Policy Research Working Paper 9105

Free Primary Education, Fertility, and Women's Access to the Labor Market

Evidence from Ethiopia

Luke Chicoine

WORLD BANK GROUP
Development Economics
Knowledge and Strategy Team
January 2020

Policy Research Working Paper 9105

Abstract

This article investigates the causal relationship between women's schooling and fertility by exploiting variation generated by the removal of school fees in Ethiopia. The increase in schooling caused by the reform is identified using both geographic variation in the intensity of its impact and temporal variation generated by the timing of the implementation. The model finds that the removal of school fees led to an increase in schooling for Ethiopian women and that each additional year of schooling led to a reduction in fertility. An investigation of the underlying mechanisms linking schooling and fertility finds that the decline in fertility is associated with an increase in labor market opportunity and a reduction in women's ideal number of children.

This paper is a product of the Knowledge and Strategy Team, Development Economics. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The author may be contacted at lchicoin@bates.edu.

Free Primary Education, Fertility, and Women's Access to the Labor Market: Evidence from Ethiopia

Luke Chicoine*

JEL classification: O55, J13, I25, I26

Keywords: free primary education; returns to schooling; fertility; Ethiopia

*Department of Economics, Bates College and IZA - Institute of Labor Economics. Address: Pettengill Hall, 4 Andrews Rd, Lewiston, ME 04240. Email: lchicoin@bates.edu.The author would like to thank Anjali Adukia, Lori Beaman, Seema Jayachandran, Adrienne Lucas, Kazuya Masuda, and Sarah Pearlman for their extremely helpful feedback; the Department of Social Policy at the London School of Economics and Political Science for their support, especially from Berkay Ozcan and Jorge Garcia-Hombrados; and members of the Navarra Center for International Development and participants at the 2018 Africa Meeting of the Econometric Society, the 2018 Annual Conference of the European Society for Population Economics, the 2018 Nordic Conference on Development Economics, the 2017 Midwest International Economic Development Conference, the 2017 Centre for the Study of African Economies Conference, the 2017 Liberal Arts Colleges Development Conference, and the 2017 Maine Economic Conference for helpful comments.

1 Introduction

Prominently positioned among the Millennium Development Goals, universal primary education has become a central tenet of the international development effort. As far back as the 1970s, the most readily available policy tool for promoting enrollment has been the removal of school fees. This type of policy was implemented in Kenya and Nigeria in the 1970s, in Zimbabwe and Tanzania in the 1980s, and in Ethiopia, Malawi, and Uganda in the 1990s. More recently, this policy has been aggressively pursued by international development organizations as a key tool in achieving the goal of universal primary education, as evidenced by over a dozen additional countries removing school fees since 2000 (Kattan and Burnett, 2004; World Bank, 2009). The accelerated proliferation of these fee-removal programs over the past few decades highlights the importance of gaining a greater understanding of the consequences of these reforms; however, a recent systematic review (Snilstveit et al., 2016) by the International Initiative for Impact Evaluation (3ie) concluded that little is known about the long-term impact of reducing school fees.

This article evaluates the returns to a nationwide free primary education (FPE) program in Ethiopia. The removal of school fees in grades one through ten is found to generate an increase in schooling. Using a two-stage least squares (2SLS) model, each additional year of schooling generated by the reform is found to reduce fertility by more than 0.4 births.

The article uses data from the Ethiopian census and from three rounds of the Demographic and Health Survey (DHS). The increase in schooling is identified by combining two dimensions of variation, the timing of the reform and geographic variation in schooling outcomes for cohorts who completed their education prior to the introduction of the reform. Motivated by the work of Bleakley (2010), Lucas (2010, 2013), and Lucas and Mbiti (2012a,b), the identification relies on the concept that although the FPE policy itself is applied uniformly across the country, the intensity of the reform in a specific location depends on the pre-existing characteristics of that area. In this setting, as proposed in Chicoine (2019), removing school fees from an area of high pre-reform educational attainment will have a small impact relative to removing the same fees in an area with a low pre-reform education level.

Investigating the mechanisms through which the increase in schooling leads to a reduction in fertility for Ethiopian women can yield an increased understanding of the household fertility decision-making process. The increase in schooling generated by the FPE reform is found to increase literacy rates, and it leads to women working in higher-quality jobs and wanting fewer children. However, as exposure to the reform increases, women are no more likely to use contraception, and there is no evidence of an increase in empowerment. The totality of these findings suggests that the decline in the ideal number of children and the associated increase in economic activity are the central mechanisms through which the increase in schooling

has reduced fertility for Ethiopian women.

Earlier literature (Ainsworth et al., 1996; Lam and Duryea, 1999; Schultz, 1994, 1997) has documented the negative relationship between schooling and fertility that exists in the data. To identify the effect of education, Osili and Long (2008) used school construction in Nigeria, and Keats (2018) exploited a discontinuity around the implementation of FPE in Uganda. Both articles found that education led to a reduction in fertility of between 0.263 and 0.36 births for each additional year of schooling. Ozier (2018) also showed that access to secondary school reduced teen pregnancy in Kenya, and Zenebe Gebre (2018) found that an FPE reform in Malawi led to reductions in fertility through the age of 25. Although these articles all found a similar relationship between schooling and fertility, the mechanisms vary. In addition to the timing of marriage and evidence of increased labor market productivity, Keats (2018) also found evidence of increased use of contraceptives. In Malawi, Zenebe Gebre (2018) documented strong evidence of an increase in the use of contraception and a move away from agricultural employment.

Outside of Africa, the evidence of a causal relationship between schooling and fertility has been more mixed. Fort et al. (2016) discovered evidence of a positive causal relationship between schooling and fertility in continental Europe but a negative relationship in the United Kingdom, and Clark and Bono (2016) found that school quality in the United Kingdom had a significant positive impact on women's earnings and a negative effect on fertility. Exploiting discontinuities at starting ages, McCrary and Royer (2011) found no evidence that schooling affected the probability of motherhood.

The results of this article are significant in three ways. First, the article presents an application of a difference-in-differences identification strategy that can be used in a variety of settings to study national-level reforms with a minimal amount of pre-reform information needed for identification. Measuring the impact of national-level removal of user fees was one of the key categories found to need further study in the 3ie systematic review of education policy (Snilstveit et al., 2016). Second, this article finds strong evidence of a negative relationship between schooling and fertility, and investigates the detailed pathways through which this relationship develops. Third, the article finds significant evidence of positive returns to schooling, through both reduction in fertility and improvement in labor market outcomes. This result suggests that increased schooling generated by the removal of school fees led to lasting increases in education that bettered the day-to-day lives of Ethiopian women.

2 Background and Education Reform

After 17 years of military and communist rule, the Ethiopian People's Revolutionary Democratic Front took power in 1991 and quickly established a transitional government (Ofcansky and Berry, 1993). This govern-

ment introduced a new federal structure with nine regional governments and two independent administrative councils in Addis Ababa and Dire Dawa. The 11 regions were established along historical ethnic lines, with each region representing the first administrative area level within the county, similar to a state or province. The regions were then divided into 60 zones, as shown in fig. 1.

Before the start of the 1995 school year, the new government introduced the *Education and Training Policy*, which removed school fees for grades one through ten in all government-run schools. At the time the policy was enacted, these schools educated over 90 percent of primary school students in Ethiopia, and although there was no formal tuition fee prior to 1995, schools often imposed per-student fees to cover the cost of operation. The reform itself had no enforcement mechanism, but most of the country had complied with the decree by 1996 (Negash, 1996; Oumer, 2009; World Bank, 2009; UNESCO, 2007).

In addition to the removal of school fees, between 1991 and 1995 the transitional government also introduced local language instruction in four of the country's 11 regions. The introduction of local language instruction was complicated, and the literature finds mixed evidence of the consequences of mother tongue instruction (MTI) on schooling in Ethiopia. Although two previous articles found evidence of a positive impact of MTI in Ethiopia (Seid [2016] and, conditional on enrollment, Ramachandran [2017]), Zenebe Gebre (2014) exploited variation in the timing of the introduction of MTI in each language and found that MTI had a negative impact on schooling. Chicoine (2019) further isolated the negative impact of MTI to regions of Ethiopia that introduced the languages with translations using the Roman script, an alphabet never previously used in translations of the new languages of instruction.

To focus the analysis on the consequences of an increase in schooling, the main body of this article examines the returns to schooling generated by the removal of school fees in the seven regions of the country that did not change the language of instruction during this period. With this restriction, the identification strategy exploits variation in the pre-reform levels of the remaining 32 zones of the country. Isolating the effect of the FPE program yields a more focused analysis within the main text of the article but does not diminish the importance of considering the MTI reforms. The combined effect of the two reforms, their impact on schooling and fertility, and the potential mechanisms through which schooling impacts Ethiopian women's decisions are considered in detail in Appendix Section C.

3 Identification Strategy

This section describes and expands on the method proposed by Chicoine (2019) for identifying the impact of the FPE reform on schooling in Ethiopia. The intensity of the reform is jointly determined by both location within Ethiopia and the timing of the reform's implementation. Although the *Education and Training Policy*

removed school fees in grades one through ten throughout Ethiopia, the local magnitude of the reform's impact depends on pre-reform levels of education in each part of the country. This concept is similar to that underlying the strategy of Bleakley (2010) and Lucas (2010, 2013), which used pre-eradication levels of malaria to identify local variation in the impact of eradication programs; Lucas and Mbiti (2012a,b) applied the same concept more directly to the post-2000 removal of school fees in Kenya. A similar difference-in-differences identification strategy can be applied to Ethiopia. Following the reform, ten years of fee-free schooling became available to every single student; however, prior to the reform, some portion of these grades were already being completed. In areas of the country where schooling levels were high before the reform's implementation, the removal of school fees would have had only a small impact relative to regions where few students attended school in the pre-reform period. Across Ethiopia, this pre-reform level of schooling is evaluated for each of the 60 zones in the country.

In each zone, z, the maximum potential magnitude of the reform, M_z, is calculated using information on schooling of individuals from that zone born between 1966 and 1969.[1] Only data for women are used to calculate the measures described in this article. Women with birth dates between 1966 and 1969 were born significantly prior to the implementation of the reform, such that even if they entered primary school five years late and completed ten years of education, they would not have had access to any free schooling. In each zone, some fraction of the population, $F_{z,0}$, never enters school; in other words, they complete zero years of schooling. For this subset of the population, the reform has the potential to increase schooling by ten years. An additional portion of the population, $F_{z,1}$, dropped out after completing one year of schooling; this subset of the population could gain as many as nine years of additional schooling, and so on. The maximum potential magnitude of the reform in zone z is then calculated as the product of the number of potential additional years of schooling and the fraction of the population that dropped out after each grade,

$$M_z^{\text{FPE}} = \sum_{g=0}^{9}(10-g)F_{z,g}. \tag{1}$$

Equation (1) represents the number of free years of schooling made available by the reform in each zone, beyond what was being completed prior to the reform's implementation. For students who make the decision to enter school following the reform's implementation, the reform can directly increase schooling for them by as much as M_z, relative to the pre-reform level of schooling in their zone. This maximum magnitude of the reform applies to all individuals entering school in 1995 or later, or, if starting school on time at age seven, cohorts born no earlier than 1987. Cohorts born in each successive year prior to 1987 benefited from one

[1] These data are from the 1994 Ethiopian census, collected by the Ethiopian Central Statistical Agency and made available as part of the Integrated Public Use Microdata Series (IPUMS) International by the Minnesota Population Center and the Ethiopian Central Statistical Agency (2017).

less year of free schooling; therefore, on-time entrants in the 1986 cohort benefited only after completing at least grade one. Finally, on-time entrants born in 1977 or earlier would have completed all ten grades prior to 1995 and so gained zero years of free schooling.[2] Assuming on-time entrance into school and continuous progression, the maximum benefit of the FPE reform for each cohort is as follows:

$$M_{zy}^{\text{FPE}} = \begin{cases} \sum_{g=0}^{9} (10-g) \cdot F_{z,g} & \text{if } y \geq 1987, \\ \sum_{g=1987-y}^{9} (10-g) \cdot F_{z,g} & \text{if } 1978 \leq y \leq 1986, \\ 0 & \text{if } y \leq 1977. \end{cases} \tag{2}$$

Data from the Ethiopian census provide zone-specific information on the actual starting age of children in Ethiopia, allowing the on-time entry assumption to be relaxed. Because students often enter school at ages other than the legal starting age of seven, an individual's year of birth does not determine their year of school entry but rather a possible range of years in which the individual could enter school. The calculation of the reform's impact can be adjusted to take into account the possibilities of starting school as early as age six, one year early, and as late as age 12, five years late. The central assumption made regarding variation in entry probability is that the relative age distribution within each zone is constant over time; this means that even though all ages are more likely to enter school in the post-reform period, if a seven-year-old is twice as likely to enter school relative to a six-year-old in the census data, then a seven-year-old remains twice as likely to enter school in both the pre- and the post-reform states of the world.[3] Following the removal of school fees, the maximum impact of the reform would be that every student could potentially enter school. To represent this possibility, the starting probabilities, $S_{z,a}$, are assumed to sum to 1, holding the relative probabilities from the data constant across each age:

$$\sum_{a=6}^{12} S_{z,a} \quad = \quad 1. \tag{3}$$

The following set of equations (4) uses the 1985 cohort as an example to illustrate how starting ages are included in the calculation of the impact of FPE on each cohort. First, some fraction of the cohort, $S_{z,6}$,

[2] The timing of the impact on each cohort, assuming on-time entry, is shown in Appendix Table A.1.

[3] Justification for this assumption is shown in Appendix Figure B.1; when scaled to full entry, age specific probabilities yield a consistent pattern (Appendix Figure B.1c). Data from the 1984, 1994, and 2007 rounds of the census are compared. The 1984 census is the only fully pre-reform round of the census, but the administrative boundaries were changed at the beginning of the transitional administration. The starting-age probabilities in the 1994 census were likely directly affected by the ongoing reforms. Therefore, the 2007 census, which is made up of a set of respondents whose entry decisions were made after the post-reform equilibrium had been established, is used in the main body of the article to calculate starting ages. Under the assumption that relative starting ages should be consistent over time, this round of the survey provides the clearest representation of the equilibrium relative starting ages within the current administrative boundaries. Estimates using alternative starting-age calculations from the other census rounds, with the 1984 values weighted by overlapping area into the 1994 boundaries (panel F) and the 1994 start values (panel G), can be found in Appendix Section D.2.

would start school one year early at age 6; this fraction of the sample will be assigned the magnitude, from equation (2), for the previous year, 1984.

$$\text{Age 6:} \quad S_{z,6}M^{\text{FPE}}_{z,1984} = \quad S_{z,6}\sum_{g=3}^{9}(10-g)F_{z,g} \quad , \tag{4a}$$

$$\text{Age 7:} \quad S_{z,7}M^{\text{FPE}}_{z,1985} = \quad S_{z,7}\sum_{g=2}^{9}(10-g)F_{z,g} \quad , \tag{4b}$$

$$\text{Age 8:} \quad S_{z,8}M^{\text{FPE}}_{z,1986} = \quad S_{z,8}\sum_{g=1}^{9}(10-g)F_{z,g} \quad , \tag{4c}$$

$$\text{Summarized:} \quad \sum_{a=6}^{8} S_{z,a}M^{\text{FPE}}_{z,(1985+a-7)}. \tag{4d}$$

As the birth year assigned to the magnitude measure in (4) moves later, an extra grade of free schooling is added to the calculation. This pattern continues through age 8, the last age at which the school entry decision is made in the pre-FPE environment. The age-specific calculations for these three ages are summarized in a single term in equation (4d).

For starting ages 9 to 12, the first part of the calculation simply interacts the entry probability with the maximum potential magnitude from equation (1). In addition to entrants at each of these ages, there exists a stock of marginal students who would have entered school between the ages of 6 and 8 if they could have done so for free, but faced a fee when they made their initial decision. At each age, this stock of students is denoted by $(S_{z,a} - S_{z,a,\text{pre}})$. As in equation (3), $S_{z,a,\text{pre}}$ is a set of relative starting ages but scaled to equal the fraction of students who entered school in the pre-reform environment, such that $\sum_{a=6}^{12} S_{z,a,\text{pre}} = (1 - F_{z,0})$. The reform's impact for entrants of ages 9 to 12 is then written as

$$M^{\text{FPE}}_{z}\sum_{a=9}^{12} S_{z,a} + [(10)F_{z,0}]\frac{1}{e^{9-7}}\sum_{a=6}^{8}(S_{z,a} - S_{z,a,\text{pre}}) \tag{5}$$

where, in addition to the post-reform entrants, the stock of outstanding would-be entrants makes the decision on whether to enter exactly one time, at the youngest possible age. These marginal students who are able to enter in the post-reform period for the first time at age 9 also gain 10 free years of schooling. Finally, by

delaying entry, it is likely that some fraction of would-be entrants are now tied to other responsibilities and constrained from entering at later ages. This constraint is represented by the fraction $\frac{1}{e^{a-7}}$, where a is equal to the age of entry being considered, in this case 9. As the post-reform age gets closer to 7, the legal age of entry, this constraint approaches 1 and binds fewer students from delayed entry.

The full starting-age-adjusted intensity of the FPE reform for the 1985 cohort is then

$$I^{\text{FPE}}_{z,1985} = \sum_{a=6}^{8} S_{z,a} M^{\text{FPE}}_{z,(1985+a-7)} + M^{\text{FPE}}_{z} \sum_{a=9}^{12} S_{z,a} + [(10)F_{z,0}] \frac{1}{e^{9-7}} \sum_{a=6}^{8} (S_{z,a} - S_{z,a,\text{pre}}). \tag{6}$$

Equation (6) is a combination of (4d) for pre-FPE starting ages and (5) for post-FPE starting ages. Iterating equation (6) forward three years, when even six-year-old entrants are post-reform, demonstrates that the 1988 cohort is the first fully post-reform cohort:

$$I^{\text{FPE}}_{z,1988} = \sum_{a=6}^{12} S_{z,a} M^{\text{FPE}}_{z} = M^{\text{FPE}}_{z} \sum_{a=6}^{12} S_{z,a} = M^{\text{FPE}}_{z}. \tag{7}$$

Every cohort born in 1988 or later is affected by the maximum potential magnitude of the reform, M_z.[4]

The average of the FPE intensity measure I^{FPE}_{zy} in regions without any MTI introduction is shown as the solid black line in fig. 2, for each cohort. For comparison and to demonstrate the type of variation in the intensity measure, the FPE measure is also shown for Addis Ababa, the most educated region in the country. The height of each line can be considered the number of additional free years generated by the FPE reform. Prior to the reform, there were more students in higher grades in Addis Ababa, leading to a greater effect size in earlier cohorts; but due to the higher level of initial schooling, the maximum magnitude of the effect in Addis Ababa is much smaller. Not only does the intensity measure predict larger increases in areas with lower levels of initial schooling, but it also generates significant variation in the path of the predicted effect across cohorts prior to the post-reform period.

4 Data

4.1 Data Sources

Individual-level outcome data for Ethiopian women are from the 2005, 2011, and 2016 rounds of the Ethiopian Demographic and Health Survey (DHS) (Central Statistical Agency of Ethiopia 2005; 2011; 2016). The DHS data used in this article are from the merged individual women and birth history datasets, and include data

[4]The explicit set of equations used for all cohort-specific intensity calculations can be found in Appendix Section A.

from 58 of Ethiopia's 60 zones and 30 of the 32 non-MTI zones.[5] The data available for individual women in the DHS include detailed information on birth date, district of residence, education, health, contraceptive use, and employment. To further analyze the main outcome of the study with an alternative sample, data from the 2007 Ethiopian census are also combined with the DHS data. The census data include information on age, schooling, and total number of births. These data can be used to demonstrate that the conclusions of this study are not unique to the DHS sample.

