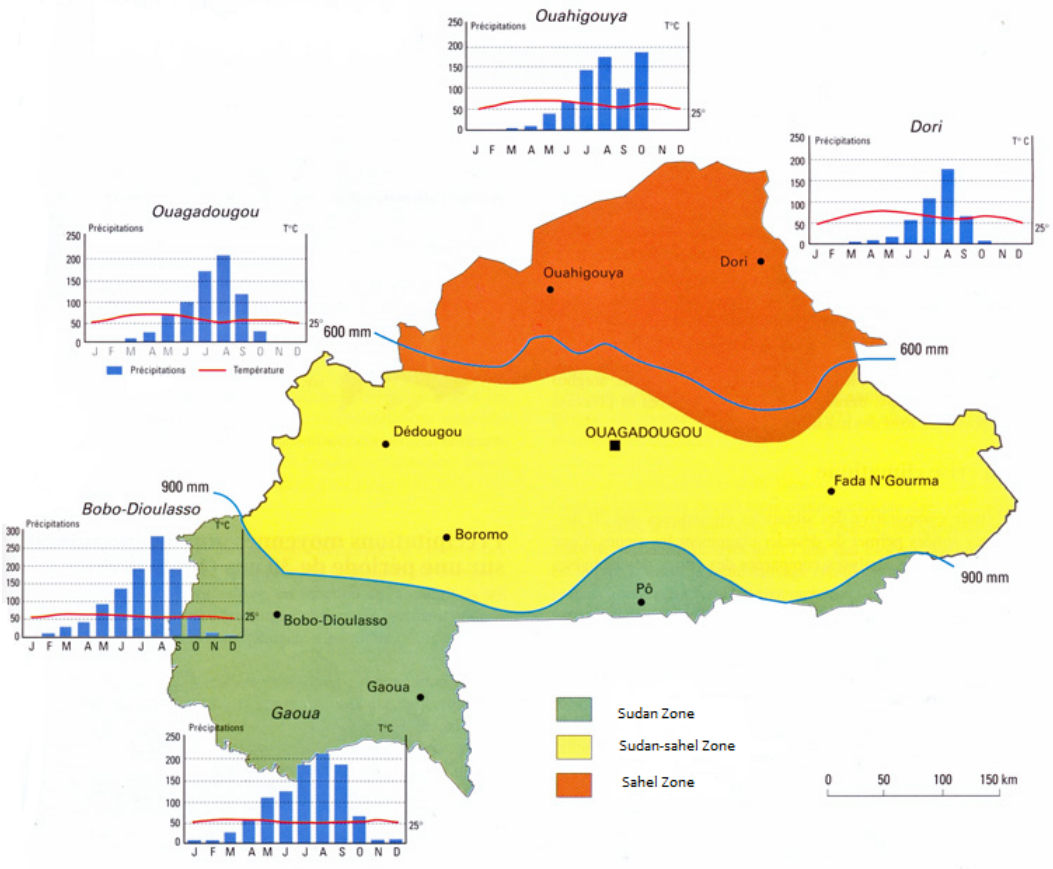
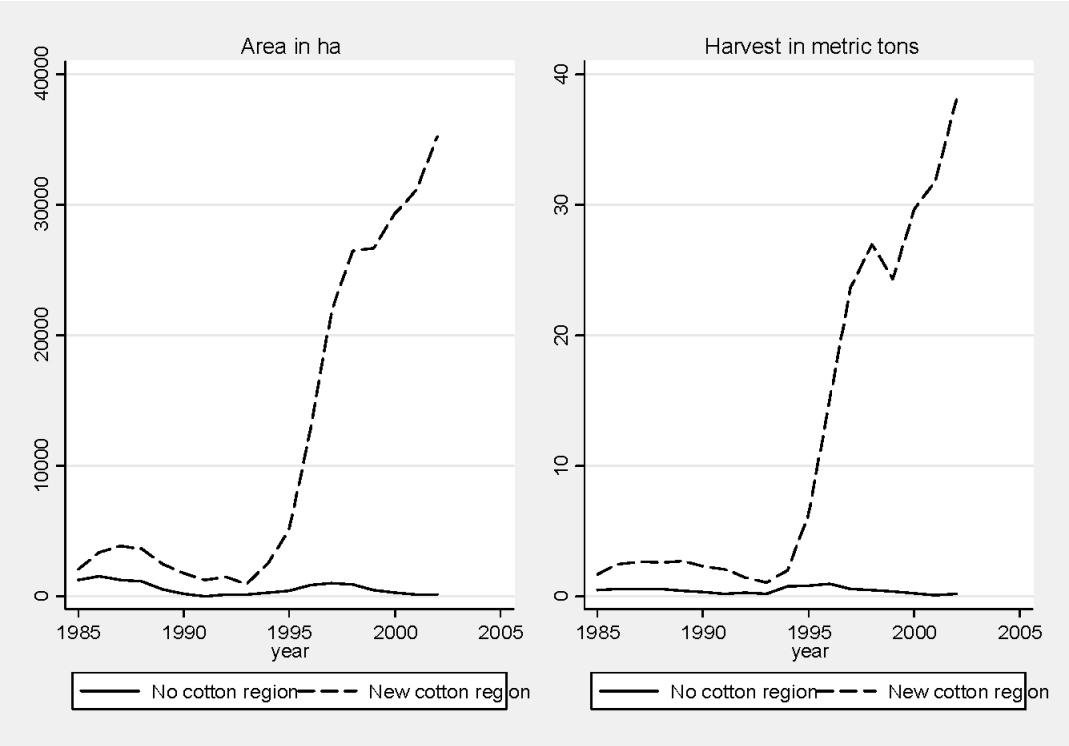
Figures

Figure 1: Mean annual rainfall of Burkina Faso for 1961-1990



Source: The Ministry of Environment of Burkina Faso.

Figure 2: Evolution of cotton production in new-cotton and non-cotton regions



Notes: Authors' calculations using administrative data from the Ministry of Agriculture of Burkina Faso.

Result Tables

Table 1A: Descriptive Statistics (1994)

	Old cotton region	New cotton region	Non cotton region	Difference with non cott. reg.	
				Old cott. reg.	New cott. reg.
	(1)	(2)	(3)	(4)	(5)
Enrolled	0.263	0.203	0.176	0.087**	0.027
Enrolled, boys	0.309	0.240	0.224	0.085	0.016
Enrolled, girls	0.211	0.156	0.119	0.092***	0.036
Grade	0.946	0.718	0.630	0.316**	0.088
Grade, boys	1.094	0.863	0.815	0.279	0.048
Grade, girls	0.779	0.533	0.413	0.366***	0.12
Child labor	0.413	0.424	0.416	-0.002	0.009
Child labor, boys	0.404	0.417	0.427	-0.024	-0.01
Child labor, girls	0.424	0.434	0.402	0.022	0.032
Farm labor	0.405	0.416	0.407	-0.002	0.009
Farm labor, boys	0.397	0.415	0.424	-0.027	-0.01
Farm labor, girls	0.414	0.418	0.387	0.027	0.031
Age	10.496	10.331	10.605	-0.109	-0.274***
Female	0.468	0.439	0.460	0.009	-0.021
Cotton	0.218	0.024	0.031	0.187***	-0.007
Sorghum	0.813	0.850	0.787	0.025	0.062
Millet	0.673	0.866	0.872	-0.200***	-0.006
HH. head education	0.110	0.070	0.051	0.059**	0.019
HH. head age	50.338	50.671	51.088	-0.75	-0.417
HH. head male	0.964	0.973	0.979	-0.015	-0.005
HH. size	12.005	10.902	12.112	-0.107	-1.21

Notes: * significant at 10%; ** significant at 5%, *** significant at 1%.
Authors' calculations using the rural sub-samples of Burkina Faso's 1994 priority survey.