4.2 Summary Statistics

The summary statistics for the DHS data used in this article are presented in table 1. The table shows information for women in the last three fully pre-reform cohorts, 1968 to 1970, and the first three entirely post-reform cohorts, 1988 to 1990. Although later cohorts are younger, they have higher levels of schooling and literacy and far fewer births. The extremely low number of births in the post-reform sample is likely due to women in this sample being no older than 26. For this reason, it can be informative to examine whether the reduction in fertility is also seen at specific ages; these samples include only women older than the stated age, and allow for a more direct comparison. The number of births to women at the ages of 20 and 25 are also found to decline by over 60 percent between the two cohort groups. This magnitude is consistent with the observed decline in ideal family size. Younger women are significantly less likely to work in the unskilled manual or agricultural sectors, and are slightly more likely to work in either of the other two employment categories, skilled manual or professional and service or sales. Finally, probably because of the increased literacy rate, younger cohorts are more likely to have recently read about family planning, although they are no more likely to report knowledge of modern contraceptive methods.

5 Estimation Strategy

The central estimating model is a 2SLS model. The first stage is defined by the equation

$$\text{YrsSchl}_{izy} = \theta_0 + \theta_1 I_{zy}^{\text{FPE}} + \sum_{p=1}^{3} \theta_2^p \, \text{Age}_{izy}^p + \delta_z + \tau_y + \delta_z \text{Trend}_y + \nu_{izy}. \tag{8}$$

The dependent variable is YrsSchl_{izy}, the years of schooling for person i from zone z born in year y; I_{zy}^{FPE} is the zone- and birth-year-specific estimated intensity of FPE, as described in Section 3. The first-stage estimate of θ_1 can be interpreted as the impact of providing an additional fee-free year of school. A third-

[5] DHS geocodes and administrative district data are cross-referenced with administrative boundaries using two sources: IPUMS International (2017) and the Food and Agriculture Organization GeoNetwork's Global Administrative Unit Layers (GAUL) maps (2015).

order polynomial in age is included to take into account the fact that three waves of the DHS survey are being used, and τ_y is a set of birth-year-specific fixed effects that capture any cohort-specific effects of the reform; δ_z is a vector of zone-specific fixed effects that capture any time-invariant characteristics of the different areas throughout Ethiopia, and $\delta_z \text{Trend}_y$ is a set of zone-specific linear trends that captures secular changes over time within each zone of Ethiopia.[6]

This first-stage equation is used to estimate the exogenous increase in schooling generated by the removal of school fees in Ethiopia. The predicted increase in schooling can then be used in the second stage to estimate the causal relationship between schooling and births or any other outcome of interest:

$$B_{izy} = \alpha_0 + \beta \widehat{\text{YrsSchl}}_{izy} + \sum_{p=1}^{3} \alpha_2^p \, \text{Age}_{izy}^p + \phi_z + \mu_y + \phi_z \text{Trend}_y + \varepsilon_{izy}. \tag{9}$$

The dependent variable B_{izy} is the outcome of interest, initially the number of births to person i from zone z born in year y. The second-stage equation uses the same set of control variables as equation (8), and the coefficient on the predicted years of schooling, β, captures the causal impact of one additional year of schooling exogenously generated by the education reform. The baseline specification used throughout the article includes all women born between 1970, the first fully pre-reform cohort, and 1988, the fully post-reform cohort. Standard errors are clustered by zone to allow for within-zone correlation (Bertrand et al., 2004).

The ordinary least squares (OLS) relationship between schooling and fertility can be studied using a modified version of equation (9), where the predicted level of schooling is replaced with each individual's actual level of schooling, YrsSchl_{izy}. However, the OLS estimates are likely biased if schooling is correlated with unobservable characteristics that also affect the number of children women choose to have. If women who are more likely to achieve higher levels of schooling also have higher economic ambition and lower levels of desired fertility, the OLS estimates would be biased upward, overstating the true relationship. Alternatively, measurement error in schooling could lead to a downward bias of the OLS estimate that may even be larger than the ability bias that is more often discussed (Card, 2001). In fact, causal work in sub-Saharan Africa that directly compared OLS and instrumental variables (IV) estimates found evidence that OLS estimates significantly underreport the relationship between schooling and fertility (Osili and Long, 2008).

The central assumption underlying this identification strategy is that education reforms in Ethiopia, such as the removal of school fees, impact women's fertility decisions only through the effect on their level of schooling. This requires that contemporaneous changes in government policy and the conclusion of the

[6]The set of fixed effects and trends is similar to what was used in the empirical strategy employed by a number of previous studies to evaluate education reforms, including Black et al. (2005), Bleakley (2010), Lucas and Mbiti (2012a,b), Fort et al. (2016), Holmlund et al. (2011), and Lundborg et al. (2014).

Ethiopian civil war not be correlated with year of birth and pre-reform levels of schooling in the same way as the FPE reform. Potential bias generated by contemporaneous changes in educational investments, the impact of the civil war, and the 2000 law banning marriage for those under 18 are explored in more detail in Section 6.4. Additionally, it would be problematic if women and families relocated at the time of the reform's implementation in such a way that higher-ability students sorted into areas with higher predicted intensity of the reform. However, this type of sorting is unlikely to occur in the studied setting. First, data from the 2016 Living Standards Measurement Study show that 86 percent of respondents in the relevant cohort range live in their region of birth. Furthermore, the intensity measure is explicitly designed to predict a greater impact of the reform in areas with lower initial levels of schooling. A violation of this assumption would entail the unlikely scenario that higher-ability students' families were moving to areas that were worse off at the time of reform implementation, even though they could have received the same reduction in fees in their original education zone.

6 Results

6.1 Effect of FPE on Years of Schooling and Fertility

To begin the analysis, the OLS relationship documents the general correlation seen in the data. This is done by estimating equation (9) using the reported years of schooling from the data, not the predicted level from the first stage. A negative relationship between fertility and schooling has been well documented in the literature (Ainsworth et al., 1996; Lam and Duryea, 1999; Schultz, 1994, 1997). The OLS estimates are shown in column 1 of table 2. The estimates in panel A use data from both the census and the DHS, those in panel B use census data only, and those in panel C use only DHS data. Unsurprisingly, the OLS model estimates a strong negative relationship between schooling and fertility. However, these estimates are unlikely to describe a causal relationship between schooling and fertility if unobserved characteristics that impact women's schooling also affect the fertility decision. To address this concern, an exogenous increase in schooling generated by the FPE reform in Ethiopia is identified, and an IV technique is used to investigate the impact of this increase in education on women's fertility.

To examine whether exposure to FPE in Ethiopia generated an identifiable increase in years of schooling, the first-stage equation, equation (8), is estimated using each combination of data. The estimates in column 2 of table 2 show that for each additional year of free schooling made available, years of schooling increased by over one-tenth of a year. This relationship is statistically significant at the 95 percent confidence level for all three samples, and at the 99 percent confidence level when the census data are included. The first-

stage F-statistic ranges from 5.93 to 37.62.[7] For all three samples, the intensity measure predicts a strong negative relationship between exposure to the FPE reform and number of children born. In column 3, reduced-form estimates show that each additional year of free schooling made available reduces the number of births by between 0.057 and 0.064. Estimates across all three samples yield values that are qualitatively and quantitatively similar, providing evidence that the associations found in table 2 are not reliant on any one source of data.

The results from the first stage demonstrate a broad strength in the intensity measure's ability to identify the increase in schooling generated by FPE in Ethiopia. Estimating the second stage of the 2SLS model focuses on the relationship between the predicted level of schooling and birth rates, as described by equation (9). The results in column 4 of table 2 demonstrate that the exogenous increase in schooling generated by the reform led to a reduction in fertility of 0.437 births for each additional year of schooling when using the combined sample. The estimate is larger when using the more recent data from the DHS, but remains similar across all three data combinations. Each estimate is statistically significant at the 99 percent confidence level.[8] Consistent with the findings in table 2, 2SLS estimates obtained by Osili and Long (2008) for Nigeria, Keats (2018) for Uganda, and Fort et al. (2016) for the United Kingdom are significantly larger in magnitude than the negative OLS relationship, and Zenebe Gebre (2018) found similar evidence in Malawi linking schooling to reductions in fertility.

6.2 Mechanisms

The results in table 2 provide evidence that additional schooling generated by the removal of school fees led to a reduction in fertility for Ethiopian women. This subsection explores in greater detail the decisions and changes in behavior that may be driving the relationship between schooling and fertility.

Once married, there are three broad, but not mutually exclusive, avenues through which the household fertility decision is made. First, the increase in schooling could increase a woman's opportunity cost of time, impacting her desired number of children. Second, increased schooling could potentially lead to a change in relative bargaining power over the joint fertility decision, and this is likely to lower fertility rates because women generally desire fewer children than their husbands.[9] A change in the use of contraception, especially of forms not visible to the spouse, could be one way in which a change in the bargaining position might be observable in the data. Finally, higher levels of schooling could lead to different outcomes in the marriage

[7] The first stage F-statistics for the DHS-only data are less than 10; therefore, Anderson and Rubin (1949) confidence sets are given in the supplementary online appendix for all DHS-only 2SLS estimates from the main body of the article.

[8] Across all three samples, the upper bound of the Anderson-Rubin weak IV robust confidence sets is never more positive than -0.265 (Appendix Table B.1).

[9] More than one in three women from pre-reform cohorts report their husband wanting more children than they do, while only nine percent report that they would like to have a larger family than their husband.

market, potentially affecting the characteristics of a woman's husband and his ideal family size. In addition, it is important to consider that the schooling reform in Ethiopia may also have directly affected the extensive margin decision to marry and the timing of a woman's first birth.

The first two points are directly investigated in the following subsections using data available from the DHS. However, with only the non-MTI regions of the country and the timing of the reform relative to the data collection, restricting the sample to examine the characteristics of only married women and their husbands removes too many post-reform women from the latest cohorts and significantly weakens the predictive power of the first-stage estimate. Therefore, the discussion regarding impact of schooling on the timing of marriage and births and on the characteristics of husbands will be in the context of the national sample after also taking the MTI reforms into account.[10]

Examining the first two potential channels yields evidence that additional schooling leads to women being more literate, less tolerant of domestic abuse, and increasingly likely to work in more productive sectors of the economy. The increase in the opportunity cost of their time generated by this increase in productivity is associated with a decline in the women's ideal number of children. However, there is no consistent evidence of changes in contraception use, investments in health, or control over household decisions. These findings largely isolate economic motivations such as the increased opportunity cost of time, which is associated with a woman's decreased demand for children, as the central driver of the reduction in fertility.

6.2.1 Knowledge, Beliefs, and Contraception Use

To form any expectation that the increase in schooling could lead to improved labor market access or understanding of healthcare, it is important to first demonstrate that learning occurred for Ethiopian women during their additional time in school. Estimates in column 1 of table 3 demonstrate that the additional schooling generated by the reform led to a large increase in literacy, and the estimate in column 2 provides evidence that each additional year of schooling led to an increased likelihood of 4.7 percentage points of reading about family planning in a periodical.[11] Although the increase in schooling led to an increased likelihood of reading about family planning, general knowledge of family planning methods is widespread and unaffected by the reform, as shown by column 3. Additionally, the increase in literacy and access to information did not lead to statistically significant changes in health, as measured by body mass index (BMI) and, to take into consideration early-in-life investments, height.

[10] Husbands are, on average, more than seven years older than their wives; therefore, unless the reform reduces the age of the matched husband, even women born in the latest year of the sample, 1988, will have husbands who are on average not greatly affected by the removal of school fees. The median age difference ranges from six to seven years throughout the sample.

[11] The literacy variable is equal to 1 if the respondent demonstrates that they are able to read a complete sentence and is equal to 0 otherwise. These outcomes are shown for a combined sample of men and women in Chicoine (2019), and the increased effect on literacy is consistent with the findings from a combined sample that includes observations from the 2007 census and the 2016 Living Standards and Measurement Study.

One of the three key channels through which schooling could impact fertility is via an increase in women's control over household decisions. The estimate in column 6 of table 3 suggests that the increase in schooling may change the way women view their marriage partnership. In the DHS, women were asked about five possible justifications for domestic violence, and each additional year of schooling decreased the number of reasons women find acceptable. This is largely driven by reductions in accepting the refusal of sex or burning of food as acceptable reasons.[12] With an updated view on marriage and increased access to knowledge, a possible way for Ethiopian women to increase control over the fertility decision is through increased use of contraception. However, the estimate in column 7 shows no evidence that additional schooling led to an increase in the use of modern methods of contraception. The possibility that this null finding is driven by the husband's preferences might mean that women become more likely to conceal their contraception use. To investigate this possibility, the indicator variable used in column 8 is only set equal to 1 if the method of contraception used is not visible to the husband (Ashraf et al., 2014). The estimated effect of schooling on hidden contraception use is again not statistically significant.

The results in table 3 show that while the increase in schooling improved women's literacy and access to healthcare information, it did not lead to increased use of available healthcare resources to exert higher levels of control over their fertility decisions. These findings provide initial evidence that schooling did not improve the power of Ethiopian women to make household fertility decisions. In addition, among married women throughout Ethiopia, exposure to the reform appears not to increase their belief that they should be able to make decisions about traveling to see family, personal healthcare, and household purchases.[13] Like the healthcare results, these findings reinforce the idea that the increase in schooling has helped women to better understand their opportunities and their right not to fear violence within their household, but that it has not led to improvements in their ability to control household decisions. This evidence suggests that increased bargaining power is unlikely to play a role in post-marriage reductions in fertility.

6.2.2 Effect on the Labor Market

Although the results in Section 6.2.1 provide evidence that there is no improvement in women's relative position within the household, the increase in schooling could still lead to women exerting increased influence on the household fertility decision by lowering their desired number of children. If the reform is not merely increasing schooling but also generating learning, as is suggested by the evidence in table 3, this could also lead to improved labor market outcomes for Ethiopian women. This increase in productivity would generate an increase in the cost of the women's time—and an increase in their opportunity cost of raising children.

[12] Coefficient estimates for the five separate justifications of domestic violence can be found in Appendix Table B.4.

[13] Coefficient estimates for the empowerment outcomes can be found Coefficient estimates for the empowerment outcomes can be found in Appendix Table C.15.

An increase in opportunity cost would manifest itself in a reduced demand for children and a smaller ideal family size. This reduction in women's bargaining position would have the effect of lowering household fertility levels and is explored in this subsection.

Table 4 examines the impact of increased schooling on labor market outcomes in columns 1–4, and on a woman's ideal number of children in column 5. The estimated impact of schooling on the likelihood of working is large but not statistically significant at the 90 percent confidence level. However, each additional year of schooling does increase the likelihood of working in a professional or skilled occupation by 5.9 percentage points; this result is statistically significant at the 95 percent confidence level. The category of skilled/professional occupations includes the professional, clerical, and skilled manual job groups in the DHS; common occupations in these groups include teaching, healthcare-related work, associate business administration, and crafts, garment, and trade work. The increase in employment in the skilled and professional sector seems to be driven by a reduction in the likelihood of employment in the unskilled and agriculture sectors, although the estimated effect in these sectors is not statistically significant at conventional levels. Furthermore, the employment results are not being driven by employment decisions of the husband. Only 14 percent of women in Ethiopia work at the same job as their husband; when they are removed from the sample, the estimated effect of a year of schooling on the likelihood of skilled/professional employment remains large, 0.058, and statistically significant at the 95 percent confidence level.[14]

The final column of table 4 examines whether the increase in education generates the expected negative relationship between the opportunity cost of time and ideal family size. The estimate in column 5 indicates that each additional year of schooling reduces a woman's ideal number of children by 0.786. The magnitude of this change is larger than the estimated reduction in number of births in table 2.[15] This provides evidence that the increased labor market productivity is leading to women desiring fewer children, one of the three pathways through which the household fertility decision is made, but also that they may be constrained away from fully adjusting the number of births to match their desired change.

6.3 National Results with Consideration of Mother Tongue Instruction

The analysis is repeated by including the four MTI regions and adding intensity measures for the predicted exposure to the new language of instruction. Detailed discussion of the impact of the MTI program on schooling outcomes can be found in Chicoine (2019), and the calculations of the region-specific intensity measures can be found in Appendix Section C. The inclusion of the MTI regions and consideration of the combined effect of the FPE and MTI reforms yields estimates that are consistent with those discussed in the

[14] These estimates can be found in Appendix Table C.12.

[15] Ideal number of children is censored at 20; no women in the DHS report having more than 18 children. Non-numerical responses are assigned the maximum value, and a tobit model is estimated.

preceding subsections.

The estimated effect of each additional year of schooling on fertility is smaller when the MTI regions are included: each additional year of schooling yields 0.273 fewer births. However, the estimated effect is statistically significant, at no less than the 95 percent confidence level across all three dataset combinations. The national estimates also yield similar conclusions for literacy, the likelihood of reading about family planning, and reduced acceptance of domestic violence. Similar to the FPE-only estimates, inclusion of the MTI reform and regions in the analysis also generates evidence that women become more likely to work in skilled/professional occupations, and produces slightly larger point estimates in the reduction of ideal family size, although with a p-value of 0.16.[16]

The introduction of the MTI reform in the analysis both increases the size of the dataset and adds extra sources of variation via the region-specific introductions of the new languages of instruction. In addition to replicating the previous analysis, the inclusion of the MTI reform allows for analyses that focus on subsets of the data. First, to study the impact of schooling on the marriage market, the sample is restricted to include only married women. This analysis finds evidence that the increase in women's schooling leads to their marrying men with higher levels of schooling, even though husbands are an average of seven years older than their wives and largely unaffected by the reforms. Furthermore, husbands are more likely to be working in service and sales sectors, and are no more likely to want more children than their wives, even when she desires fewer children. These findings again suggest that improvements in labor market outcomes and an increased opportunity cost of time are likely the drivers of reductions in fertility.

The extension also allows for an examination of how schooling impacts the timing of birth and marriage decisions at specific ages. These results provide evidence that the reforms reduce the likelihood of a woman being married at the ages of 21 to 24, and they reduce the likelihood of a woman's first birth occurring between ages 23 and 25.[17] This suggests that the reforms are leading to a postponement of marriage and first birth for women in their early twenties. This timing, significantly after the completion of primary school, reduces the possibility of an incarceration effect driving the results. A remaining concern is that postponements of early fertility decisions tend to be replaced by additional births at later ages (Black et al., 2008; Geruso and Royer, 2018). However, the reforms in Ethiopia have a greater negative effect on fertility at each subsequent age from 22 through 29; the evidence suggests that the reduction in fertility actually increases as women age.[18]

[16] All estimates of joint effect of both reforms can be found in Appendix Section C.3.
[17] These results can be found in Appendix Figure C.2.
[18] These results can be found in Appendix Figure C.1.

6.4 Threats to Validity

6.4.1 Contemporaneous Investment in Lagging Areas

The post-reform magnitudes from equation (1) are inversely related to pre-reform levels of schooling. If the government matched the FPE program with increased levels of investment in lagging regions of the country, these investments would be correlated with post-reform levels of the intensity measure. Examining the correlation between pre-reform education levels and the change in regional spending on education would provide insight into how funding was allocated following the implementation of the reform; finding a strong negative correlation would suggest a disproportionate increase in funding to areas with lower pre-reform levels of schooling. Levels of regional per-student spending in 1993, the first year for which data are available, exhibit a strong positive correlation with pre-reform education levels, as would be expected. Then comparing pre-reform education levels with the growth in spending through 1996, as the reforms are implemented, and through 2001, well after the implementation, yields correlations of 0.01 and 0.17, respectively (World Bank, 2005). This indicates that there is very little relationship between pre-reform education levels and the post-reform investment decisions of the regional governments.

Furthermore, the inclusion of the MTI reform in the analysis does not change the article's main results. A beneficial characteristic of including the MTI reform is that the identification strategy of the combination of the FPE and MTI reforms does not simply exploit a change in policy at a single point in time; the variation exploited by the joint reforms is introduced at four points in time, in different parts of the country. The initial returns to MTI in Tigray were found to be positive; this was followed by the introduction of MTI with script change in three additional regions, which initially put downward pressure on schooling prior to the removal of school fees (Chicoine, 2019). The remaining seven regions of the country were then positively affected by the removal of school fees in 1995. The pattern of results for schooling, fertility, and the mechanisms linking the two are largely consistent; therefore, any alternative explanation would have to follow this pattern, significantly reducing the possibility that the intensity measure is capturing spurious correlations that could be assigned to a competing policy. The pattern of implementation is likely unique to the combination of the FPE and MTI reforms.