Table 1B: Descriptive Statistics (1994-2003)

	Old cotton region	New cotton region	Non cotton region	Difference with non cott. reg.	
				Old cott. reg.	New cott. reg.
	(1)	(2)	(3)	(4)	(5)
Enrolled	0.232	0.213	0.206	0.026	0.007
Enrolled, boys	0.268	0.235	0.253	0.016	-0.017
Enrolled, girls	0.190	0.188	0.154	0.037	0.035
Grade	0.934	0.836	0.794	0.14	0.043
Grade, boys	1.099	0.914	0.966	0.133	-0.051
Grade, girls	0.743	0.751	0.603	0.14	0.148
Child labor	0.555	0.528	0.521	0.035	0.008
Child labor, boys	0.545	0.536	0.533	0.012	0.003
Child labor, girls	0.568	0.520	0.507	0.061	0.013
Farm labor	0.548	0.540	0.506	0.042	0.034
Farm labor, boys	0.540	0.546	0.518	0.023	0.029
Farm labor, girls	0.558	0.533	0.493	0.065	0.04
Age	10.614	10.559	10.466	0.147***	0.093
Female	0.464	0.478	0.474	-0.01	0.004
Cotton	0.403	0.113	0.028	0.374***	0.085*
Sorghum	0.788	0.884	0.863	-0.075	0.021
Millet	0.745	0.851	0.877	-0.132***	-0.026
HH. head education	0.081	0.052	0.043	0.037***	0.009
HH. head age	50.310	50.134	50.510	-0.2	-0.376
HH. head male	0.969	0.961	0.973	-0.004	-0.012
HH. size	11.424	10.098	10.539	0.885	-0.441

Notes: * significant at 10%; ** significant at 5%, *** significant at 1%.
Authors' calculations using the rural sub-samples of Burkina Faso's 1998 and 2003 priority surveys.

Table 2: Impact cotton expansion on crop choice

	(1) Cotton	(2) Millet	(3) Sorghum	(4) Maize	(5) Cotton	(6) Millet	(7) Sorghum	(8) Maize
Panel A: New cotton region								
Newcott×Postreform	0.093**	-0.030	-0.152	-0.157	0.102**	-0.036	-0.061	0.114
	[0.042]	[0.062]	[0.088]	[0.118]	[0.036]	[0.032]	[0.035]	[0.101]
Postreform	0.071	-0.127**	-0.081**	0.658***	0.024	-0.175***	-0.270***	0.266**
	[0.044]	[0.057]	[0.035]	[0.051]	[0.025]	[0.054]	[0.058]	[0.118]
Newcott	-0.006	-0.035	0.107	0.108				
	[0.008]	[0.027]	[0.082]	[0.118]				
F-test Newcott×Postreform	4.85	0.23	2.97	1.76	8.01	1.26	3.02	1.28
Observations	10,109	10,109	10,109	10,109	10,109	10,109	10,109	10,109
R-squared	0.012	0.003	0.006	0.005	0.004	0.000	0.000	0.001
Panel B: Old cotton region								
Oldcott×postreform	-0.098**	0.121*	-0.003	-0.129	0.002	-0.064	0.076*	0.037
	[0.045]	[0.070]	[0.100]	[0.143]	[0.036]	[0.049]	[0.040]	[0.126]
Postreform	0.717***	-0.009	-0.472***	0.588	0.362***	0.567	-0.300**	0.172
	[0.074]	[0.297]	[0.097]	[0.370]	[0.090]	[0.366]	[0.144]	[0.279]
Oldcott	0.165***	-0.228***	0.085	0.095				
	[0.040]	[0.059]	[0.099]	[0.128]				
F-test Oldcott×Postreform	4.786	3.011	0.001	0.813	0.005	1.710	3.725	0.085
Observations	13,361	13,361	13,361	13,361	13,361	13,361	13,361	13,361
R-squared	0.023	0.028	0.005	0.004	0.000	0.000	0.000	0.000
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Head age and education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	No	No	No	No	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent is a binary variable indicating whether a household is observing growing a giving crop in the survey year. All regressions control household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects. In addition, columns 5-8 also control for province fixed effects. The sample consists of all rural households with at least a school age child.

Table 3: Impact cotton Adoption on school enrollment and years of education completed

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
Newcott×Postreform	0.011	-0.010	0.037**	0.019	-0.075	0.134**
	[0.018]	[0.025]	[0.014]	[0.075]	[0.106]	[0.060]
Postreform	0.029	0.069	0.005	0.123	0.261	0.010
	[0.031]	[0.061]	[0.031]	[0.136]	[0.185]	[0.134]
Newcott	-0.003	-0.022	0.012	-0.013	-0.077	0.036
	[0.023]	[0.032]	[0.017]	[0.082]	[0.120]	[0.053]
Female	-0.103***			-0.375***		
	[0.020]			[0.070]		
Observations	19,540	10,238	9,302	19,540	10,238	9,302
R-squared	0.018	0.001	0.001	0.013	0.001	0.001
Newcott×Postreform+Newcott	0.007	-0.033	0.049***	0.006	-0.152	0.170**
	[0.026]	[0.035]	[0.018]	[0.115]	[0.152]	[0.079]
Panel B: Old cotton region						
Oldcott×Postreform	-0.044*	-0.061*	-0.025	-0.151	-0.206*	-0.092
	[0.024]	[0.030]	[0.021]	[0.095]	[0.119]	[0.083]
Postreform	0.219***	0.361***	0.076***	0.845***	1.239***	0.404**
	[0.050]	[0.060]	[0.025]	[0.197]	[0.251]	[0.143]
Oldcott	0.056	0.061	0.044	0.265*	0.329*	0.179
	[0.033]	[0.041]	[0.026]	[0.138]	[0.168]	[0.107]
Female	-0.116***			-0.452***		
	[0.013]			[0.045]		
Observations	26,983	14,146	12,837	26,983	14,146	12,837
R-squared	0.022	0.002	0.001	0.018	0.002	0.001
Oldcott×Postreform+Oldcott	0.012	0.001	0.019	0.114	0.124	0.087
	[0.021]	[0.027]	[0.019]	[0.095]	[0.117]	[0.082]
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	No	No	No	No	No	No

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child is enrolled in school at the time of the survey. In columns 4-6, the dependent variable is the number of years of education completed. The regressions also control for child age, household head's age, education and gender, the month in which the survey was fielded and year of the survey.

Table 4: Impact of cotton adoption on school enrollment and years of education completed, controlling for province fixed effects

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
Newcott×Postreform	0.019	0.004	0.039**	0.062	-0.007	0.145**
	[0.019]	[0.029]	[0.014]	[0.084]	[0.124]	[0.061]
Postreform	-0.017	0.043	0.028	-0.081	0.099	0.061
	[0.027]	[0.053]	[0.021]	[0.111]	[0.163]	[0.085]
Female	-0.102***			-0.368***		
	[0.020]			[0.070]		
Observations	19,540	10,238	9,302	19,540	10,238	9,302
R-squared	0.017	0.000	0.000	0.012	0.000	0.000
Panel B: Old cotton region						
Oldcott×Postreform	-0.030	-0.038	-0.018	-0.079	-0.107	-0.042
	[0.025]	[0.032]	[0.020]	[0.104]	[0.128]	[0.091]
Postreform	0.185***	0.321***	0.071***	0.704***	1.055***	0.369**
	[0.044]	[0.047]	[0.021]	[0.184]	[0.215]	[0.135]
Female	-0.115***			-0.445***		
	[0.013]			[0.045]		
Observations	26,983	14,146	12,837	26,983	14,146	12,837
R-squared	0.021	0.001	0.000	0.016	0.000	0.000
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child is enrolled in school at the time of the survey. In columns 4-6, the dependent variable is the highest grade attained. All regressions control for child age, household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects.

Table 5: Impact of cotton adoption on school enrollment and years of education completed of younger cohorts

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
Newcott×Cohort1A	0.013	-0.013	0.046*	0.092	0.025	0.190*
	[0.028]	[0.036]	[0.025]	[0.102]	[0.126]	[0.090]
Cohort1A	0.186***	0.229***	0.121***	0.384***	0.487***	0.217***
	[0.027]	[0.038]	[0.020]	[0.089]	[0.131]	[0.073]
Female	-0.068***			-0.234***		
	[0.012]			[0.038]		
Observations	13,864	7,407	6,457	13,864	7,407	6,457
R-squared	0.023	0.021	0.009	0.009	0.005	0.003
Panel B: Old cotton region						
Oldcott×Cohort2A	0.018	0.011	0.031	0.107	0.109	0.123
	[0.026]	[0.033]	[0.024]	[0.102]	[0.129]	[0.097]
Cohort2A	0.185***	0.231***	0.115***	0.370***	0.473***	0.186**
	[0.027]	[0.036]	[0.021]	[0.095]	[0.131]	[0.075]
Female	-0.076***			-0.287***		
	[0.008]			[0.030]		
Observations	20,200	10,970	9,230	20,200	10,970	9,230
R-squared	0.028	0.025	0.010	0.012	0.007	0.002
Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child is enrolled in school at the time of the survey. In columns 4-6, the dependent variable is the highest grade attained.
Cohort1A includes children born between 1987-1996 and observed in the 1998 or 2003 survey rounds.
Cohort2A (excluded group) regroups children born between 1972-1981 and observed in survey rounds.
Children from the younger cohort (Cohort1A) would have been affected by the policy reform if they resided in the new cotton region.
All specifications control for child age, household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects.