6.4.2 Quality

One concern is that increases in class size that occurred after the implementation of the reform could lead to a reduction of quality of education following the reform. However, this reduction in education quality would not directly impact the first stage, which measures years of schooling, not learning. Any reductions in quality of education correlated with larger increases in enrollment would simply make it less likely that

there is any impact of the increase in schooling on later-in-life outcomes. It is doubtful that less learning (lower-quality education) in the early years of primary school would lead to reduced fertility and improved future labor market outcomes. If anything, even for students that would have attended school anyway, this would likely attenuate estimates toward zero. The evidence of these long-term improvements and evidence of significant increases in literacy suggest that learning occurred at a level sufficient to generate consequential later-in-life improvements.

6.4.3 Conclusion of Ethiopian Civil War

The long-simmering conflict in Ethiopia erupted in the late 1980s, with a vast majority of the fighting occurring to the north of the capital, Addis Ababa. Geocoded data from the Uppsala Conflict Data Program (Sundberg and Melander, 2013; Croicu and Sundberg, 2015; Allansson et al., 2017) make it possible to match deaths related to "organized violence" that occurred as early as 1989 to the zones used in the study.

To investigate whether characteristics of the areas most affected by the civil war are driving the results, zones are removed at two separate cutoffs and the models re-estimated. The first cutoff removes four zones that had over 4,000 deaths between 1989 and 1991; these zones contained over 75 percent of all deaths during this period. A less restrictive cutoff removes all zones with at least 500 deaths related to organized violence; these zones account for 96 percent of all deaths included in the data. Removing these zones from the data and re-estimating equations (8) and (9) generates similar sets of findings. The results reveal a similar pattern: 12 different first-stage specifications yield a consistent effect of the FPE intensity measure that ranges between 0.098 and 0.135. The 2SLS estimates show that each additional year of schooling led to between 0.254 and 0.550 fewer births for Ethiopian women, estimates that remain both qualitatively and quantitatively similar to the baseline findings of the article.[19]

6.4.4 Child Marriage Law

In 2000, Ethiopia changed the minimum legal age of marriage from 15 to 18. In the following decade, regions throughout the country adopted the law (McGavock, 2015; Garcia Hombrados, 2018). However, the combined FPE and MTI analysis finds statistically significant delays in marriage only between the ages of 21 and 24.[20] This timing means that the result is unlikely to be related to the law outlawing marriage prior to age 18.

[19]These estimates, and those for the paper's other outcomes, using the mortality cutoffs can be found in Panel L and Panel M of tables throughout Appendix Section D.2.

[20]These results can be found in Appendix Figure C.2.

7 Conclusion

This article finds evidence that free primary education led to an increase in schooling in Ethiopia, and that the increase in schooling led to a significant reduction in the number of births for Ethiopian women. This reduction is partially generated through a delay in first marriage and birth, and a reduced demand for children is also found to be associated with new labor market opportunities. There is no evidence of increased empowerment for women or of any change in the likelihood of contraception use. The totality of the evidence suggests that the central mechanism through which the increase in education generated by the removal of school fees reduces fertility is via the increase in women's labor market activity and the associated reduction in their ideal number of children.

The identification strategy employed in this article can be used to causally identify the returns to increased levels of schooling generated by national-level reforms. It provides a powerful tool for examining the return to free primary education in any number of countries, which is an area of research in need of additional attention, as highlighted by 3ie's report (Snilstveit et al., 2016). The results of this article suggest that large increases in enrollment, often generated by the removal of school fees, are able to outweigh any possible negative effect of declining education quality, a finding that is consistent with recent work of Keats (2018) and Zenebe Gebre (2018). This is an important finding because the removal of school fees is a policy lever that has been used in many parts of the world.

References

Ainsworth, M., Beegle, K., and Nyamete, A. (1996). The Impact of Women's Schooling on Fertility and Contraceptive Use: A Study of Fourteen sub-Saharan African Countries. *World Bank Economic Review*, 10(1):85–122.

Allansson, M., Melander, E., and Themner, L. (2017). Organized Violence, 1989-2016. *Journal of Peace Research*, 54(4):574–587.

Anderson, T. and Rubin, H. (1949). Estimation of the Parameters of a Single Equation in a Complete System of Stochastic Equations. *Annals of Mathematical Statistics*, 20(1):46–63.

Ashraf, N., Field, E., and Lee, J. (2014). Household Bargaining and Excess Fertility: An Experimental Study in Zambia. *American Economic Review*, 104(7):2210–2237.

Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How Much Should We Trust Differences-In-Differences Estimates? *Quarterly Journal of Economics*, 119(1):249–275.

Black, S. E., Devereux, P. J., and Salvanes, K. G. (2005). Why the Apple Doesn't Fall Far: Understanding Intergenerational Transmission of Human Capital. *American Economic Review*, 95(1):437–449.

Black, S. E., Devereux, P. J., and Salvanes, K. G. (2008). Staying in the Classroom and Out of the Maternity Ward? The Effect of Compulsory Schooling Laws on Teenage Births. *Economic Journal*, 118(530):1025–1054.

Bleakley, H. (2010). Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure. *American Economic Journal: Applied Economics*, 2(2):1–45.

Boothe, K. and Walker, R. (1997). Mother Tongue Education in Ethiopia: From Policy to Implementation. *Language Problems and Language Planning*, 21(1):1–19.

Card, D. (2001). Estimating the Return to Schooling: Progress on Some Persistent Econometric Poblems. *Econometrica*, 69(5):1127–1160.

Central Statistical Authority (Ethiopia) and ICF (2016). Ethiopia Demographic and Health Survey 2016.

Central Statistical Authority (Ethiopia) and ICF International (2011). Ethiopia Demographic and Health Survey 2011.

Central Statistical Authority (Ethiopia) and ORC Macro (2005). Ethiopia Demographic and Health Survey 2005.

Chicoine, L. (2019). Schooling with Learning: The Effect of Free Primary Education and Mother Tongue Instruction Reforms in Ethiopia. *Economics of Education Review*, 69(April):94–2017.

Clark, D. and Bono, E. D. (2016). The Long-run Effects of Attending an Elite School: Evidence from the United Kingdom. *American Economic Journal: Applied Economics*, 8(1):150–176.

Croicu, M. and Sundberg, R. (2015). UCDP GED Codebook version 2.0. Department of Peace and Conflict Research, Uppsala University.

Finlay, K., Magnusson, L., and Schaffer, M. E. (2013). WEAKIV: Stata Module to Perform Weak-instrument-robust Tests and Confidence Intervals for Instrumental-variable (IV) Estimation of Linear, Probit and Tobit Models.

Food and Agriculture Organization of the United Nations. FAO GeoNetwork. (2015). Global Administrative Unit Layers (GAUL).

Fort, M., Schneeweis, N., and Winter-Ebmer, R. (2016). Is Education Always Reducing Fertility? Evidence from Compulsory Schooling Reforms. *Economic Journal*, 126(595):1823–1855.

Garcia Hombrados, J. (2018). Child Marriage and Infant Mortality: Evidence from Ethiopia. Working Paper No. 1317. Department of Economics, University of Sussex.

Geruso, M. and Royer, H. (2018). The Impact of Education on Family Formation: Quasi-Experimental Evidence from the UK. NBER Working Paper No. 24332.

Heugh, D. K., Benson, C., Bogale, B., and Yohannes, M. A. G. (2007). Study on Medium of Instruction in Primary Schools in Ethiopia. Final Report. Commissioned by the Ministry of Education.

Holmlund, H., Lindahl, M., and Plug, E. (2011). The Causal Effect of Parents' Schooling on Children's Schooling: A Comparison of Estimation Methods. *Journal of Economic Literature*, 49(3):615–651.

Kattan, R. B. and Burnett, N. (2004). User Fees in Primary Education. World Bank Education Advisory Service.

Keats, A. (2018). Women's Schooling, Fertility, and Child Health Outcomes: Evidence from Uganda's Free Primary Education Program. *Journal of Development Economics*. Forthcoming.

Lam, D. and Duryea, S. (1999). Effects of Schooling on Fertility, Labor Supply, and Investments in Children, with Evidence from Brazil. *Journal of Human Resources*, 34(1):160–192.

Lucas, A. M. (2010). Malaria Eradication and Educational Attainment: Evidence from Paraguay and Sri Lanka. *American Economic Journal: Applied Economics*, 2(2):46.

Lucas, A. M. (2013). The Impact of Malaria Eradication on Fertility. *Economic Development and Cultural Change*, 61(3):607–631.

Lucas, A. M. and Mbiti, I. M. (2012a). Access, Sorting, and Achievement: The Short-Run Effects of Free Primary Education in Kenya. *American Economic Journal: Applied Economics*, 4(4):226–253.

Lucas, A. M. and Mbiti, I. M. (2012b). Does Free Primary Education Narrow Gender Differences in Schooling? Evidence from Kenya. *Journal of African Economies*, 21(5):691–722.

Lundborg, P., Nilsson, A., and Rooth, D.-O. (2014). Parental Education and Offspring Outcomes: Evidence from the Swedish Compulsory School Reform. *American Economic Journal: Applied Economics*, 6(1):253–278.

McCrary, J. and Royer, H. (2011). The Effect of Female Education on Fertility and Infant Health: Evidence from School Entry Policies Using Exact Date of Birth. *American Economic Review*, 101(1):158–195.

McGavock, T. J. (2015). Child Brides, Bargaining Power, and Reform of Ethiopia's Family Law. Working Paper.

Minnesota Population Center and the Ethiopian Central Statistical Agency (2017). Integrated Public Use Microdata Series, International: Version 6.5.

Negash, T. (1996). Rethinking Education in Ethiopia. Uppsala. Nordiska Afrikainstituet.

Ofcansky, T. P. and Berry, L. B. (1993). Ethiopia, A Country Study. Washington DC. Federal Research Division, Library of Congress.

Osili, U. O. and Long, B. T. (2008). Does Female Schooling Reduce Fertility? Evidence from Nigeria. *Journal of Development Economics*, 87(1):57–75.

Oumer, J. (2009). The Challenges of Free Primary Education in Ethiopia. UNESCO: International Institute for Educational Planning.

Ozier, O. (2018). The Impact of Secondary Schooling in Kenya: A Regression Discontinuity Analysis. *Journal of Human Resources*, 53(1):157–188.

Ramachandran, R. (2017). Language Use in Education and Human Capital Formation: Evidence from the Ethiopian Educational Reform. *World Development*, 98:195–213.

Schultz, T. P. (1994). Human Capital, Family Planning, and Their Effects on Population Growth. *American Economic Review*, 84(2):255–260.

Schultz, T. P. (1997). Demand for Children in Low Income Countries. *Handbook of Population and Family Economics*, 1:349–430.

Seid, Y. (2016). Does learning in mother tongue matter? Evidence from a natural experiment in Ethiopia. *Economics of Education Review*, 55:21–38.

Snilstveit, B., Stevenson, J., Menon, R., Phillips, D., Gallagher, E., Geleen, M., Jobse, H., Schmidt, T., and Jimenez, E. (2016). The Impact of Education Programmes on Learning and School Participation in Low- and Middle-Income Countries. *3ie Systematic Review Summary*, 7.

Sundberg, R. and Melander, E. (2013). Introducing the UCDP Georeferenced Event Dataset. *Journal of Peace Research*, 50(4):523–532.

UNESCO (2007). World Data on Education. Geneva. UNESCO: International Bureau of Education.

USAID (1987). Final Disaster Report: The Ethiopian Drought/Famine. Technical report, USAID, Addis Ababa.

World Bank (2005). Education in Ethiopia: Strengthening the Foundation for Sustainable Progress. Washington D.C. World Bank.

World Bank (2009). Abolishing School Fees in Africa: Lessons from Ethiopia, Ghana, Kenya, Malawi, and Mozambique. Washington D.C. World Bank.

Zenebe Gebre, T. (2014). Effects of Mother Tongue Education on Schooling and Child Labor Outcomes. Working Paper.

Zenebe Gebre, T. (2018). Free Primary Education, Timing of Fertility, and Total Fertility. *World Bank Economic Review*, Forthcoming.

Figures and Tables

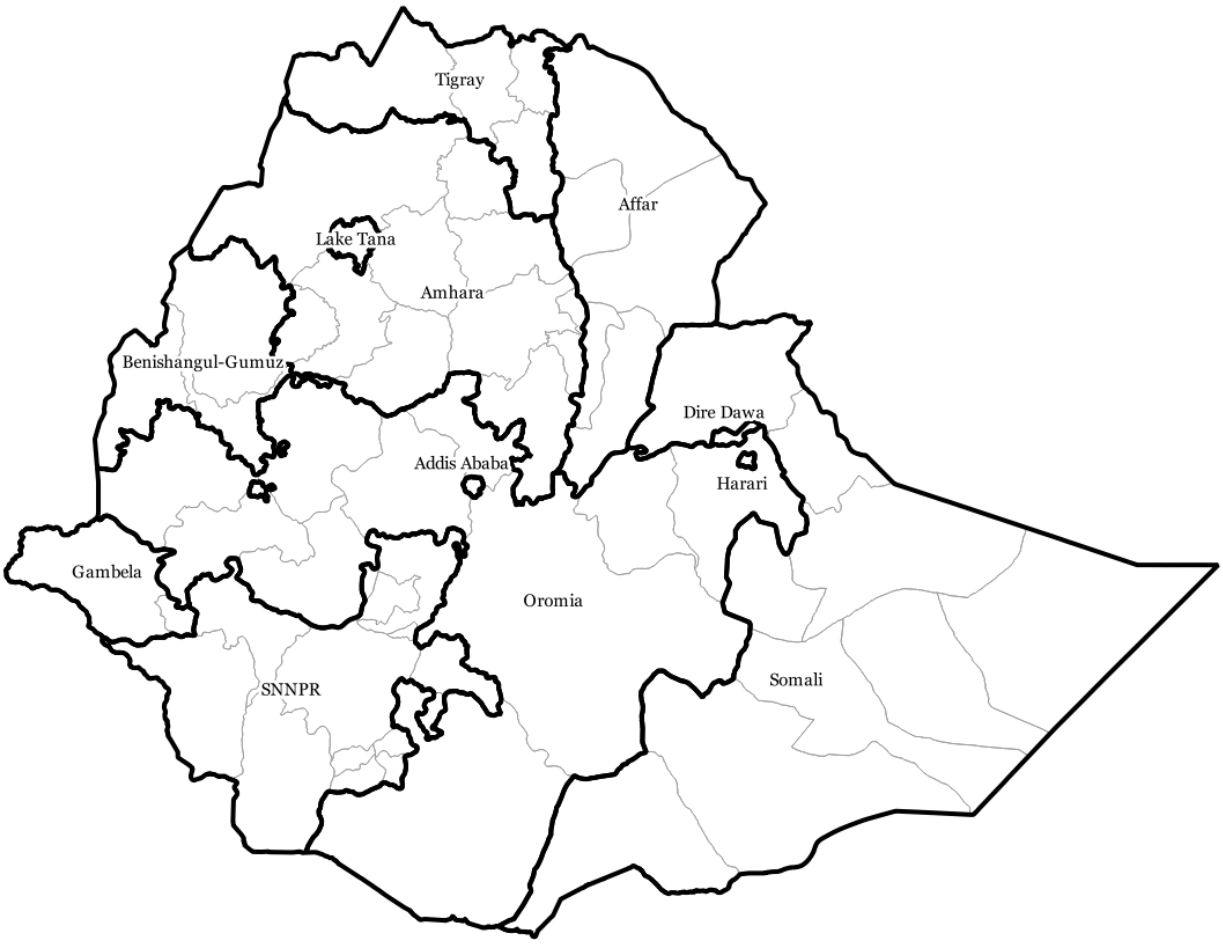


Figure 1: Map of Ethiopian Regions (Dark Border) and Zones.

Source: Author's creation using spatially harmonized first- and second-level administrative boundaries from IPUMS International.

Note: This figure is a reproduction of fig. 1 in Chicoine (2019).

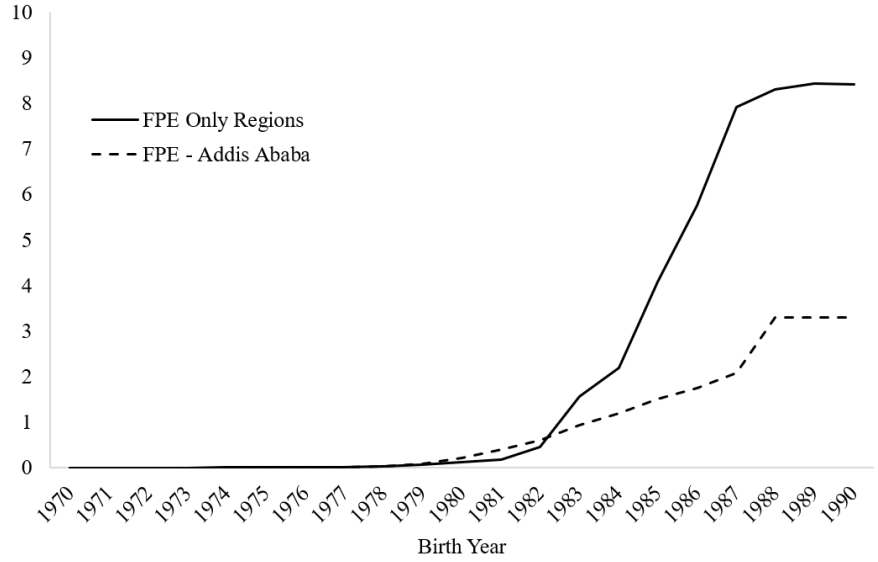


Figure 2: FPE Intensity Measure in Non-MTI Regions, by Birth Year

Source: Author's analysis based on years-of-schooling data from the 1994 Ethiopian census and school-attendance data from the 2007 Ethiopian census.

Note: The figure shows the average maximum number of school years gained following the removal of school fees throughout Ethiopia in 1995. The data are from 30 zones within seven regions—Addis Ababa, Affar, Amhara, Benishangul-Gumuz, Gambela, Harari, Somali—that did not introduce mother tongue instruction (MTI) prior to implementation of the free primary education (FPE) program.

Table 1: Summary Statistics

Birth Cohorts	1968 to 1970		1988 to 1990	
	N	Mean	N	Mean
Years of Schooling	1,448	1.477	2,950	4.140
Literacy	1,430	0.164	2,857	0.427
Number of Births	1,448	5.578	2,950	0.941
Births by Age 20	1,448	1.317	1,654	0.813
Births by Age 25	1,448	2.741	674	1.749
Ideal Number of Children	1,448	7.704	2,950	4.527
Currently Working	1,446	0.321	2,945	0.333
Sector of Current Work				
Skilled Manual or Professional	1,429	0.082	2,912	0.098
Service or Sales	1,429	0.100	2,912	0.138
Unskilled Manual or Agriculture	1,429	0.312	2,912	0.240
Read About Family Planning	1,448	0.063	2,947	0.115
Knowledge of Modern Family Planning Method	1,448	0.920	2,950	0.911

Source: Author's analysis based on data for women in the 2005, 2011, and 2016 rounds of the Ethiopian Demographic and Health Survey (DHS).

Note: Ideal number of children is censored at 20; no women in the DHS report having more than 18 children, and non-numerical responses are assigned the maximum value. Skilled manual or professional jobs include professional, clerical, and skilled manual occupation groups; the other categories exactly describe the included job groups.