Table 6: Impact cotton adoption on Child work and farm labor

	Child Work			Farm Labor		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
Newcott×Postreform	-0.127	-0.051	-0.235***	-0.092	0.001	-0.223**
	[0.079]	[0.080]	[0.078]	[0.082]	[0.078]	[0.090]
Postreform	0.206	-0.203	-0.005	0.248	-0.133	0.070
	[0.147]	[0.123]	[0.150]	[0.152]	[0.117]	[0.170]
Female	0.012			0.006		
	[0.048]			[0.049]		
Observations	10,656	5,695	4,961	10,656	5,695	4,961
R-squared	0.002	0.001	0.005	0.001	0.000	0.005
Panel B: Old cotton region						
Oldcott×Postreform	-0.087**	-0.073**	-0.085*	-0.069	-0.056	-0.066
	[0.034]	[0.033]	[0.046]	[0.045]	[0.034]	[0.076]
Postreform	0.555***	0.707***	0.308***	0.542***	0.728***	0.252**
	[0.054]	[0.064]	[0.082]	[0.071]	[0.054]	[0.120]
Female	0.025			0.018		
	[0.030]			[0.031]		
Observations	17,461	9,337	8,124	17,461	9,337	8,124
R-squared	0.002	0.001	0.000	0.001	0.001	0.000
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Household head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child worked in the week before the survey. In column 4-6, the dependent variable is a binary variable that indicates whether a child worked on the farm. All regressions control for child age, household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects.

Table 7: Impact of cotton adoption on school enrollment and years of education completed of younger cohorts not affected by the policy

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
Newcott×Cohort1B	0.006	0.011	0.007	0.045	0.076	0.065
	[0.009]	[0.011]	[0.009]	[0.074]	[0.092]	[0.085]
Cohort1B	-0.001	0.003	-0.004	-0.003	0.029	-0.035
	[0.005]	[0.008]	[0.004]	[0.043]	[0.066]	[0.033]
Female	-0.008*			-0.064*		
	[0.004]			[0.032]		
Observations	3,698	2,213	1,485	3,698	2,213	1,485
R-squared	0.001	0.000	0.000	0.001	0.000	0.000
Panel B: Old cotton region						
Oldcott×Cohort2B	0.006	0.009	0.005	0.045	0.065	0.036
	[0.007]	[0.009]	[0.008]	[0.061]	[0.069]	[0.071]
Cohort2B	-0.003	-0.004	-0.000	-0.016	-0.028	-0.002
	[0.006]	[0.007]	[0.005]	[0.047]	[0.061]	[0.049]
Female	-0.010***			-0.083***		
	[0.003]			[0.027]		
Observations	6,325	3,776	2,549	6,325	3,776	2,549
R-squared	0.002	0.000	0.000	0.002	0.000	0.000
Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes
Household head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child is enrolled in school at the time of the survey. In columns 4-6, the dependent variable is the highest grade attained.
Cohort1B comprises children born between 1972-1979 observed in the 1998 or 2003 survey rounds.
Cohort2B (excluded group) regroups children born between 1959-1966 observed in 1998 or 2003 rounds.
None of these cohorts would have been affected by the policy change.
All specifications control for cohort-age dummies, household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects.

Table 8: Impact of cotton adoption on child enrollment and years of education in urban areas

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
New×Postreform	0.005	0.033	-0.008	-0.319	-0.016	-0.524
	[0.096]	[0.115]	[0.081]	[0.483]	[0.639]	[0.340]
Postreform	-0.265***	-0.276***	-0.145***	-1.424***	-2.866***	0.665***
	[0.006]	[0.033]	[0.025]	[0.111]	[0.262]	[0.039]
Female	-0.062***			-0.300***		
	[0.007]			[0.021]		
Observations	6,722	3,309	3,413	6,722	3,309	3,413
R-squared	0.006	0.000	0.000	0.004	0.000	0.001
Panel B: Old cotton region						
Old×Postreform	0.002	-0.022	0.029	-0.078	-0.229	0.077
	[0.029]	[0.033]	[0.030]	[0.236]	[0.208]	[0.274]
Postreform	-0.285***	-0.266***	-0.213***	-1.497***	-2.761***	0.352
	[0.022]	[0.023]	[0.054]	[0.098]	[0.203]	[0.212]
Female	-0.080***			-0.341***		
	[0.009]			[0.034]		
Observations	10,320	5,154	5,166	10,320	5,154	5,166
R-squared	0.009	0.000	0.000	0.005	0.001	0.000
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Household head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child is enrolled in school at the time of the survey. In columns 4-6, the dependent variable is the highest grade attained. The sample consists of households living in urban areas. Additional controls are child age dummies, household head's age, education and gender, survey month dummies and province fixed effects.

Table 9: Impact of cotton adoption on child work and farm labor in urban areas

	Child Work			Farm Labor		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: New cotton region						
Newcott×Postreform	0.000	-0.012	0.012	-0.003	-0.021	0.012
	[0.029]	[0.081]	[0.036]	[0.052]	[0.114]	[0.024]
Postreform	0.025	0.120***	-0.071*	-0.021	0.028**	-0.059
	[0.023]	[0.023]	[0.037]	[0.026]	[0.012]	[0.047]
Female	-0.021***			-0.015*		
	[0.005]			[0.007]		
Observations	6,074	2,994	3,080	6,074	2,994	3,080
R-squared	0.001	0.000	0.000	0.001	0.000	0.000
Panel B: Old cotton region						
Oldcott×Postreform	-0.005	-0.007	-0.009	0.013	0.010	0.012
	[0.031]	[0.045]	[0.030]	[0.019]	[0.024]	[0.025]
Postreform	0.064*	0.128***	-0.004	0.007	0.024	-0.012
	[0.035]	[0.028]	[0.048]	[0.023]	[0.014]	[0.040]
Female	-0.020***			-0.006		
	[0.006]			[0.007]		
Observations	9,297	4,650	4,647	9,297	4,650	4,647
R-squared	0.001	0.000	0.000	0.000	0.000	0.000
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Household head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child worked in the week before the survey. In column 4-6, the dependent variable is a binary variable that indicates whether a child worked on the farm. The sample is restricted to urban households. All regressions control for child age, household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects.

Table 10: Impact of cotton adoption on rural household expenditures

	Total Expenditure			
	(1)	(2)	(3)	(4)
Newcott×Postreform	1,281.150**		1,844.869***	
	[543.499]		[407.764]	
Oldcott×Postreform		563.737		-10.647
		[529.820]		[628.436]
Postreform	5,023.598***	8,487.975***	2,337.428***	8,657.582***
	[1,574.270]	[1,885.088]	[761.113]	[1,481.396]
Newcott	-508.786			
	[294.867]			
Oldcott		-209.103		
		[359.062]		
Observations	7,321	9,721	7,321	9,721
R-squared	0.001	0.000	0.002	0.000
Household head age and education	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes
Province fixed effects	No	No	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable represents household expenditures per capita. The control variables are household head's age and education, and survey month dummies. In columns 3 and 4, regressions include province fixed effects.