Table 2: Effect of Years of Schooling on Number of Children Born

	Number of Children Born (OLS)	**Years of Schooling** (First Stage)	**Number of Children Born** (Reduced Form)	**Number of Children Born** (2SLS)
	(1)	(2)	(3)	(4)
		A. Census + DHS		
Years of Schooling$_{izy}$	-0.120			
	(0.016)			
	[0.000]			
Add'l Years of Free Schooling (I_{zy}^{FPE})		0.131	-0.057	
		(0.034)	(0.016)	
		[0.001]	[0.001]	
Years of $\widehat{\text{Schooling}}_{izy}$				-0.437
				(0.090)
				[0.000]
First Stage F-Statistic		14.80		14.80
Number of Clusters	32	32	32	32
N	83,005	83,005	83,005	83,005
		B. Census Only		
Years of Schooling$_{izy}$	-0.097			
	(0.015)			
	[0.000]			
Add'l Years of Free Schooling (I_{zy}^{FPE})		0.154	-0.064	
		(0.025)	(0.014)	
		[0.001]	[0.000]	
Years of $\widehat{\text{Schooling}}_{izy}$				-0.417
				(0.074)
				[0.000]
First Stage F-Statistic		37.62		37.62
Number of Clusters	32	32	32	32
N	69,083	69,083	69,083	69,083
		C. DHS Only		
Years of Schooling$_{izy}$	-0.130			
	(0.017)			
	[0.000]			
Add'l Years of Free Schooling (I_{zy}^{FPE})		0.112	-0.059	
		(0.046)	(0.021)	
		[0.021]	[0.007]	
Years of $\widehat{\text{Schooling}}_{izy}$				-0.529
				(0.165)
				[0.001]
First Stage F-Statistic		5.93		5.93
Number of Clusters	30	30	30	30
N	13,922	13,922	13,922	13,922

Source: Author's analysis in panel A is based on data from the Ethiopian census of 2007 and from the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016; each data source is used separately in panels B and C.

Note: The dependent variable is years of schooling in column 2 and is number of births in the other three columns. Years of Schooling$_{izy}$ is the reported number of years of schooling from the data; Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted number of years of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age when multiple survey waves are included. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table 3: Effect of Years of Schooling on Knowledge and Health

	Literacy	Read about Fam. Planning	Know about Fam. Planning	BMI (z-score)	Height (z-score)	Acceptable Reasons for Domestic Violence (of 5)	Use Modern Contraception	Use Hidden Contraception
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years of $\widehat{\text{Schooling}}_{izy}$	0.092	0.048	-0.013	0.316	-0.271	-0.361	-0.018	-0.035
	(0.028)	(0.029)	(0.024)	(0.355)	(0.302)	(0.211)	(0.051)	(0.042)
	[0.001]	[0.097]	[0.594]	[0.374]	[0.369]	[0.087]	[0.721]	[0.402]
Mean of Dependent (Pre-Reform Cohorts)	0.164	0.063	0.920	0.085	-0.160	2.318	0.193	0.142
First Stage F-Statistic	6.10	5.92	5.93	1.91	2.22	5.67	5.93	5.93
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: BMI = body mass index. The dependent variable is described at the top of each of the eight columns. In columns 1–3, 7, and 8 it is an indicator that equals 1 if true; in columns 4 and 5 it is a standardized value of the described outcome; and in column 6 it is the count from 0 to 5 of acceptable reasons for domestic violence (going out without permission, neglecting children, arguing with husband, refusing sex, burning food). Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table 4: Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference

		Sector of Work			
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)
Years of $\widehat{\text{Schooling}}_{izy}$	0.093	0.059	0.064	-0.048	-0.786
	(0.058)	(0.028)	(0.047)	(0.031)	(0.468)
	[0.107]	[0.033]	[0.169]	[0.116]	[0.093]
Mean of Dependent (Pre-Reform Cohorts)	0.321	0.082	0.100	0.312	7.704
First Stage F-Statistic	6.06	6.63	6.63	6.63	6.26
N	13,909	13,755	13,755	13,755	13,789

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: The dependent variable is described at the top of each of the five columns. In columns 1–4 it is an indicator that equals 1 if true, and in column 5 it is the ideal number of children. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Ideal number of children is censored at 20; no women in the Demographic and Health Survey report having more than 18 children, and non-numerical responses are assigned the maximum value. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression, and the second-stage estimate in column 5 is generated using a tobit model. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Appendix

Summary of Appendix

Sections

A Timing and Equations for FPE Intensity Measure

B Additional Results: Tables and Figures

C Mother Tongue Instruction

- C.1 Background
- C.2 MTI Intensity Measure, by Region
  - C.2.1 Oromia
  - C.2.2 SNNPR
  - C.2.3 Dire Dawa
  - C.2.4 Tigray
- C.3 National Estimates: Accounting for FPE and MTI
- C.4 Combined Instrument and Reduced Form Estimates, by Age

D Alternative Samples and Specifications

- D.1 Pre-Treatment Trends and Placebo Estimates
- D.2 Alternative Samples and Specifications

Figures

B.1 School Entry Probabilities from Three Census Rounds

C.1 Effect of Reforms on Number of Births, by Age

C.2 Effect of Reforms on Timing of First Birth, Marriage, and Intercourse, by Age

D.1 Comparison of Pre-treatment Trends

Tables

A.1 Timing of FPE Reform with On Time Entry, by Birth Year

Anderson-Rubin Weak IV Confidence Sets

B.1 Effect of FPE on Years of Schooling and Number of Children Born

B.2 Effect of Years of Schooling on Knowledge and Health

B.3 Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference

B.4 Effect of Schooling on Beliefs Regarding Domestic Violence

C.1 Oromia – MTI Implementation

C.2 SNNPR – MTI Implementation

C.3 Dire Dawa – MTI Implementation

C.4 Tigray – MTI Implementation

C.5 MTI+Script Regions: Timing of FPE and MTI Reforms with On Time Entry, by Birth Year

C.6 Tigray: Timing of FPE and MTI Reforms with On Time Entry, by Birth Year

National Estimates with Separate Instruments: Accounting for FPE and MTI

C.7 Effect of Reforms on Years of Schooling and Number of Births (Census + DHS)

C.8 Effect of Reforms on Years of Schooling and Number of Births (Census)

C.9 Effect of Reforms on Years of Schooling and Number of Births (DHS)

C.10 Effect of Years of Schooling on Knowledge and Health

C.11 Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference

C.12 Effect of Years of Schooling on Sector of Employment - Job Different than Husband

C.13 Effect of Schooling on Husband's Characteristics

C.14 Effect of Schooling Regarding Domestic Violence (Married Women Only)

C.15 Effect of Schooling on Beliefs Regarding Women's Empowerment

Tables continued...

C.16 Testing for Differences Across Reform Instruments

National Estimates with Combined Instrument: Accounting for FPE and MTI

C.17 Effect of Reforms on Years of Schooling and Number of Births (DHS)

C.18 Effect of Years of Schooling on Knowledge and Health

C.19 Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference

C.20 Effect of Schooling on Husband's Characteristics

C.21 Effect of Reforms on Likelihood of First Birth, Marriage, and Intercourse, by Age

D.1 Placebo Estimates of Misplaced Timing of Reform Prior to Actual Implementation

D.2 Additional Language(s) in Boothe and Walker (1997) Definition

D.3 Additional Language(s) in Zenebe Gebre (2014) Definition

D.4 Effect of FPE and MTI Reforms on Years of School

D.5 Effect of Reforms on Years of Schooling: Joint Intensity Measure

D.6 Effect of Years of Schooling on Knowledge and Health

D.7 Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference

A Timing and Equations for FPE Intensity Measure

Explicit equations used to calculate the FPE intensity measure $\left(I_{zy}^{FPE}\right)$ for women in each zone z, and birth year y, are listed below. The magnitude $(M_{z,y})$ and start age $(S_{z,a})$ variables used in the calculation are described in Section 3. The timing of how the reform impacts each cohort, assuming school entrance at age seven, is outlined in Appendix Table A.1. Those born in 1972 and who enter school at age 12, five years late, would still complete all ten years of schooling prior to the implementation of the reform (reference the 1977 $(= 1972 + 5)$ birth cohort in Appendix Table A.1). Members of the 1972 birth cohort, or any previous cohort, could start school at any relevant age, from six to 12, and still not be affected by the reform; therefore,

$$I_{z,1972}^{FPE} = 0.$$

Those born in 1973 and entering school at age 12 would potentially receive their tenth year of education for free, but only if they made it through the first nine grades. Those born in 1974 and starting at 12 could potentially have up to two free years of schooling, only if they have completed the first eight grades, and if starting at age 11 only one free year of school, and so on:

$$I_{z,1973}^{FPE} = S_{z,12}M_{z,1978}^{FPE} = S_{z,12}\left(10-9\right)F_{z,9},$$

$$I_{z,1974}^{FPE} = S_{z,12}M_{z,1979}^{FPE} + S_{z,11}M_{z,1978} = S_{z,12}\sum_{g=8}^{9}\left(10-g\right)F_{z,g} + S_{z,11}\left(10-9\right)F_{z,9}.$$

This iteration continues in the same way through the 1981 cohort. All students born through 1981, even those who start school five years late, at age 12, will make the school entry decision in the pre-reform period.

$$I_{z,1975}^{FPE} = S_{z,12}M_{z,1980}^{FPE} + S_{z,11}M_{z,1979}^{FPE} + S_{z,10}M_{z,1978}^{FPE},$$

$$I_{z,1976}^{FPE} = S_{z,12}M_{z,1981}^{FPE} + S_{z,11}M_{z,1980}^{FPE} + S_{z,10}M_{z,1979}^{FPE} + S_{z,9}M_{z,1978}^{FPE},$$

$$I_{z,1977}^{FPE} = S_{z,12}M_{z,1982}^{FPE} + S_{z,11}M_{z,1981}^{FPE} + S_{z,10}M_{z,1980}^{FPE} + S_{z,9}M_{z,1979}^{FPE} + S_{z,8}M_{z,1978}^{FPE},$$

$$I_{z,1978}^{FPE} = S_{z,12}M_{z,1983}^{FPE} + S_{z,11}M_{z,1982}^{FPE} + S_{z,10}M_{z,1981}^{FPE} + S_{z,9}M_{z,1980}^{FPE} + S_{z,8}M_{z,1979}^{FPE} + S_{z,7}M_{z,1978}^{FPE},$$

$$\begin{aligned} I_{z,1979}^{FPE} &= S_{z,12}M_{z,1984}^{FPE} + S_{z,11}M_{z,1983}^{FPE} + S_{z,10}M_{z,1982}^{FPE} + S_{z,9}M_{z,1981}^{FPE} \\ &+ S_{z,8}M_{z,1980}^{FPE} + S_{z,7}M_{z,1979}^{FPE} + S_{z,6}M_{z,1978}^{FPE}, \end{aligned}$$

$$
\begin{aligned}
I^{FPE}_{z,1980} &= S_{z,12}M^{FPE}_{z,1985} + S_{z,11}M^{FPE}_{z,1984} + S_{z,10}M^{FPE}_{z,1983} + S_{z,9}M^{FPE}_{z,1982} \\
&\quad + S_{z,8}M^{FPE}_{z,1981} + S_{z,7}M^{FPE}_{z,1980} + S_{z,6}M^{FPE}_{z,1979},
\end{aligned}
$$

$$
\begin{aligned}
I^{FPE}_{z,1981} &= S_{z,12}M^{FPE}_{z,1986} + S_{z,11}M^{FPE}_{z,1985} + S_{z,10}M^{FPE}_{z,1984} + S_{z,9}M^{FPE}_{z,1983} \\
&\quad + S_{z,8}M^{FPE}_{z,1982} + S_{z,7}M^{FPE}_{z,1981} + S_{z,6}M^{FPE}_{z,1980},
\end{aligned}
$$

The 1982 cohort is the first to incorporate the possibility of post-reform entry, as described in detail in Section 3 using the 1985 cohort as an example. As described with the 1985 example, there is a stock of students at each age that does not enter school when fees are in place, but would have entered if given the opportunity to enter for free ($S_{z,a} - S_{z,a,pre}$). For the 1982 cohort, these students have the opportunity to enter at age 12; at this late age, there is a possibility that they may be tied to some other activity that constrains them from entering school. The further this earliest post-reform entry age is from the legal entry age of seven, the greater the decline in entry for would-be post-reform entrants $1/e^{a-7}$:

$$
\begin{aligned}
I^{FPE}_{z,1982} &= S_{z,6}M^{FPE}_{z,1981} + S_{z,7}M^{FPE}_{z,1982} + S_{z,8}M^{FPE}_{z,1983} + S_{z,9}M^{FPE}_{z,1984} \\
&\quad + S_{z,10}M^{FPE}_{z,1985} + S_{z,11}M^{FPE}_{z,1986} + M^{FPE}_{z}S_{z,12} + [(10)\,F_{z,0}]\,\frac{1}{e^{12-7}}\sum_{a=6}^{11}(S_{z,a} - S_{z,a,pre}),
\end{aligned}
$$

$$
\begin{aligned}
I^{FPE}_{z,1983} &= S_{z,6}M^{FPE}_{z,1982} + S_{z,7}M^{FPE}_{z,1983} + S_{z,8}M^{FPE}_{z,1984} + S_{z,9}M^{FPE}_{z,1985} \\
&\quad + S_{z,10}M^{FPE}_{z,1986} + M^{FPE}_{z}\sum_{a=11}^{12}S_{z,a} + [(10)\,F_{z,0}]\,\frac{1}{e^{11-7}}\sum_{a=6}^{10}(S_{z,a} - S_{z,a,pre}),
\end{aligned}
$$

$$
\begin{aligned}
I^{FPE}_{z,1984} &= S_{z,6}M^{FPE}_{z,1983} + S_{z,7}M^{FPE}_{z,1984} + S_{z,8}M^{FPE}_{z,1985} + S_{z,9}M^{FPE}_{z,1986} \\
&\quad + M^{FPE}_{z}\sum_{a=10}^{12}S_{z,a} + [(10)\,F_{z,0}]\,\frac{1}{e^{10-7}}\sum_{a=6}^{9}(S_{z,a} - S_{z,a,pre}),
\end{aligned}
$$

$$
I^{FPE}_{z,1985} = S_{z,6}M^{FPE}_{z,1984} + S_{z,7}M^{FPE}_{z,1985} + S_{z,8}M^{FPE}_{z,1986} + M^{FPE}_{z}\sum_{a=9}^{12}S_{z,a} + [(10)\,F_{z,0}]\,\frac{1}{e^{9-7}}\sum_{a=6}^{8}(S_{z,a} - S_{z,a,pre}),
$$

$$
I^{FPE}_{z,1986} = S_{z,6}M^{FPE}_{z,1985} + S_{z,7}M^{FPE}_{z,1986} + M^{FPE}_{z}\sum_{a=8}^{12}S_{z,a} + [(10)\,F_{z,0}]\,\frac{1}{e^{8-7}}\sum_{a=6}^{7}(S_{z,a} - S_{z,a,pre}),
$$

$$
I^{FPE}_{z,1987} = S_{z,6}M^{FPE}_{z,1986} + M^{FPE}_{z}\sum_{a=7}^{12}S_{z,a} + [(10)\,F_{z,0}]\,(S_{z,6} - S_{z,6,pre}),
$$

$$
I^{FPE}_{z,1988} = M^{FPE}_{z}
$$

Table A.1: Timing of FPE Reform with On Time Entry, by Birth Year

Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status
1977		Born		1978		Born		1979		Born		1980		Born		1981		Born		1982		Born	
1978		0		1979		0		1980		0		1981		0		1982		0		1983		0	
1979		1		1980		1		1981		1		1982		1		1983		1		1984		1	
1980		2		1981		2		1982		2		1983		2		1984		2		1985		2	
1981		3		1982		3		1983		3		1984		3		1985		3		1986		3	
1982		4		1983		4		1984		4		1985		4		1986		4		1987		4	
1983		5		1984		5		1985		5		1986		5		1987		5		1988		5	
1984		6		1985		6		1986		6		1987		6		1988		6		1989		6	
1985	G1	7		1986	G1	7		1987	G1	7		1988	G1	7		1989	G1	7		1990	G1	7	
1986	G2	8		1987	G2	8		1988	G2	8		1989	G2	8		1990	G2	8		1991	G2	8	
1987	G3	9		1988	G3	9		1989	G3	9		1990	G3	9		1991	G3	9		1992	G3	9	
1988	G4	10		1989	G4	10		1990	G4	10		1991	G4	10		1992	G4	10		1993	G4	10	
1989	G5	11		1990	G5	11		1991	G5	11		1992	G5	11		1993	G5	11		1994	G5	11	
1990	G6	12		1991	G6	12		1992	G6	12		1993	G6	12		1994	G6	12		1995	G6	12	FPE
1991	G7	13		1992	G7	13		1993	G7	13		1994	G7	13		1995	G7	13	FPE	1996	G7	13	FPE
1992	G8	14		1993	G8	14		1994	G8	14		1995	G8	14	FPE	1996	G8	14	FPE	1997	G8	14	FPE
1993	G9	15		1994	G9	15		1995	G9	15	FPE	1996	G9	15	FPE	1997	G9	15	FPE	1998	G9	15	FPE
1994	G10	16		1995	G10	16	FPE	1996	G10	16	FPE	1997	G10	16	FPE	1998	G10	16	FPE	1999	G10	16	FPE

Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status
1983		Born		1984		Born		1985		Born		1986		Born		1987		Born		1988		Born	
1984		0		1985		0		1986		0		1987		0		1988		0		1989		0	
1985		1		1986		1		1987		1		1988		1		1989		1		1990		1	
1986		2		1987		2		1988		2		1989		2		1990		2		1991		2	
1987		3		1988		3		1989		3		1990		3		1991		3		1992		3	
1988		4		1989		4		1990		4		1991		4		1992		4		1993		4	
1989		5		1990		5		1991		5		1992		5		1993		5		1994		5	
1990		6		1991		6		1992		6		1993		6		1994		6		1995		6	
1991	G1	7		1992	G1	7		1993	G1	7		1994	G1	7		1995	G1	7	FPE	1996	G1	7	FPE
1992	G2	8		1993	G2	8		1994	G2	8		1995	G2	8	FPE	1996	G2	8	FPE	1997	G2	8	FPE
1993	G3	9		1994	G3	9		1995	G3	9	FPE	1996	G3	9	FPE	1997	G3	9	FPE	1998	G3	9	FPE
1994	G4	10		1995	G4	10	FPE	1996	G4	10	FPE	1997	G4	10	FPE	1998	G4	10	FPE	1999	G4	10	FPE
1995	G5	11	FPE	1996	G5	11	FPE	1997	G5	11	FPE	1998	G5	11	FPE	1999	G5	11	FPE	2000	G5	11	FPE
1996	G6	12	FPE	1997	G6	12	FPE	1998	G6	12	FPE	1999	G6	12	FPE	2000	G6	12	FPE	2001	G6	12	FPE
1997	G7	13	FPE	1998	G7	13	FPE	1999	G7	13	FPE	2000	G7	13	FPE	2001	G7	13	FPE	2002	G7	13	FPE
1998	G8	14	FPE	1999	G8	14	FPE	2000	G8	14	FPE	2001	G8	14	FPE	2002	G8	14	FPE	2003	G8	14	FPE
1999	G9	15	FPE	2000	G9	15	FPE	2001	G9	15	FPE	2002	G9	15	FPE	2003	G9	15	FPE	2004	G9	15	FPE
2000	G10	16	FPE	2001	G10	16	FPE	2002	G10	16	FPE	2003	G10	16	FPE	2004	G10	16	FPE	2005	G10	16	FPE

Source: Author's summary based on timing of FPE reform and school entry age.

B Additional Results: Tables and Figures

Table B.1: Effect of Years of Schooling on Number of Children Born – Replication of Table 2: Anderson-Rubin Weak IV Robust Confidence Sets

	Census + DHS	Census Only	DHS Only
	(1)	(2)	(3)
	Coefficient on Years of $\widehat{\text{Schooling}}_{izy}$		
Weak IV Robust 95% Confidence Set	-0.676, -0.275 [0.000]	-0.576, -0.285 [0.000]	-1.567, -0.265 [0.003]
First Stage F-Statistic	14.80	37.62	5.93
Number of Clusters	32	32	30
N	83,005	69,083	13,922

Source: Author's analysis based on data from the Ethiopian census of 2007 and the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: IV = instrumental variables. The dependent variable is number of children born. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age when multiple survey waves are included. Column 1 combines data from the Ethiopian census (2007) and the DHS (2005, 2011, and 2016); each data source is used separately in columns 2 and 3. Standard errors are clustered at the zone level, and Anderson and Rubin (1949) confidence sets of the 2SLS estimate are shown along with the p-value from the associated chi-squared test, given in square brackets.

Table B.2: Effect of Years of Schooling on Knowledge and Health – Replication of Table 3: Anderson-Rubin Weak IV Robust Confidence Sets

	Literacy	Read about Fam. Planning	Know about Fam. Planning	BMI (z-score)	Height (z-score)	Number of Acceptable Reason for Domestic Violence (of 5)	Use Modern Contraception	Use Hidden Contraception
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Coefficient on Years of $\widehat{\text{Schooling}}_{izy}$							
Weak IV Robust 95% Confidence Set	-0.046, 0.146 [0.088]	0.014, 0.278 [0.006]	-0.090, 0.062 [0.601]	— —	— —	-1.777, -0.015 [0.042]	-0.082, 0.366 [0.749]	-0.090, 0.278 [0.510]
First Stage F-Statistic	6.10	5.92	5.93	1.91	2.22	5.67	5.93	5.93
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: IV = instrumental variables; BMI = body mass index. The dependent variable is described at the top of each of the eight columns. In columns 1–3, 7, and 8 it is an indicator that equals 1 if true; in columns 4 and 5 it is a standardized value of the described outcome; and in column 6 it is the count from 0 to 5 of acceptable reasons for domestic violence (going out without permission, neglecting children, arguing with husband, refusing sex, burning food). Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Standard errors are clustered at the zone level, and Anderson and Rubin (1949) confidence sets of the 2SLS estimate are shown along with the p-value from the associated chi-squared test, given in square brackets.

Table B.3: Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference – Replication of Table 4: Anderson-Rubin Weak IV Robust Confidence Sets

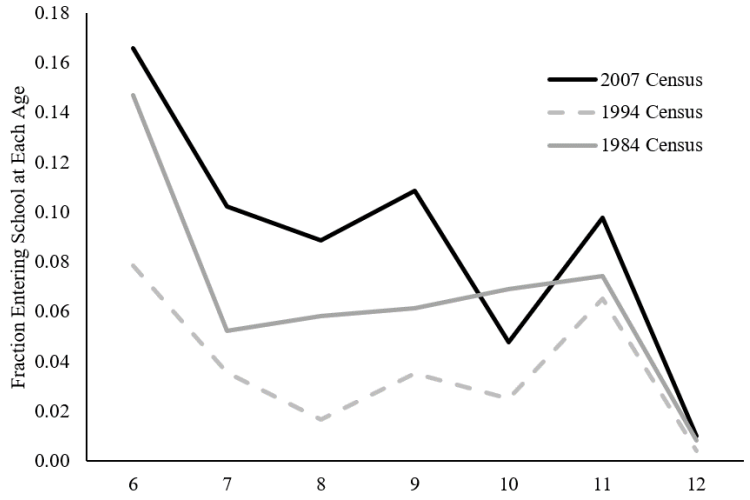
		Sector of Work			
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)
	Coefficient on Years of $\widehat{\text{Schooling}}_{izy}$				
Weak IV Robust 95% Confidence Set	-0.018, 0.382 [0.093]	0.018, 0.218 [0.005]	-0.074, 0.198 [0.228]	-0.178, 0.014 [0.107]	— —
First Stage F-Statistic	6.06	6.63	6.63	6.63	—
N	13,909	13,755	13,755	13,755	13,789

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: IV = instrumental variables. The dependent variable is described at the top of each of the five columns. In columns 1–4 it is an indicator that equals 1 if true, and in column 5 it is the ideal number of children. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Ideal number of children is censored at 20; no women in the Demographic and Health Survey report having more than 18 children, and non-numerical responses are assigned the maximum value. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Standard errors are clustered at the zone level, and Anderson and Rubin (1949) confidence sets of the 2SLS estimate are shown along with the p-value from the associated chi-squared test, given in square brackets. The tobit model with clustered standard errors in column 5 is not compatible with confidence set calculations from Finlay et al. (2013).

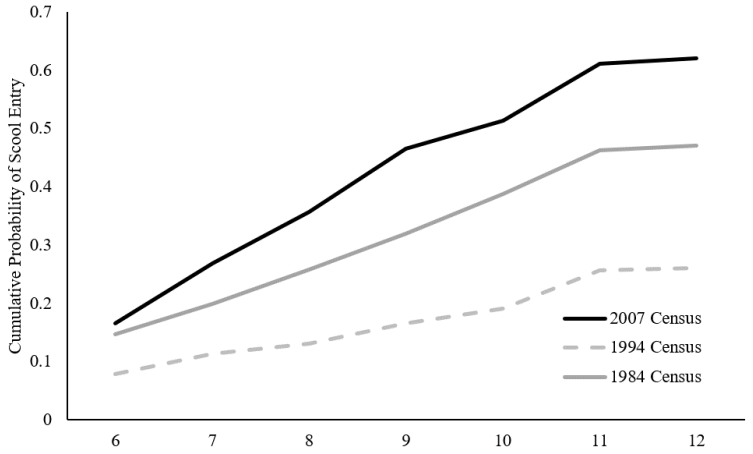
Table B.4: Effect of Schooling and Reforms on Beliefs Regarding Domestic Violence

Beating justified if wife:	Goes Out w/out Permission	Neglects Children	Argues with Husband	Refuses Sex	Burns Food
	(1)	(2)	(3)	(4)	(5)
Years of $\widehat{\text{Schooling}}_{izy}$	-0.045 (0.051) [0.380]	-0.061 (0.072) [0.399]	-0.013 (0.042) [0.753]	-0.099 (0.055) [0.074]	-0.109 (0.061) [0.073]
Mean of Dependent (Pre-Reform Cohorts)	0.537	0.535	0.491	0.408	0.491
First Stage F-Statistic	5.66	6.20	6.05	5.05	5.32
N	13,805	13,803	13,763	13,589	13,800

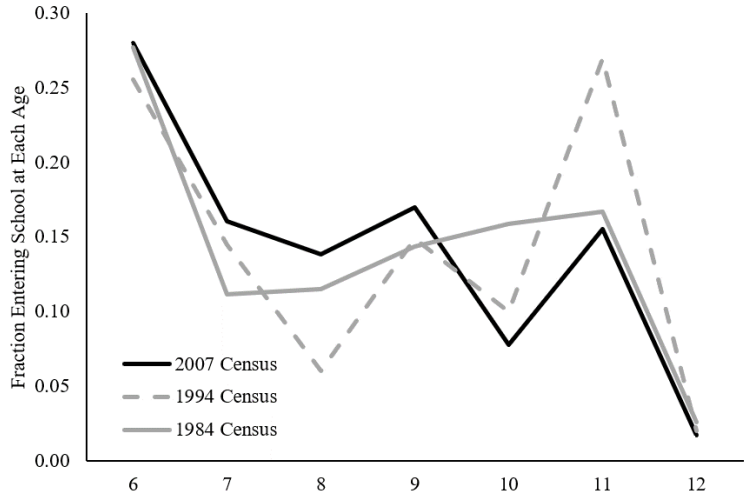
Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: The dependent variable in each column is an indicator that equals 1 if the statement is believed to be true and equals 0 otherwise. The sample includes all women born between 1970 and 1988. A 2SLS model is estimated where Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.



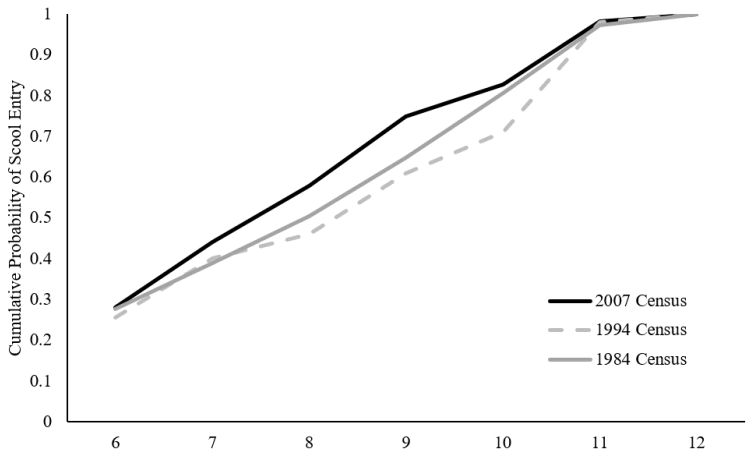
(a) Raw School Entry Probabilities, By Age



(b) Raw Cumulative School Entry Probabilities, By Age



(c) Scaled School Entry Probabilities, By Age



(d) Scaled Cumulative School Entry Probabilities, By Age

Figure B.1: School Entry Probabilities from Three Census Rounds

Source: Author's analysis based on data from the Ethiopian census in years 1984, 1994, and 2007.

C Mother Tongue Instruction

C.1 Background

Ethiopia has more than 80 languages (IPUMS, 2017), and in 1991, for the first time in more than a generation, the transitional government introduced classroom instruction in languages other than Amarigna. Amarigna was the language preferred by the government throughout the previous decades; however, by the end of the Transitional Government's second year in power, the mother tongue language for 80 percent of the country's residents had been introduced as a language of instruction (Boothe and Walker, 1997; Zenebe Gebre, 2014). The introduction of the mother tongue instruction program was complex.[21]

In 1991, the Transitional Government's Council of Representatives selected the first four languages to be introduced in the mother tongue instruction program. These languages were selected from a list of 14 that were originally used in a 1979 adult literacy campaign (Boothe and Walker, 1997). The most common language selected was Oromigna, it was spoken by 31 percent of the population at the time of the 1994 population census, roughly the same portion of the population that spoke Amarigna. The other three languages selected for the initial wave of the program were Tigrigna (6%), Sidamigna (3.5%), and Wolayitigna (2.3%). These languages were respectively the fourth, fifth and sixth most common mother tongues in the country at the time. The selection of what was almost precisely the largest languages reduces concern of favoritism from the central government, and because the new regional boundaries were drawn along traditional ethnolinguistic borders, there was little variability of where the languages could be introduced. The following round of languages were introduced in 1993, this group comprised of Somaligna (6%) and three languages within the diverse Southern Nations, Nationalities, and Peoples' Region (SNNPR) totaling an additional 4 percent of the population (Boothe and Walker, 1997; Zenebe Gebre, 2014).[22] At this point every language spoken by at least two percent of the population had been introduced, and as time passed political calculations are likely to have a role in the selection process for less prominent languages. Therefore, this paper focuses on the implementation of the initial phase of the MTI project.

The final key aspect of the introduction of the MTI program was the need to translate the primary school material from Amarigna into the new languages. Up to this point in time, any written translations of these languages had used the Ge'ez script; however, due to the historical connotations of the use of Amarigna, each region was given the option to use a different script in translation, and every region outside of Tigray selected to translate their schooling material into the Roman script. For Tigray, this allowed them to translate all of the material locally and introduce the MTI program on schedule in 1991 (Boothe and Walker, 1997;

[21] For consistency, each language will be referenced using the name from the 2007 Ethiopian Census.
[22] The languages were Hadiyigna, Gedeogna, and Kembatigna.

Zenebe Gebre, 2014). The translation for the other languages was more problematic and undertaken in a centralized conference in Addis Ababa; to this point none of these languages had widely been translated into the Roman script (Boothe and Walker, 1997; Heugh et al., 2007; Zenebe Gebre, 2014). This process led to the delay of the initial implementation of the other three first-wave languages to the 1992 school year, and the eventual repeating of the process and 1993 introduction of the following four languages.

The analysis of MTI uses dates and languages that are independently corroborated by Boothe and Walker (1997) and Zenebe Gebre (2014). Boothe and Walker (1997) is the most contemporaneous source of information of which I am aware, and Zenebe Gebre (2014) directly contacted each region's education department more than a decade and a half later to gather information on the implementation of MTI throughout the country. Both sources corroborate the introduction of seven of the eight languages outlined here, only Somaligna is missing in Zenebe Gebre (2014), and is removed from the main analysis of the paper to ensure as much accuracy as possible.[23]

C.2 MTI Intensity Measure, by Region

C.2.1 Oromia

Table C.1: Oromia – MTI Implementation

				Fraction of:	
				MT Speakers	Region Speaking
Language	**Year**	**Region**	**Grades**	**Living in Region**	**Language as MT**
Oromigna	1992	Oromia	1-8	0.93	0.84

Source: Author's analysis based on information from Boothe and Walker (1997) and Zenebe Gebre (2014).
Note: MTI = mother tongue instruction; MT = mother tongue.

Assuming that students enter the classroom on time, at age 7, the following equation describes the maximum magnitude of the MTI effect for each cohort in the Oromia region.

$$M_{z,post}^{MTI-O} = w_z \left[\sum_{g=0}^{7} (8-g) \cdot F_{z,g} \right] \qquad \textit{if } y \geq 1984$$

$$M_{zy}^{MTI-O} = w_z \left[\sum_{g=(1984-y)}^{7} (8-g) \cdot F_{z,g} \right] \quad \textit{if } 1977 \leq y \leq 1983 \text{ .}$$

$$M_{zy}^{MTI-O} = 0 \qquad \textit{if } y \leq 1976$$

[23] Alternative definitions of the MTI implementation are explored in Appendix Section D. Results using the specification that includes Somaligna as defined by Boothe and Walker (1997) can be found in Panel P of Appendix Tables D.4 and D.5, and another includes an additional early wave of language introductions through 1994, as defined by Zenebe Gebre (2014), these estimates can be found in Panel Q.

Table C.1 defines the characteristics used in the above Oromia magnitude equation. Grades one through eight use the new language of instruction; therefore, only students who would have completed fewer than eight years are affected. The w_z scalar is the fraction of the population in each zone that speaks the language being introduced, and the post-MTI cohorts begin in 1984, three years prior to the first post-FPE cohort. The timing of MTI in Oromia for on time starters for each birth year-grade combination is shown in Appendix Table (C.5), denoted by parentheses.

The cohort specific magnitudes for on time starters for Oromia $\left(M_{zy}^{MTI-O}\right)$ are translated to the MTI intensity measure to allow for starting age variation using a process similar to that for the FPE intensity measure. The following set of equations describe the explicit calculations used for cohorts in Oromia.

$$I_{z,1971}^{MTI} = 0,$$

$$I_{z,1972}^{MTI} = S_{z,12}M_{z,1977}^{MTI-O},$$

$$I_{z,1973}^{MTI} = S_{z,12}M_{z,1978}^{MTI-O} + S_{z,11}M_{z,1977}^{MTI-O},$$

$$I_{z,1974}^{MTI} = S_{z,12}M_{z,1979}^{MTI-O} + S_{z,11}M_{z,1978}^{MTI-O} + S_{z,10}M_{z,1977}^{MTI-O},$$

$$I_{z,1975}^{MTI} = S_{z,12}M_{z,1980}^{MTI-O} + S_{z,11}M_{z,1979}^{MTI-O} + S_{z,10}M_{z,1978}^{MTI-O} + S_{z,9}M_{z,1977}^{MTI-O},$$

$$I_{z,1976}^{MTI} = S_{z,12}M_{z,1981}^{MTI-O} + S_{z,11}M_{z,1980}^{MTI-O} + S_{z,10}M_{z,1979}^{MTI-O} + S_{z,9}M_{z,1978}^{MTI-O} + S_{z,8}M_{z,1977}^{MTI-O},$$

$$I_{z,1977}^{MTI} = S_{z,12}M_{z,1982}^{MTI-O} + S_{z,11}M_{z,1981}^{MTI-O} + S_{z,10}M_{z,1980}^{MTI-O} + S_{z,9}M_{z,1979}^{MTI-O} + S_{z,8}M_{z,1978}^{MTI-O} + S_{z,7}M_{z,1977}^{MTI-O},$$

$$\begin{aligned} I_{z,1978}^{MTI} = {} & S_{z,12}M_{z,1983}^{MTI-O} + S_{z,11}M_{z,1982}^{MTI-O} + S_{z,10}M_{z,1981}^{MTI-O} + S_{z,9}M_{z,1980}^{MTI-O} \\ & + S_{z,8}M_{z,1979}^{MTI-O} + S_{z,7}M_{z,1978}^{MTI-O} + S_{z,6}M_{z,1977}^{MTI-O}, \end{aligned}$$

$$\begin{aligned} I_{z,1979}^{MTI} = {} & S_{z,11}M_{z,1983}^{MTI-O} + S_{z,10}M_{z,1982}^{MTI-O} + S_{z,9}M_{z,1981}^{MTI-O} + S_{z,8}M_{z,1980}^{MTI-O} \\ & + S_{z,7}M_{z,1979}^{MTI-O} + S_{z,6}M_{z,1978}^{MTI-O} + M_{z,post}^{MTI-O}S_{z,12} + \left[(8)\,F_{z,0}\right]\frac{1}{e^{12-7}}\sum_{a=6}^{11}\left(S_{z,a} - S_{z,a,pre}\right), \end{aligned}$$

$$\begin{aligned} I_{z,1980}^{MTI} = {} & S_{z,10}M_{z,1983}^{MTI-O} + S_{z,9}M_{z,1982}^{MTI-O} + S_{z,8}M_{z,1981}^{MTI-O} + S_{z,7}M_{z,1980}^{MTI-O} \\ & + S_{z,6}M_{z,1979}^{MTI-O} + M_{z,post}^{MTI-O}\sum_{a=11}^{12}S_{z,a} + \left[(8)\,F_{z,0}\right]\frac{1}{e^{11-7}}\sum_{a=6}^{10}\left(S_{z,a} - S_{z,a,pre}\right), \end{aligned}$$

$$I^{MTI}_{z,1981} = S_{z,9}M^{MTI-O}_{z,1983} + S_{z,8}M^{MTI-O}_{z,1982} + S_{z,7}M^{MTI-O}_{z,1981} + S_{z,6}M^{MTI-O}_{z,1980}$$
$$+ M^{MTI-O}_{z,post}\sum_{a=10}^{12} S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{10-7}}\sum_{a=6}^{9}(S_{z,a} - S_{z,a,pre})\,,$$

$$I^{MTI}_{z,1982} = S_{z,8}M^{MTI-O}_{z,1983} + S_{z,7}M^{MTI-O}_{z,1982} + S_{z,6}M^{MTI-O}_{z,1981} + M^{MTI-O}_{z,post}\sum_{a=9}^{12} S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{9-7}}\sum_{a=6}^{8}(S_{z,a} - S_{z,a,pre})\,,$$

$$I^{MTI}_{z,1983} = S_{z,7}M^{MTI-O}_{z,1983} + S_{z,6}M^{MTI-O}_{z,1982} + M^{MTI-O}_{z,post}\sum_{a=8}^{12} S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{8-7}}\sum_{a=6}^{7}(S_{z,a} - S_{z,a,pre})\,,$$

$$I^{MTI}_{z,1984} = S_{z,6}M^{MTI-O}_{z,1983} + M^{MTI-O}_{z,post}\sum_{a=7}^{12} S_{z,a} + [(8)\,F_{z,0}]\,(S_{z,6} - S_{z,6,pre})\,,$$

$$I^{MTI}_{z,1985} = M^{MTI-O}_{z,post}.$$

C.2.2 SNNPR

Table C.2: SNNPR – MTI Implementation

				Fraction of:	
Language	**Year**	**Region**	**Grades**	**MT Speakers Living in Region**	**Region Speaking Language as MT**
Sidamigna	1992	SNNPR	1-4	0.99	0.18
Wolayitigna	1992	SNNPR	1-4	0.97	0.11
Hadiyigna	1993	SNNPR	1-4	0.96	0.08
Gedeogna	1993	SNNPR	1-4	0.73	0.04
Kembatigna	1993	SNNPR	1-4	0.92	0.04

Source: Author's analysis based on information from Boothe and Walker (1997) and Zenebe Gebre (2014).
Note: SNNPR = Southern Nations, Nationalities, and Peoples' Region; MTI = mother tongue instruction; MT = mother tongue.