Table 11: Cotton adoption and Child labor

	Ln(Labor)		
	(1)	(2)	(3)
Plot size in ha	-0.540	-0.555	-0.526
	[0.028]***	[0.027]***	[0.027]***
Number of boys	0.020	0.017	0.015
	[0.007]***	[0.007]**	[0.006]**
Number of girls	0.026	0.025	0.027
	[0.008]***	[0.008]***	[0.010]***
Cotton plot		0.215	
		[0.050]***	
Cotton plot×Number of boys		0.069	
		[0.022]***	
Number of girls		0.013	
		[0.030]	
Cereals plot			-0.266
			[0.025]***
Cereals plot×Number of boys			0.006
			[0.010]
Number of girls			-0.003
			[0.012]
Constant	4.935	4.932	5.079
	[0.051]***	[0.051]***	[0.052]***
Observations	34,866	34,866	34,899
R-squared	0.41	0.42	0.42

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable is the natural log of labor in man-days per hectare applied to each plot. All regressions include number of men and women, plot characteristics, plot owner's age and gender, and village fixed effects. The data are taken from the 2008 round of a household survey conducted by the Ministry of Agriculture of Burkina Faso.

A Appendix

A.1 Household cotton adoption on education outcome: 2SLS estimate

We consider another parameter of interest, that is, the effect of the policy reform on households in the new cotton regions who decided to farm cotton as a result of the policy reform. The policy reform increased the likelihood that households in the new cotton regions would choose to farm cotton, whereas some other households would not. The estimates discussed in the text assess the average effect of the policy reform in the new cotton regions, that is, the effect accounts for households who chose to farm cotton and those who did not. In this appendix, we present the two-stage least squares (2SLS) estimates in Table A1 using equation 1 as the first stage. The F-statistics (for cotton) are reported in columns 1 and 5 and are relatively small, except for in column 5 of Panel A (8.01). As a result, we show the 2SLS estimates only for the new cotton regions and control for the province fixed effects. The main assumption is that the policy reform affects a child's education outcomes only through a household's decision to grow cotton. The point estimate (significant at the five percent level) implies that enrollment increased by 36.1 percentage points for girls whose households chose to farm cotton because of the policy reform. These girls gained 1.35 (significant at the ten percent level) additional years of education. Consistent with the DID estimates, there is no significant effect on the pooled sample or boys' sub-sample.

Table A1: Impact of cotton adoption on school enrollment and years of education completed (Two Stage Least Squares)

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Cotton	0.172	0.030	0.361**	0.544	-0.059	1.353*
	[0.185]	[0.249]	[0.169]	[0.800]	[1.033]	[0.686]
Postreform	-0.028	0.046	0.003	-0.115	0.094	-0.033
	[0.029]	[0.050]	[0.023]	[0.124]	[0.145]	[0.092]
Female	-0.102***			-0.368***		
	[0.020]			[0.070]		
Observations	19,540	10,238	9,302	19,540	10,238	9,302
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Household head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The dependent variable in columns 1-3 is a binary variable indicating whether a child is enrolled in school at the time of the survey. In columns 4-6, the dependent variable is the highest grade attained. The F-statistics for the first stage is reported in column 5 of Table 2. The sample is restricted to households in the new cotton region. All regressions control for child age, household head's age, education and gender, the month in which the survey was fielded, year of the survey and province fixed effects.

A.2 Impact of policy reform before 2003

Table A2: Impact of cotton policy reform before PDDEB

	Enrollment Status			Years of education		
	Boys and girls	Boys	Girls	Boys and girls	Boys	Girls
	(1)	(2)	(3)	(4)	(5)	(6)
Newcott×Postreform	0.027	0.012	0.044**	0.049	-0.013	0.123*
	[0.022]	[0.031]	[0.018]	[0.080]	[0.107]	[0.063]
Postreform	0.133**	0.073	0.207***	0.451**	0.262	0.685***
	[0.052]	[0.062]	[0.041]	[0.186]	[0.201]	[0.164]
Female	-0.106***			-0.378***		
	[0.022]			[0.082]		
Observations	14,207	7,473	6,734	14,207	7,473	6,734
R-squared	0.021	0.000	0.004	0.016	0.000	0.003
Child age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Household head age and education	Yes	Yes	Yes	Yes	Yes	Yes
Survey month dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in brackets, clustered at the province level.
* significant at 10%; ** significant at 5%, *** significant at 1%.
Notes: The data include the 1994 round survey as the baseline and the 1998 round survey for the follow up. The dependent variable in columns 1-3 is a binary variable indicating whether a child worked in the week before the survey. In column 4-6, the dependent variable is a binary variable that indicates whether a child worked on the farm. The regressions control for child age dummies, household head age and schooling, survey month dummies and province fixed effects.