Unlike the other regions in the Ethiopia, SNNPR introduces new languages of instruction at two points within the time period MTI is considered. The timing of the 1992 implementation is denoted by brackets in Appendix Table (C.5); however, the following year two additional languages are introduced. This will have the effect of introducing two weights one for the 1992 set of languages ($w_{z,1992}$) and another for the 1993 languages ($w_{z,1993}$). The magnitude for each two introductions is offset by one year, this yields the familiar calculation of the maximum impact for the on time entrants:

$$M_{zy}^{MTI-S} = w_{z,1992}\left[\sum_{g=(1984-y)}^{3}(4-g)\cdot F_{z,g}\right] + w_{z,1993}\left[\sum_{g=(1985-y)}^{3}(4-g)\cdot F_{z,g}\right] \qquad \textit{if } 1982 \leq y \leq 1983$$

$$M_{zy}^{MTI-S} = w_{z,1992}\left[\sum_{g=(1984-y)}^{3}(4-g)\cdot F_{z,g}\right] \qquad \textit{if } y = 1981$$

$$M_{zy}^{MTI-S} = 0 \qquad \textit{if } y \leq 1980$$

After taking into account the differential timing of 1992 and 1993 language introductions, the consideration of starting age variation is similar for the cohorts prior to the post-MTI entry decision.

$$I_{z,1975}^{MTI} = 0,$$

$$I_{z,1976}^{MTI} = S_{z,12}M_{z,1981}^{MTI-S},$$

$$I_{z,1977}^{MTI} = S_{z,12}M_{z,1982}^{MTI-S} + S_{z,11}M_{z,1981}^{MTI-S},$$

$$I_{z,1978}^{MTI} = S_{z,12}M_{z,1983}^{MTI-S} + S_{z,11}M_{z,1982}^{MTI-S} + S_{z,10}M_{z,1981}^{MTI-S}.$$

Beginning with age 12 entrants in the 1979 cohort, the entry decision for speakers of the 1992 languages are affected by the MTI reform; however, the entry decision for speakers of the 1993 languages remains unaffected until the 1980 cohort. This means that the post-reform magnitude must be separated for each of the language implementations. To incorporate this variation in access to MTI, two additional maximum magnitude terms are defined in the following way:

$$M_{z,post}^{MTI-S} = \left[\sum_{g=0}^{3}(4-g)\cdot F_{z,g}\right] \qquad \textit{if } y \geq 1984$$

$$M_{z,1984,93}^{MTI-S} = w_{z,1993}\left[\sum_{g=1}^{3}(4-g)\cdot F_{z,g}\right] \qquad \textit{if } y = 1984$$

The 1992 languages will be post-reform for on time school entrants beginning with the 1984 cohort, and for simplicity, weighting adjustments to the post-reform magnitude are included within the intensity notation below. The intensity measure for the following cohorts can then be calculated as:

$$I_{z,1979}^{MTI} = S_{z,11}M_{z,1983}^{MTI-S} + S_{z,10}M_{z,1982}^{MTI-S} + S_{z,9}M_{z,1981}^{MTI-S} + S_{z,12}M_{z,1984,93}^{MTI-S} + w_{z,92}\left[M_{z,post}^{MTI-S}S_{z,12} + [(4)\,F_{z,0}]\,\frac{1}{e^{12-7}}\sum_{a=6}^{11}(S_{z,a} - S_{z,a,pre})\right]$$

$$
\begin{aligned}
I^{MTI}_{z,1980} &= S_{z,11}M^{MTI-S}_{z,1984,93} + S_{z,10}M^{MTI-S}_{z,1983} + S_{z,9}M^{MTI-S}_{z,1982} + S_{z,8}M^{MTI-S}_{z,1981} \\
&+ M^{MTI-S}_{z,post}\left[w_{z,93}S_{z,12} + w_{z,92}\sum_{a=11}^{12} S_{z,a}\right] \\
&+ [(4)\,F_{z,0}]\left\{w_{z,93}\frac{1}{e^{12-7}}\sum_{a=6}^{11}(S_{z,a} - S_{z,a,pre}) \right. \\
&\left. + w_{z,92}\frac{1}{e^{11-7}}\sum_{a=6}^{10}(S_{z,a} - S_{z,a,pre})\right\},
\end{aligned}
$$

$$
\begin{aligned}
I^{MTI}_{z,1981} &= S_{z,10}M^{MTI-S}_{z,1984,93} + S_{z,9}M^{MTI-S}_{z,1983} + S_{z,8}M^{MTI-S}_{z,1982} + S_{z,7}M^{MTI-S}_{z,1981} \\
&+ M^{MTI-S}_{z,post}\left[w_{z,93}\sum_{a=11}^{12} S_{z,a} + w_{z,92}\sum_{a=10}^{12} S_{z,a}\right] \\
&+ [(4)\,F_{z,0}]\left\{w_{z,93}\frac{1}{e^{11-7}}\sum_{a=6}^{10}(S_{z,a} - S_{z,a,pre}) \right. \\
&\left. + w_{z,92}\frac{1}{e^{10-7}}\sum_{a=6}^{9}(S_{z,a} - S_{z,a,pre})\right\},
\end{aligned}
$$

$$
\begin{aligned}
I^{MTI}_{z,1982} &= S_{z,9}M^{MTI-S}_{z,1984,93} + S_{z,8}M^{MTI-S}_{z,1983} + S_{z,7}M^{MTI-S}_{z,1982} + S_{z,6}M^{MTI-S}_{z,1981} \\
&+ M^{MTI-S}_{z,post}\left[w_{z,93}\sum_{a=10}^{12} S_{z,a} + w_{z,92}\sum_{a=9}^{12} S_{z,a}\right] \\
&+ [(4)\,F_{z,0}]\left\{w_{z,93}\frac{1}{e^{10-7}}\sum_{a=6}^{9}(S_{z,a} - S_{z,a,pre}) \right. \\
&\left. + w_{z,92}\frac{1}{e^{9-7}}\sum_{a=6}^{8}(S_{z,a} - S_{z,a,pre})\right\},
\end{aligned}
$$

$$
\begin{aligned}
I^{MTI}_{z,1983} &= S_{z,8}M^{MTI-S}_{z,1984,93} + S_{z,7}M^{MTI-S}_{z,1983} + S_{z,6}M^{MTI-S}_{z,1982} \\
&+ M^{MTI-S}_{z,post}\left[w_{z,93}\sum_{a=9}^{12} S_{z,a} + w_{z,92}\sum_{a=8}^{12} S_{z,a}\right] \\
&+ [(4)\,F_{z,0}]\left\{w_{z,93}\frac{1}{e^{9-7}}\sum_{a=6}^{8}(S_{z,a} - S_{z,a,pre}) \right. \\
&\left. + w_{z,92}\frac{1}{e^{8-7}}\sum_{a=6}^{7}(S_{z,a} - S_{z,a,pre})\right\},
\end{aligned}
$$

$$
\begin{aligned}
I_{z,1984}^{MTI} = & S_{z,7} M_{z,1984,93}^{MTI-S} + S_{z,6} M_{z,1983}^{MTI-S} \\
& + M_{z,post}^{MTI-S} \left[w_{z,93} \sum_{a=8}^{12} S_{z,a} + w_{z,92} \sum_{a=7}^{12} S_{z,a} \right] \\
& + \left[(4)\, F_{z,0} \right] \left\{ w_{z,93} \frac{1}{e^{8-7}} \sum_{a=6}^{7} \left(S_{z,a} - S_{z,a,pre} \right) \right. \\
& \left. + w_{z,92} \left(S_{z,6} - S_{z,6,pre} \right) \right\},
\end{aligned}
$$

$$
I_{z,1985}^{MTI} = S_{z,6} M_{z,1984,93}^{MTI-S} + M_{z,post}^{MTI-S} \left[w_{z,93} \sum_{a=7}^{12} S_{z,a} + w_{z,92} \right] + \left[(4)\, F_{z,0} \right] w_{z,93} \left(S_{z,6} - S_{z,6,pre} \right)
$$

$$
I_{z,1986}^{MTI} = M_{z,post}^{MTI-S}
$$

C.2.3 Dire Dawa

Table C.3: Dire Dawa – MTI Implementation

				Fraction of:	
				MT Speakers	**Region Speaking**
Language	**Year**	**Region**	**Grades**	**Living in Region**	**Language as MT**
Oromigna	1992	Dire Dawa	1-6	< 0.01	0.47

Source: Author's analysis based on information from Boothe and Walker (1997) and Zenebe Gebre (2014).
Note: MTI = mother tongue instruction; MT = mother tongue.

The one time implementation of Oromigna in Dire Dawa is similar to that in Oromia, but with two key differences. First, the language was only introduced in the first six years of school in Dire Dawa. This will again change the summation of the number of grades affected, and delay the first cohort to be introduced to the reform by two years, from 1977 to 1979. This can be seen in the following magnitude calculations for the on time starters in Dire Dawa:

$$
M_{z,post}^{MTI-DD} = w_z \left[\sum_{g=0}^{5} (6-g) \cdot F_{z,g} \right] \qquad \textit{if } y \geq \textit{1984}
$$

$$
M_{zy}^{MTI-DD} = w_z \left[\sum_{g=(1984-y)}^{5} (6-g) \cdot F_{z,g} \right] \quad \textit{if } \textit{1979} \leq y \leq \textit{1983} \ .
$$

$$
M_{zy}^{MTI-DD} = 0 \qquad \textit{if } y \leq \textit{1978}
$$

The second difference is that only 47 percent of the population of Dire Dawa speaks the language being introduced. This reduces the magnitude measure for each cohort through a smaller value of w_z, but does not impact the equations being used. The timing of MTI in Dire Dawa for on time starters for each birth year-grade combination is shown in Appendix Table (C.5), denoted by the curled brackets. The MTI intensity

measure for cohorts in Dire Dawa is described by the following equations:

$$I_{z,1973}^{MTI} = 0,$$

$$I_{z,1974}^{MTI} = S_{z,12} M_{z,1979}^{MTI-DD},$$

$$I_{z,1975}^{MTI} = S_{z,12} M_{z,1980}^{MTI-DD} + S_{z,11} M_{z,1979}^{MTI-DD},$$

$$I_{z,1976}^{MTI} = S_{z,12} M_{z,1981}^{MTI-DD} + S_{z,11} M_{z,1980}^{MTI-DD} + S_{z,10} M_{z,1979}^{MTI-DD},$$

$$I_{z,1977}^{MTI} = S_{z,12} M_{z,1982}^{MTI-DD} + S_{z,11} M_{z,1981}^{MTI-DD} + S_{z,10} M_{z,1980}^{MTI-DD} + S_{z,9} M_{z,1979}^{MTI-DD},$$

$$I_{z,1978}^{MTI} = S_{z,12} M_{z,1983}^{MTI-DD} + S_{z,11} M_{z,1982}^{MTI-DD} + S_{z,10} M_{z,1981}^{MTI-DD} + S_{z,9} M_{z,1980}^{MTI-DD} + S_{z,8} M_{z,1979}^{MTI-DD},$$

$$\begin{aligned} I_{z,1979}^{MTI} = {} & S_{z,11} M_{z,1983}^{MTI-DD} + S_{z,10} M_{z,1982}^{MTI-DD} + S_{z,9} M_{z,1981}^{MTI-DD} + S_{z,8} M_{z,1980}^{MTI-DD} \\ & + S_{z,7} M_{z,1979}^{MTI-DD} + M_{z,post}^{MTI-DD} S_{z,12} + [(6)\, F_{z,0}] \frac{1}{e^{12-7}} \sum_{a=6}^{11} (S_{z,a} - S_{z,a,pre}), \end{aligned}$$

$$\begin{aligned} I_{z,1980}^{MTI} = {} & S_{z,10} M_{z,1983}^{MTI-DD} + S_{z,9} M_{z,1982}^{MTI-DD} + S_{z,8} M_{z,1981}^{MTI-DD} + S_{z,7} M_{z,1980}^{MTI-DD} \\ & + S_{z,6} M_{z,1979}^{MTI-DD} + M_{z,post}^{MTI-DD} \sum_{a=11}^{12} S_{z,a} + [(6)\, F_{z,0}] \frac{1}{e^{11-7}} \sum_{a=6}^{10} (S_{z,a} - S_{z,a,pre}), \end{aligned}$$

$$\begin{aligned} I_{z,1981}^{MTI} = {} & S_{z,9} M_{z,1983}^{MTI-DD} + S_{z,8} M_{z,1982}^{MTI-DD} + S_{z,7} M_{z,1981}^{MTI-DD} + S_{z,6} M_{z,1980}^{MTI-DD} \\ & + M_{z,post}^{MTI-DD} \sum_{a=10}^{12} S_{z,a} + [(6)\, F_{z,0}] \frac{1}{e^{10-7}} \sum_{a=6}^{9} (S_{z,a} - S_{z,a,pre}), \end{aligned}$$

$$I_{z,1982}^{MTI} = S_{z,8} M_{z,1983}^{MTI-DD} + S_{z,7} M_{z,1982}^{MTI-DD} + S_{z,6} M_{z,1981}^{MTI-DD} + M_{z,post}^{MTI-DD} \sum_{a=9}^{12} S_{z,a} + [(6)\, F_{z,0}] \frac{1}{e^{9-7}} \sum_{a=6}^{8} (S_{z,a} - S_{z,a,pre}),$$

$$I_{z,1983}^{MTI} = S_{z,7} M_{z,1983}^{MTI-DD} + S_{z,6} M_{z,1982}^{MTI-DD} + M_{z,post}^{MTI-DD} \sum_{a=8}^{12} S_{z,a} + [(6)\, F_{z,0}] \frac{1}{e^{8-7}} \sum_{a=6}^{7} (S_{z,a} - S_{z,a,pre}),$$

$$I_{z,1984}^{MTI} = S_{z,6} M_{z,1983}^{MTI-DD} + M_{z,post}^{MTI-DD} \sum_{a=7}^{12} S_{z,a} + [(6)\, F_{z,0}] (S_{z,6} - S_{z,6,pre}),$$

$$I_{z,1985}^{MTI} = M_{z,post}^{MTI-DD}.$$

C.2.4 Tigray

Table C.4: Tigray – MTI Implementation

				Fraction of:	
				MT Speakers	Region Speaking
Language	Year	Region	Grades	Living in Region	Language as MT
Tigrigna	1991	Tigray	1-8	0.93	0.95

Source: Author's analysis based on information from Boothe and Walker (1997) and Zenebe Gebre (2014).
Note: MTI = mother tongue instruction; MT = mother tongue.

The initial calculations of the maximum impact of the MTI reform for on time starters are similar to that of Oromia. In Tigray, the reform is implemented one year earlier due to the use of the Ge'ez script, but both provinces introduced a single language for eight years of primary school. The timing can also be seen in Appendix Table C.6.

$$M_{z,post}^{MTI-T} = w_z \left[\sum_{g=0}^{7} (8-g) \cdot F_{z,g} \right] \qquad \textit{if } y \geq \textit{1983}$$

$$M_{zy}^{MTI-T} = w_z \left[\sum_{g=(1983-y)}^{7} (8-g) \cdot F_{z,g} \right] \quad \textit{if } \textit{1976} \leq y \leq \textit{1982} \cdot$$

$$M_{zy}^{MTI-T} = 0 \qquad \textit{if } y \leq \textit{1975}$$

The birth year specific MTI intensity measure for Tigray again precedes the timing of Oromia by one year, and is described by the following equations:

$$I_{z,1970}^{MTI-T} = 0,$$

$$I_{z,1971}^{MTI-T} = S_{z,12} M_{z,1976}^{MTI-T},$$

$$I_{z,1972}^{MTI-T} = S_{z,12} M_{z,1977}^{MTI-T} + S_{z,11} M_{z,1976}^{MTI-T},$$

$$I_{z,1973}^{MTI-T} = S_{z,12} M_{z,1978}^{MTI-T} + S_{z,11} M_{z,1977}^{MTI-T} + S_{z,10} M_{z,1976}^{MTI-T},$$

$$I_{z,1974}^{MTI-T} = S_{z,12} M_{z,1979}^{MTI-T} + S_{z,11} M_{z,1978}^{MTI-T} + S_{z,10} M_{z,1977}^{MTI-T} + S_{z,9} M_{z,1976}^{MTI-T},$$

$$I_{z,1975}^{MTI-T} = S_{z,12} M_{z,1980}^{MTI-T} + S_{z,11} M_{z,1979}^{MTI-T} + S_{z,10} M_{z,1978}^{MTI-T} + S_{z,9} M_{z,1977}^{MTI-T} + S_{z,8} M_{z,1976}^{MTI-T},$$

$$I_{z,1976}^{MTI-T} = S_{z,12} M_{z,1981}^{MTI-T} + S_{z,11} M_{z,1980}^{MTI-T} + S_{z,10} M_{z,1979}^{MTI-T} + S_{z,9} M_{z,1978}^{MTI-T} + S_{z,8} M_{z,1977}^{MTI-T} + S_{z,7} M_{z,1976}^{MTI-T},$$

$$
\begin{aligned}
I_{z,1977}^{MTI} &= S_{z,12}M_{z,1982}^{MTI-T} + S_{z,11}M_{z,1981}^{MTI-T} + S_{z,10}M_{z,1980}^{MTI-T} + S_{z,9}M_{z,1979}^{MTI-T} \\
&\quad + S_{z,8}M_{z,1978}^{MTI-T} + S_{z,7}M_{z,1977}^{MTI-T} + S_{z,6}M_{z,1976}^{MTI-T},
\end{aligned}
$$

$$
\begin{aligned}
I_{z,1978}^{MTI-T} &= S_{z,11}M_{z,1982}^{MTI-T} + S_{z,10}M_{z,1981}^{MTI-T} + S_{z,9}M_{z,1980}^{MTI-T} + S_{z,8}M_{z,1979}^{MTI-T} \\
&\quad + S_{z,7}M_{z,1978}^{MTI-T} + S_{z,6}M_{z,1977}^{MTI-T} + M_{z,post}^{MTI-T}S_{z,12} + [(8)\,F_{z,0}]\,\frac{1}{e^{12-7}}\sum_{a=6}^{11}(S_{z,a} - S_{z,a,pre}),
\end{aligned}
$$

$$
\begin{aligned}
I_{z,1979}^{MTI-T} &= S_{z,10}M_{z,1982}^{MTI-T} + S_{z,9}M_{z,1981}^{MTI-T} + S_{z,8}M_{z,1980}^{MTI-T} + S_{z,7}M_{z,1979}^{MTI-T} \\
&\quad + S_{z,6}M_{z,1978}^{MTI-T} + M_{z,post}^{MTI-T}\sum_{a=11}^{12}S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{11-7}}\sum_{a=6}^{10}(S_{z,a} - S_{z,a,pre}),
\end{aligned}
$$

$$
\begin{aligned}
I_{z,1980}^{MTI-T} &= S_{z,9}M_{z,1982}^{MTI-T} + S_{z,8}M_{z,1981}^{MTI-T} + S_{z,7}M_{z,1980}^{MTI-T} + S_{z,6}M_{z,1979}^{MTI-T} \\
&\quad + M_{z,post}^{MTI-T}\sum_{a=10}^{12}S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{10-7}}\sum_{a=6}^{9}(S_{z,a} - S_{z,a,pre}),
\end{aligned}
$$

$$
I_{z,1981}^{MTI-T} = S_{z,8}M_{z,1982}^{MTI-T} + S_{z,7}M_{z,1981}^{MTI-T} + S_{z,6}M_{z,1980}^{MTI-T} + M_{z,post}^{MTI-T}\sum_{a=9}^{12}S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{9-7}}\sum_{a=6}^{8}(S_{z,a} - S_{z,a,pre}),
$$

$$
I_{z,1982}^{MTI-T} = S_{z,7}M_{z,1982}^{MTI-T} + S_{z,6}M_{z,1981}^{MTI-T} + M_{z,post}^{MTI-T}\sum_{a=8}^{12}S_{z,a} + [(8)\,F_{z,0}]\,\frac{1}{e^{8-7}}\sum_{a=6}^{7}(S_{z,a} - S_{z,a,pre}),
$$

$$
I_{z,1983}^{MTI-T} = S_{z,6}M_{z,1982}^{MTI-T} + M_{z,post}^{MTI-T}\sum_{a=7}^{12}S_{z,a} + [(8)\,F_{z,0}]\,(S_{z,6} - S_{z,6,pre}),
$$

$$
I_{z,1984}^{MTI-T} = M_{z,post}^{MTI-T}.
$$

Table C.5: MTI+Script Regions: Timing of FPE and MTI Reforms with On Time Entry, by Birth Year

Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status
1977		Born		1978		Born		1979		Born		1980		Born		1981		Born		1982		Born	
1978		0		1979		0		1980		0		1981		0		1982		0		1983		0	
1979		1		1980		1		1981		1		1982		1		1983		1		1984		1	
1980		2		1981		2		1982		2		1983		2		1984		2		1985		2	
1981		3		1982		3		1983		3		1984		3		1985		3		1986		3	
1982		4		1983		4		1984		4		1985		4		1986		4		1987		4	
1983		5		1984		5		1985		5		1986		5		1987		5		1988		5	
1984		6		1985		6		1986		6		1987		6		1988		6		1989		6	
1985	G1	7		1986	G1	7		1987	G1	7		1988	G1	7		1989	G1	7		1990	G1	7	
1986	G2	8		1987	G2	8		1988	G2	8		1989	G2	8		1990	G2	8		1991	G2	8	
1987	G3	9		1988	G3	9		1989	G3	9		1990	G3	9		1991	G3	9	[{ (MTI) }]	1992	G3	9	[{ (MTI) }]
1988	G4	10		1989	G4	10		1990	G4	10		1991	G4	10		1992	G4	10	[{ (MTI) }]	1993	G4	10	[{ (MTI) }]
1989	G5	11		1990	G5	11		1991	G5	11		1992	G5	11	{ (MTI) }	1993	G5	11	{ (MTI) }	1994	G5	11	{ (MTI) }
1990	G6	12		1991	G6	12		1992	G6	12	{ (MTI) }	1993	G6	12	{ (MTI) }	1994	G6	12	{ (MTI) }	1995	G6	12	{ (FPE) }
1991	G7	13		1992	G7	13	(MTI)	1993	G7	13	(MTI)	1994	G7	13	(MTI)	1995	G7	13	(FPE)	1996	G7	13	(FPE)
1992	G8	14	(MTI)	1993	G8	14	(MTI)	1994	G8	14	(MTI)	1995	G8	14	(FPE)	1996	G8	14	(FPE)	1997	G8	14	(FPE)
1993	G9	15		1994	G9	15		1995	G9	15	FPE	1996	G9	15	FPE	1997	G9	15	FPE	1998	G9	15	FPE
1994	G10	16		1995	G10	16	FPE	1996	G10	16	FPE	1997	G10	16	FPE	1998	G10	16	FPE	1999	G10	16	FPE

Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status
1983		Born		1984		Born		1985		Born		1986		Born		1987		Born		1988		Born	
1984		0		1985		0		1986		0		1987		0		1988		0		1989		0	
1985		1		1986		1		1987		1		1988		1		1989		1		1990		1	
1986		2		1987		2		1988		2		1989		2		1990		2		1991		2	
1987		3		1988		3		1989		3		1990		3		1991		3		1992		3	
1988		4		1989		4		1990		4		1991		4		1992		4		1993		4	
1989		5		1990		5		1991		5		1992		5		1993		5		1994		5	
1990		6		1991		6		1992		6		1993		6		1994		6		1995		6	
1991	G1	7		1992	G1	7	[{ (MTI) }]	1993	G1	7	[{ (MTI) }]	1994	G1	7	[{ (MTI) }]	1995	G1	7	[{ (FPE) }]	1996	G1	7	[{ (FPE) }]
1992	G2	8	[{ (MTI) }]	1993	G2	8	[{ (MTI) }]	1994	G2	8	[{ (MTI) }]	1995	G2	8	[{ (FPE) }]	1996	G2	8	[{ (FPE) }]	1997	G2	8	[{ (FPE) }]
1993	G3	9	[{ (MTI) }]	1994	G3	9	[{ (MTI) }]	1995	G3	9	[{ (FPE) }]	1996	G3	9	[{ (FPE) }]	1997	G3	9	[{ (FPE) }]	1998	G3	9	[{ (FPE) }]
1994	G4	10	[{ (MTI) }]	1995	G4	10	[{ (FPE) }]	1996	G4	10	[{ (FPE) }]	1997	G4	10	[{ (FPE) }]	1998	G4	10	[{ (FPE) }]	1999	G4	10	[{ (FPE) }]
1995	G5	11	{ (FPE) }	1996	G5	11	{ (FPE) }	1997	G5	11	{ (FPE) }	1998	G5	11	{ (FPE) }	1999	G5	11	{ (FPE) }	2000	G5	11	{ (FPE) }
1996	G6	12	{ (FPE) }	1997	G6	12	{ (FPE) }	1998	G6	12	{ (FPE) }	1999	G6	12	{ (FPE) }	2000	G6	12	{ (FPE) }	2001	G6	12	{ (FPE) }
1997	G7	13	(FPE)	1998	G7	13	(FPE)	1999	G7	13	(FPE)	2000	G7	13	(FPE)	2001	G7	13	(FPE)	2002	G7	13	(FPE)
1998	G8	14	(FPE)	1999	G8	14	(FPE)	2000	G8	14	(FPE)	2001	G8	14	(FPE)	2002	G8	14	(FPE)	2003	G8	14	(FPE)
1999	G9	15	FPE	2000	G9	15	FPE	2001	G9	15	FPE	2002	G9	15	FPE	2003	G9	15	FPE	2004	G9	15	FPE
2000	G10	16	FPE	2001	G10	16	FPE	2002	G10	16	FPE	2003	G10	16	FPE	2004	G10	16	FPE	2005	G10	16	FPE

Source: Author's analysis based on information from Boothe and Walker (1997) and Zenebe Gebre (2014).

Note: MTI = mother tongue instruction; FPE = free primary education. Grades with ( ) mean that MTI is in place in Oromia, { } indicates MTI in Dire Dawa, and [] indicates the initial introduction of MTI in the Southern Nations, Nationalities, and Peoples' Region (SNNPR). Years with MTI mean that no FPE is in place; FPE within brackets indicates that both FPE and MTI are in place in the specified region(s); and FPE without any type of brackets marks grades with FPE but no MTI.

Table C.6: Tigray: Timing of FPE and MTI Reforms with On Time Entry, by Birth Year

Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status
1977		Born		1978		Born		1979		Born		1980		Born		1981		Born		1982		Born	
1978		0		1979		0		1980		0		1981		0		1982		0		1983		0	
1979		1		1980		1		1981		1		1982		1		1983		1		1984		1	
1980		2		1981		2		1982		2		1983		2		1984		2		1985		2	
1981		3		1982		3		1983		3		1984		3		1985		3		1986		3	
1982		4		1983		4		1984		4		1985		4		1986		4		1987		4	
1983		5		1984		5		1985		5		1986		5		1987		5		1988		5	
1984		6		1985		6		1986		6		1987		6		1988		6		1989		6	
1985	G1	7		1986	G1	7		1987	G1	7		1988	G1	7		1989	G1	7		1990	G1	7	
1986	G2	8		1987	G2	8		1988	G2	8		1989	G2	8		1990	G2	8		1991	G2	8	MTI
1987	G3	9		1988	G3	9		1989	G3	9		1990	G3	9		1991	G3	9	MTI	1992	G3	9	MTI
1988	G4	10		1989	G4	10		1990	G4	10		1991	G4	10	MTI	1992	G4	10	MTI	1993	G4	10	MTI
1989	G5	11		1990	G5	11		1991	G5	11	MTI	1992	G5	11	MTI	1993	G5	11	MTI	1994	G5	11	MTI
1990	G6	12		1991	G6	12	MTI	1992	G6	12	MTI	1993	G6	12	MTI	1994	G6	12	MTI	1995	G6	12	(FPE)
1991	G7	13	MTI	1992	G7	13	MTI	1993	G7	13	MTI	1994	G7	13	MTI	1995	G7	13	(FPE)	1996	G7	13	(FPE)
1992	G8	14	MTI	1993	G8	14	MTI	1994	G8	14	MTI	1995	G8	14	(FPE)	1996	G8	14	(FPE)	1997	G8	14	(FPE)
1993	G9	15		1994	G9	15		1995	G9	15	FPE	1996	G9	15	FPE	1997	G9	15	FPE	1998	G9	15	FPE
1994	G10	16		1995	G10	16	FPE	1996	G10	16	FPE	1997	G10	16	FPE	1998	G10	16	FPE	1999	G10	16	FPE

Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status	Birth Year	Grade	Age	Reform Status
1983		Born		1984		Born		1985		Born		1986		Born		1987		Born		1988		Born	
1984		0		1985		0		1986		0		1987		0		1988		0		1989		0	
1985		1		1986		1		1987		1		1988		1		1989		1		1990		1	
1986		2		1987		2		1988		2		1989		2		1990		2		1991		2	
1987		3		1988		3		1989		3		1990		3		1991		3		1992		3	
1988		4		1989		4		1990		4		1991		4		1992		4		1993		4	
1989		5		1990		5		1991		5		1992		5		1993		5		1994		5	
1990		6		1991		6		1992		6		1993		6		1994		6		1995		6	
1991	G1	7	MTI	1992	G1	7	MTI	1993	G1	7	MTI	1994	G1	7	MTI	1995	G1	7	(FPE)	1996	G1	7	(FPE)
1992	G2	8	MTI	1993	G2	8	MTI	1994	G2	8	MTI	1995	G2	8	(FPE)	1996	G2	8	(FPE)	1997	G2	8	(FPE)
1993	G3	9	MTI	1994	G3	9	MTI	1995	G3	9	(FPE)	1996	G3	9	(FPE)	1997	G3	9	(FPE)	1998	G3	9	(FPE)
1994	G4	10	MTI	1995	G4	10	(FPE)	1996	G4	10	(FPE)	1997	G4	10	(FPE)	1998	G4	10	(FPE)	1999	G4	10	(FPE)
1995	G5	11	(FPE)	1996	G5	11	(FPE)	1997	G5	11	(FPE)	1998	G5	11	(FPE)	1999	G5	11	(FPE)	2000	G5	11	(FPE)
1996	G6	12	(FPE)	1997	G6	12	(FPE)	1998	G6	12	(FPE)	1999	G6	12	(FPE)	2000	G6	12	(FPE)	2001	G6	12	(FPE)
1997	G7	13	(FPE)	1998	G7	13	(FPE)	1999	G7	13	(FPE)	2000	G7	13	(FPE)	2001	G7	13	(FPE)	2002	G7	13	(FPE)
1998	G8	14	(FPE)	1999	G8	14	(FPE)	2000	G8	14	(FPE)	2001	G8	14	(FPE)	2002	G8	14	(FPE)	2003	G8	14	(FPE)
1999	G9	15	FPE	2000	G9	15	FPE	2001	G9	15	FPE	2002	G9	15	FPE	2003	G9	15	FPE	2004	G9	15	FPE
2000	G10	16	FPE	2001	G10	16	FPE	2002	G10	16	FPE	2003	G10	16	FPE	2004	G10	16	FPE	2005	G10	16	FPE

Source: Author's analysis based on information from Boothe and Walker (1997) and Zenebe Gebre (2014).

Note: FPE = free primary education; MTI = mother tongue instruction. Years with (FPE) indicate grade-year combinations in which both MTI and FPE are in place.

C.3 National Estimates: Accounting for FPE and MTI

Table C.7: National Estimates of Effect of Years of Schooling on Number of Children Born - Census + DHS

	Number of Children Born (OLS)	**Years of Schooling** (First Stage)	**Number of Children Born** (Reduced Form)	**Number of Children Born** (2SLS)
	(1)	(2)	(3)	(4)
Years of Schooling$_{izy}$	-0.149			
	(0.015)			
	[0.000]			
Add'l Years of Free Schooling $\left(I_{zy}^{FPE}\right)$		0.115	-0.051	
		(0.044)	(0.016)	
		[0.011]	[0.002]	
Add'l Year of MTI No Script Change $\left(I_{zy}^{MTI-T}\right)$		0.183	-0.007	
		(0.070)	(0.018)	
		[0.012]	[0.687]	
Add'l Year of MTI with Script Change $\left(I_{zy}^{MTI}\right)$		-0.119	0.064	
		(0.052)	(0.028)	
		[0.025]	[0.028]	
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$		-0.008	-0.001	
		(0.006)	(0.002)	
		[0.169]	[0.630]	
$I_{zy}^{FPE} \times I_{zy}^{MTI}$		0.001	-0.004	
		(0.005)	(0.002)	
		[0.767]	[0.028]	
Years of $\widehat{\text{Schooling}}_{izy}$				-0.273
				(0.109)
				[0.012]
First Stage F-Statistic		14.09		14.09
Number of Clusters	60	60	60	60
N	205,141	205,141	205,141	205,141

Source: Author's analysis based on data from the Ethiopian census of 2007 and the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: The dependent variable is either years of schooling in column 2 or number of births in the other three columns. Years of Schooling$_{izy}$ is the reported years of schooling from the data; Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.8: National Estimates of Effect of Years of Schooling on Number of Children Born - Census

	Number of Children Born (OLS)	**Years of Schooling** (First Stage)	**Number of Children Born** (Reduced Form)	**Number of Children Born** (2SLS)
	(1)	(2)	(3)	(4)
Years of Schooling_{izy}	-0.120			
	(0.012)			
	[0.000]			
Add'l Years of Free Schooling $\left(I_{zy}^{FPE}\right)$		0.120	-0.060	
		(0.037)	(0.017)	
		[0.002]	[0.001]	
Add'l Year of MTI No Script Change $\left(I_{zy}^{MTI-T}\right)$		0.201	-0.011	
		(0.052)	(0.011)	
		[0.000]	[0.321]	
Add'l Year of MTI with Script Change $\left(I_{zy}^{MTI}\right)$		-0.081	-0.001	
		(0.024)	(0.011)	
		[0.002]	[0.894]	
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$		-0.003	0.005	
		(0.003)	(0.001)	
		[0.318]	[0.001]	
$I_{zy}^{FPE} \times I_{zy}^{MTI}$		0.005	-0.008	
		(0.003)	(0.001)	
		[0.062]	[0.000]	
Years of $\widehat{\text{Schooling}}_{izy}$				-0.297
				(0.144)
				[0.039]
First Stage F-Statistic		9.72		9.72
Number of Clusters	60	60	60	60
N	180,243	180,243	180,243	180,243

Source: Author's analysis based on data from the Ethiopian census of 2007.

Note: The dependent variable is either years of schooling in column 2 or number of births in the other three columns. Years of Schooling_{izy} is the reported years of schooling from the data; Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects and zone-specific linear trends. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.9: National Estimates of Effect of Years of Schooling on Number of Children Born - DHS

	Number of Children Born (OLS)	**Years of Schooling** (First Stage)	**Number of Children Born** (Reduced Form)	**Number of Children Born** (2SLS)
	(1)	(2)	(3)	(4)
Years of Schooling$_{izy}$	-0.162			
	(0.016)			
	[0.000]			
Add'l Years of Free Schooling $\left(I_{zy}^{FPE}\right)$		0.115	-0.057	
		(0.053)	(0.021)	
		[0.035]	[0.009]	
Add'l Year of MTI No Script Change $\left(I_{zy}^{MTI-T}\right)$		0.175	-0.012	
		(0.087)	(0.025)	
		[0.049]	[0.636]	
Add'l Year of MTI with Script Change $\left(I_{zy}^{MTI}\right)$		-0.128	0.092	
		(0.073)	(0.041)	
		[0.085]	[0.031]	
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$		-0.010	-0.003	
		(0.008)	(0.002)	
		[0.239]	[0.204]	
$I_{zy}^{FPE} \times I_{zy}^{MTI}$		-0.001	-0.002	
		(0.007)	(0.003)	
		[0.930]	[0.342]	
Years of $\widehat{\text{Schooling}}_{izy}$				-0.365
				(0.147)
				[0.001]
First Stage F-Statistic		6.91		6.91
Number of Clusters	58	58	58	58
N	24,898	24,898	24,898	24,898

Source: Author's analysis based on data from the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: The dependent variable is either years of schooling in column 2 or number of births in the other three columns. Years of Schooling$_{izy}$ is the reported years of schooling from the data; Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.10: National Estimates of Effect of Years of Schooling on Knowledge and Health

	Literacy	Read about Fam. Planning	Know about Fam. Planning	BMI (z-score)	Height (z-score)	Acceptable Reasons for Domestic Violence (of 5)	Use Modern Contraception	Use Hidden Contraception
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years of $\widehat{\text{Schooling}}_{\text{izy}}$	0.122	0.053	0.023	0.206	0.132	-0.254	-0.006	-0.011
	(0.019)	(0.018)	(0.020)	(0.096)	(0.104)	(0.124)	(0.030)	(0.025)
	[0.000]	[0.004]	[0.255]	[0.031]	[0.204]	[0.041]	[0.830]	[0.655]
Mean of Dependent (Pre-Reform Cohorts)	0.115	0.046	0.935	-0.020	-0.168	2.681	0.162	0.127
First Stage F-Statistic	7.73	6.91	6.91	6.13	5.01	8.42	6.91	6.91
N	24,480	24,885	24,898	19,491	19,879	24,052	24,898	24,898

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: BMI = body mass index. The dependent variable is described at the top of each of the eight columns. In columns 1–3, 7, and 8 it is an indicator that equals 1 if true; in columns 4 and 5 it is a standardized value of the described outcome; and in column 6 it is the count from 0 to 5 of acceptable reasons for domestic violence (going out without permission, neglecting children, arguing with husband, refusing sex, burning food). Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.11: National Estimates of Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference

		Sector of Work			
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)
Years of $\widehat{\text{Schooling}}_{\text{izy}}$	0.010	0.033	0.020	-0.034	-0.923
	(0.042)	(0.017)	(0.025)	(0.034)	(0.658)
	[0.809]	[0.053]	[0.433]	[0.319]	[0.160]
Mean of Dependent (Pre-Reform Cohorts)	0.342	0.072	0.126	0.279	7.623
First Stage F-Statistic	6.93	7.91	7.91	7.91	6.60
N	24,882	24,607	24,607	24,607	24,649

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: The dependent variable is described at the top of each of the five columns. In columns 1–4 it is an indicator that equals 1 if true, and in column 5 it is the ideal number of children. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Ideal number of children is censored at 20; no women in the Demographic and Health Survey report having more than 18 children, and non-numerical responses are assigned the maximum value. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression, and the second-stage estimate in column 5 is generated using a tobit model. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.12: Effect of Years of Schooling on Sector of Employment: Job Different than Husband

	Sector of Current Work		
	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual
	(1)	(2)	(3)
	A. Non-MTI Regions Only		
Years of $\widehat{\text{Schooling}}_{\text{izy}}$	0.058	0.062	-0.027
	(0.023)	(0.034)	(0.019)
	[0.011]	[0.071]	[0.250]
First Stage F-Statistic	12.48	12.48	12.48
N	11,870	11,870	11,870
	B. National Estimates (FPE + MTI)		
Years of $\widehat{\text{Schooling}}_{\text{izy}}$	0.035	0.014	0.004
	(0.015)	(0.024)	(0.029)
	[0.019]	[0.569]	[0.879]
First Stage F-Statistic	8.22	8.22	8.22
N	21,242	21,242	21,242

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: MTI = mother tongue instruction; FPE = free primary education. The dependent variable is an indicator that equals 1 if employed in the denoted sector and 0 otherwise. In panel A, Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with only the FPE intensity measure, I_{zy}^{FPE}; in panel B additional instruments include two MTI intensity measures, $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include women in birth cohorts from 1970 to 1988 working in different jobs than their husbands. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.13: National Estimates of Effect of Wife's Schooling on Husband's Characteristics, Married Women Only

	Wife's Years of Schooling [First Stage - Married Only]	Husband's Age	Husband's Years of Schooling	Husband's Occupation: Skilled / Professional	Husband's Occupation: Service / Sales	Husband's Occupation: Agriculture / Unskilled Manual	Husband Wants More Children
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Add'l Years of Free Schooling (I_{zy}^{FPE})	0.009						
	(0.063)						
	[0.891]						
Add'l Year of MTI No Script Change (I_{zy}^{MTI-T})	0.066						
	(0.058)						
	[0.261]						
Add'l Year of MTI with Script Change (I_{zy}^{MTI})	-0.212						
	(0.080)						
	[0.010]						
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$	0.001						
	(0.010)						
	[0.947]						
$I_{zy}^{FPE} \times I_{zy}^{MTI}$	0.009						
	(0.007)						
	[0.207]						
Years of $\widehat{\text{Schooling}}_{izy}$		1.009	1.116	0.026	0.099	-0.130	-0.029
		(0.884)	(0.372)	(0.028)	(0.031)	(0.045)	(0.052)
		[0.254]	[0.003]	[0.350]	[0.001]	[0.004]	[0.570]
Mean of Dependant (Pre-Reform Cohorts)	1.15	49.48	2.28	0.083	0.081	0.792	0.370
First Stage F-Statistic	4.69	6.35	7.10	6.40	6.40	6.40	5.89
N	20,959	18,174	19,784	19,814	19,814	19,814	12,761

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: MTI = mother tongue instruction. The dependent variable is described at the top of each of the six columns. The first-stage estimate of the effect of the reforms on years of schooling for married women is shown in column 1. The dependent variables in columns 4–7 are indicator variables that equal 1 if true. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All samples include married women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.14: National Estimates of Effect of Schooling on Beliefs Regarding Domestic Violence, Married Women Only

	Acceptable Reasons for Domestic Violence (of 5)	Beating justified if wife: Goes Out w/out Permission	Neglects Children	Argues with Husband	Refuses Sex	Burns Food
	(1)	(2)	(3)	(4)	(5)	(6)
Years of $\widehat{\text{Schooling}}_{izy}$	-0.399	-0.080	-0.020	-0.117	-0.089	-0.087
	(0.171)	(0.044)	(0.052)	(0.055)	(0.048)	(0.045)
	[0.020]	[0.071]	[0.698]	[0.033]	[0.106]	[0.051]
Mean of Dependent (Pre-Reform Cohorts)	2.80	0.582	0.617	0.553	0.485	0.574
First Stage F-Statistic	7.94	6.64	6.82	6.31	7.92	6.85
N	17,658	18,067	18,065	18,027	17,873	18,072

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: The dependent variable in column 1 is the count from 0 to 5 of acceptable reasons for domestic violence, and the dependent variables in columns 2–6 are indicators that equal 1 if the statement is believed to be true and 0 otherwise. The sample includes all married women born between 1970 and 1988. A 2SLS model is estimated where Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.15: National Estimates of Effect of Schooling on Beliefs Regarding Women's Empowerment, Married Women Only

	Travel to Visit Family / Friends (1)	Personal Healthcare (2)	Large Household Purchases (3)
	A. Wife should at least have a say in decision		
Years of $\widehat{\text{Schooling}}_{izy}$	-0.056	-0.066	-0.065
	(0.043)	(0.040)	(0.035)
	[0.194]	[0.097]	[0.066]
Mean of Dependent (Pre-Reform Cohorts)	0.783	0.721	0.650
First Stage F-Statistic	6.60	6.59	6.59
N	18,138	18,139	18,139
	B. Wife should be able to make decision alone		
Years of $\widehat{\text{Schooling}}_{izy}$	-0.064	-0.029	-0.041
	(0.039)	(0.030)	(0.027)
	[0.102]	[0.334]	[0.118]
Mean of Dependent Variable (Pre-Reform Cohorts)	0.163	0.161	0.128
First Stage F-Statistic	6.60	6.59	6.59
N	18,138	18,139	18,139

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: The dependent variable in each column is an indicator that equals 1 if the statement is believed to be true and 0 otherwise. The sample includes all married women born between 1970 and 1988. A 2SLS model is estimated where Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure I_{zy}^{FPE}, two mother tongue instruction (MTI) intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

C.4 Combined Instrument and Reduced Form Estimates, by Age

The previous subsection, Appendix Section C.3, estimates the effect of the FPE and MTI reforms on schooling using five instruments. However, reduced form analysis across different ages would become cumbersome with the large number of variables; combining the impact of the two reforms would allow for easier graphical representation of the impact of the reforms across different ages. Cutting the data by age is only possible with the inclusion of both reforms, this allows for the use of the national sample and additional variation from the timing of the MTI implementation.

Creating a single instrument that measures exposure to both the FPE and MTI reforms, and predicts changes in schooling, requires a simplifying assumption from the five-instrument model used in Appendix Section C.3. The necessary baseline assumption is that the magnitude of the effect of an additional year of FPE on schooling is the same as each additional year of MTI, in either a positive (no script change) or negative (with script change) direction. For simplicity, it is also assumes that there is no interaction between the two reforms, only one of the six interaction terms in the first stage of Appendix Tables C.7 to C.9 has a p-value below 0.15. These assumptions yield a combined intensity measure that can be expressed using the following equation:

$$\Delta I_{zy} = I_{zy}^{FPE} + I_{zy}^{MTI-T} - I_{zy}^{MTI}. \tag{C.1}$$

I_{zy}^{MTI-T} is zero for all non-Tigray regions, and is shown to be positive in Appendix Tables C.7 to C.9. Similarly, I_{zy}^{MTI}, is only non-zero for MTI regions other than Tigray (as described in Appendix Section C.2), and shown to be negatively associated with schooling in Appendix Tables C.7 to C.9.[24] Additionally, the differences in the estimated effect of each intensity measure can also be statistically tested. Using the estimates from the DHS in Appendix Table C.9, the survey that contains all age specific outcomes of interest, the null hypothesis that each combination of the three intensity measures has an equal effect on schooling is tested in Appendix Table C.16. Across the four tests, the null hypothesis of equality cannot be rejected, and no p-value is larger than 0.5.

In addition to testing the equality of each first stage coefficient, the combined intensity measure (ΔI_{zy}) is also used to re-estimate the effect of years of schooling on number of children born, and all outcomes from Appendix Tables C.10, C.11, and C.13. The estimates using the combined intensity measure can be found in Appendix Tables C.17 to C.20; in each case, the combined intensity measure yields estimates similar to the model using five instruments. Most importantly, the estimated effect of an additional year of schooling

[24]The additive portion of ΔI_{zy} does not double count years in which both FPE and MTI are available in the region. Both reforms making one additional year of schooling available can never increase schooling by more than a single year.

on number of births is within 44-thousandths (-0.321 versus -0.365), a nearly identical result. The same pattern is seen across nearly every estimate in the tables examining health and knowledge, the labor market, and the marriage market. The conclusions generated by the two different instrument strategies are both quantitatively and qualitatively consistent. The most significant difference is that the first stage F-statistic for the combined measure is more than 2.5 times larger.

The single variable that is able to capture the variation in the introduction of both the FPE and MTI reforms can be used to estimate a set of reduced form models to quantify the impact of the reforms on central outcomes related to fertility at specific ages. For example, the reduced form effect of the reforms on number of births at each age is shown in Appendix Figure C.1. The downward sloping black line is the coefficient estimate on the combined estimator, the 90 and 95 percent confidence intervals are shown with the dashed and solid gray lines, respectively. At the younger ages, 15 through 19, there is no effect of schooling on number of births. At the age of 20, the effect is slightly larger, and becomes statistically significant at the 90 percent confidence level. The estimated effect becomes increasingly negative and statistically significant at the 95 percent confidence level at the age of 23, increasing in magnitude by 58 percent relative to the effect at 22. The effect continues to become increasingly negative through the age of 29, and remains statistically significant.

The combination of the low levels of schooling attainment and the reduction in fertility manifesting itself in the women's early twenties makes it unlikely that any type of incarceration effect, women physically being in the classroom, is affecting the results in the paper. Furthermore, Black et al. (2008) and Geruso and Royer (2018) also find that reductions in teenage fertility tend to be replaced by increases in additional births at later ages. Although the effects seen in Appendix Figure C.1 are not for completed fertility, the later introduction of the effect and the continued growth in magnitude through age 29 makes the retrenchment seen in the teenage fertility literature less likely to occur in this setting.

The same type of reduced form model is then used to examine the effect of the reform on the timing of first birth, intercourse, and marriage in Appendix Figure C.2. The coefficients shown in the figure are from reduced form estimates using the combined intensity measure. The effect of an additional year of FPE and MTI without script change on the timing of a woman's first birth (black bars), first marriage (white), and sexual intercourse (dotted) are shown. The first statistically significant changes are the reductions in the likelihood of first marriage and intercourse by the age of 21. The magnitude of these changes become larger at the age of 22; evaluating the magnitudes at the post-reform average of the joint intensity measure suggests reductions in the likelihood of first marriage and intercourse of 7.2 percentage points and 4.8 percentage points, respectively. The effect of the reform on these two outcomes remains statistically significant through the age of 24, before a substantial reduction in magnitude and loss of statistical significance beginning at

the age of 25.

As would be expected, the impact of the reform on the timing of first birth lags the effect on first marriage and intercourse. This timing suggests that the reform's impact on the marriage decision is leading to an initial delay in women's fertility. Again, using the post-reform average of the joint intensity measure, the estimated effect at the age of 23 suggests that the reform reduced the likelihood of first birth by 8.5 percentage points. In fact, the reduction in the likelihood of first birth by the age of 23 coincides with the large reduction in number of births by this age seen in Appendix Figure C.1. The effect on the likelihood of first birth remains statistically significant through the age of 25, again one year later than the effect on first marriage and intercourse. While these changes help explain some of the reduction in fertility, the magnitude of the reductions in number of births continues to grow beyond the age of 25 suggesting post-marriage decisions are likely changing, as well. The values of the reduced form coefficient estimates in Appendix Figures C.1 and C.2 can be found in Appendix Table C.21.

Table C.16: National Estimates of Effect of Years of Schooling on Number of Children Born - DHS

	Years of Schooling (First Stage)
	(1)
Add'l Years of Free Schooling (I_{zy}^{FPE})	0.115
	(0.053)
	[0.035]
Add'l Year of MTI No Script Change (I_{zy}^{MTI-T})	0.175
	(0.087)
	[0.049]
Add'l Year of MTI with Script Change (I_{zy}^{MTI})	-0.128
	(0.073)
	[0.085]
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$	-0.010
	(0.008)
	[0.239]
$I_{zy}^{FPE} \times I_{zy}^{MTI}$	-0.001
	(0.007)
	[0.930]
N	24,898

F-Test	F-Statistic	P-Value
$I_{zy}^{FPE} = I_{zy}^{MTI-T}$	0.46	[0.501]
$I_{zy}^{FPE} = (-1) \times I_{zy}^{MTI}$	0.01	[0.905]
$I_{zy}^{MTI-T} = (-1) \times I_{zy}^{MTI}$	0.12	[0.731]
$I_{zy}^{FPE} = I_{zy}^{MTI-T} = (-1) \times I_{zy}^{MTI}$	0.23	[0.794]

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: MTI = mother tongue instruction. Column 1 is reproduced from Table C.9 in this supplementary online appendix. The dependent variable is years of schooling. The sample includes women in birth cohorts from 1970 to 1988. The regression includes birth year and zone fixed effects, zone-specific linear trends, and a cubic for age when multiple survey waves are included. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.17: National Estimates of Effect of Years of Schooling on Number of Children Born - DHS - Combined Instrument

	Years of Schooling (First Stage)	**Number of Children Born** (Reduced Form)	**Number of Children Born** (2SLS)
	(1)	(2)	(3)
Add'l Years of FPE or MTI w/out Script Change (ΔI_{zy})	0.115 (0.026) [0.000]	-0.037 (0.019) [0.019]	
Years of $\widehat{\text{Schooling}}_{izy}$			-0.321 (0.156) [0.040]
First Stage F-Statistic	19.56		19.56
Number of Clusters	58	58	58
N	24,898	24,898	24,898

Source: Author's analysis based on data from the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: The dependent variable is years of schooling in column 1 and is number of births in the other two columns. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted number of years of schooling, instrumented with the combined intensity measure, ΔI_{zy}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age when multiple survey waves are included. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.18: National Estimates of Effect of Years of Schooling on Knowledge and Health - Combined Instrument

	Literate	Read about Fam. Planning	Know about Fam. Planning	BMI (z-score)	Height (z-score)	Acceptable Reasons for Domestic Violence (of 5)	Use Modern Contraception	Use Hidden Contraception
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years of $\widehat{\text{Schooling}}_{izy}$	0.121	0.047	0.023	0.234	0.031	-0.310	-0.009	-0.017
	(0.019)	(0.021)	(0.022)	(0.132)	(0.142)	(0.121)	(0.031)	(0.027)
	[0.000]	[0.027]	[0.287]	[0.076]	[0.830]	[0.010]	[0.773]	[0.535]
First Stage F-Statistic	20.27	19.55	19.56	9.70	8.22	19.45	19.56	19.56
N	24,480	24,885	24,898	19,491	19,879	24,052	24,898	24,898

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: BMI = body mass index. The dependent variable is described at the top of each of the eight columns. In columns 1–3, 7, and 8 it is an indicator that equals 1 if true; in columns 4 and 5 it is a standardized value of the described outcome; and in column 6 it is the count from 0 to 5 of acceptable reasons for domestic violence (going out without permission, neglecting children, arguing with husband, refusing sex, burning food). Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the combined intensity measure, ΔI_{zy}. All samples include women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.19: National Estimates of Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference - Combined Instrument

		Sector of Work			
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)
Years of $\widehat{\text{Schooling}}_{\text{izy}}$	0.017	0.044	0.016	-0.039	-0.902
	(0.043)	(0.015)	(0.028)	(0.033)	(0.493)
	[0.692]	[0.004]	[0.573]	[0.241]	[0.068]
First Stage F-Statistic	19.68	20.64	20.64	20.64	19.37
N	24,882	24,607	24,607	24,607	24,649

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: The dependent variable is described at the top of each of the five columns. In columns 1–4 it is an indicator that equals 1 if true, and in column 5 it is the ideal number of children. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Ideal number of children is censored at 20; no women in the Demographic and Health Survey report having more than 18 children, and non-numerical responses are assigned the maximum value. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the combined intensity measure, ΔI_{zy}. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression, and the second-stage estimate in column 5 is generated using a tobit model. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.20: National Estimates of Effect of Wife's Exposure to Reforms on Husband's Characteristics, Married Women Only - Combined Instrument

	Wife's Years of Schooling [First Stage - Married Only]	Husband's Age	Husband's Years of Schooling	Husband's Occupation: Skilled / Professional	Husband's Occupation: Service / Sales	Husband's Occupation: Agriculture / Unskilled Manual	Husband Wants More Children
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Add'l Years of FPE or MTI w/out Script Change (ΔI_{zy})	0.097						
	(0.041)						
	[0.020]						
Years of $\widehat{\text{Schooling}}_{izy}$		-0.017	0.869	-0.039	0.121	-0.129	-0.069
		(0.976)	(0.475)	(0.044)	(0.047)	(0.043)	(0.078)
		[0.986]	[0.067]	[0.375]	[0.010]	[0.003]	[0.374]
First Stage F-Statistic	5.70	5.70	6.94	6.97	6.97	6.97	5.86
N	18,174	18,174	17,998	19,814	19,814	19,814	12,761

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: FPE = free primary education; MTI = mother tongue instruction. The dependent variable is described at the top of each of the six columns. The first-stage estimate of the effect of the reforms on years of schooling for married women is shown in column 1. The dependent variables in columns 4–7 are indicator variables that equal 1 if true. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the combined intensity measure, ΔI_{zy}. All samples include married women in birth cohorts from 1970 to 1988. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table C.21: Effect of Reform on Number of Births and Likelihood of First Birth, Marriage, and Intercourse, by Age
Coefficient Estimates from Appendix Figures C.1 and C.2

Age:	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
							A. Number of Births								
Add'l Years of FPE or MTI	-0.006	-0.005	-0.000	-0.009	-0.008	-0.019	-0.023	-0.031	-0.049	-0.056	-0.059	-0.078	-0.085	-0.084	-0.106
w/out Script Change	(0.005)	(0.005)	(0.008)	(0.009)	(0.010)	(0.012)	(0.012)	(0.016)	(0.019)	(0.020)	(0.025)	(0.031)	(0.037)	(0.043)	(0.044)
(ΔI_{zy})	[0.228]	[0.347]	[0.987]	[0.327]	[0.445]	[0.103]	[0.058]	[0.054]	[0.011]	[0.007]	[0.023]	[0.014]	[0.024]	[0.055]	[0.019]
N	24,898	24,616	24,058	23,221	22,791	21,842	21,514	20,582	19,710	18,919	17,005	16,106	14,949	13,063	12,189
							B. First Birth								
Add'l Years of FPE or MTI	-0.005	-0.004	-0.003	-0.003	-0.004	-0.006	-0.006	-0.006	-0.013	-0.011	-0.011	-0.007	-0.006	-0.006	-0.002
w/out Script Change	(0.004)	(0.003)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.006)
(ΔI_{zy})	[0.204]	[0.166]	[0.500]	[0.550]	[0.368]	[0.270]	[0.257]	[0.269]	[0.019]	[0.024]	[0.018]	[0.127]	[0.263]	[0.245]	[0.680]
N	24,898	24,616	24,058	23,221	22,791	21,842	21,514	20,582	19,710	18,919	17,005	16,106	14,949	13,063	12,189
							C. First Marriage								
Add'l Years of FPE or MTI	-0.001	0.001	-0.002	-0.003	-0.004	-0.005	-0.008	-0.011	-0.010	-0.008	-0.003	-0.000	-0.002	0.000	0.004
w/out Script Change	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)
(ΔI_{zy})	[0.904]	[0.849]	[0.798]	[0.428]	[0.320]	[0.303]	[0.024]	[0.005]	[0.027]	[0.038]	[0.324]	[0.902]	[0.680]	[0.948]	[0.189]
N	24,898	24,616	24,058	23,221	22,791	21,842	21,514	20,582	19,710	18,919	17,005	16,106	14,949	13,063	12,189
							D. First Intercourse								
Add'l Years of FPE or MTI	-0.001	-0.003	-0.004	0.000	-0.001	-0.003	-0.006	-0.008	-0.008	-0.004	-0.001	-0.000	0.001	0.003	0.003
w/out Script Change	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
(ΔI_{zy})	[0.864]	[0.508]	[0.420]	[0.983]	[0.807]	[0.411]	[0.062]	[0.006]	[0.017]	[0.095]	[0.719]	[0.921]	[0.753]	[0.244]	[0.296]
N	24,898	24,616	24,058	23,221	22,791	21,842	21,514	20,582	19,710	18,919	17,005	16,106	14,949	13,063	12,189

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016).

Note: FPE = free primary education; MTI = mother tongue instruction. In panel A the dependent variable is number of births by the stated age; in the remaining panels, the dependent variable is an indicator that equals 1 if the event occurred by the denoted age and 0 otherwise. All samples include women in birth cohorts from 1970 to 1988 who are older than the denoted age. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

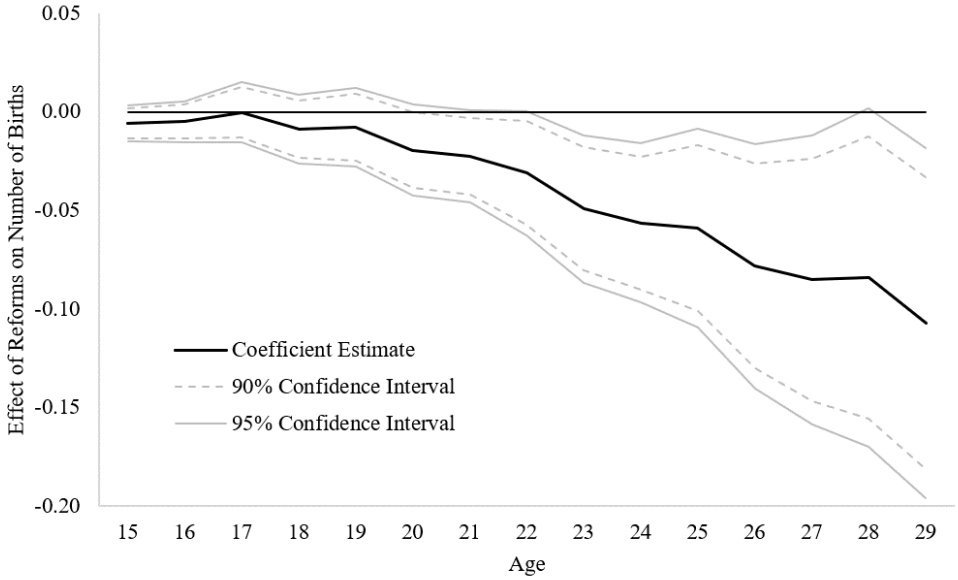


Figure C.1: Reduced form Estimates of the Effect of the Reforms on Number of Births, by Age

Source: Author's analysis of data from the Ethiopian Demographic and Health Survey (2005, 2011, and 2016).
Note: The dependent variable is the number of births by the stated age. Coefficient estimates are from a reduced-form model using the combined intensity measure ΔI_{zy} and a sample of women older than the age stated.

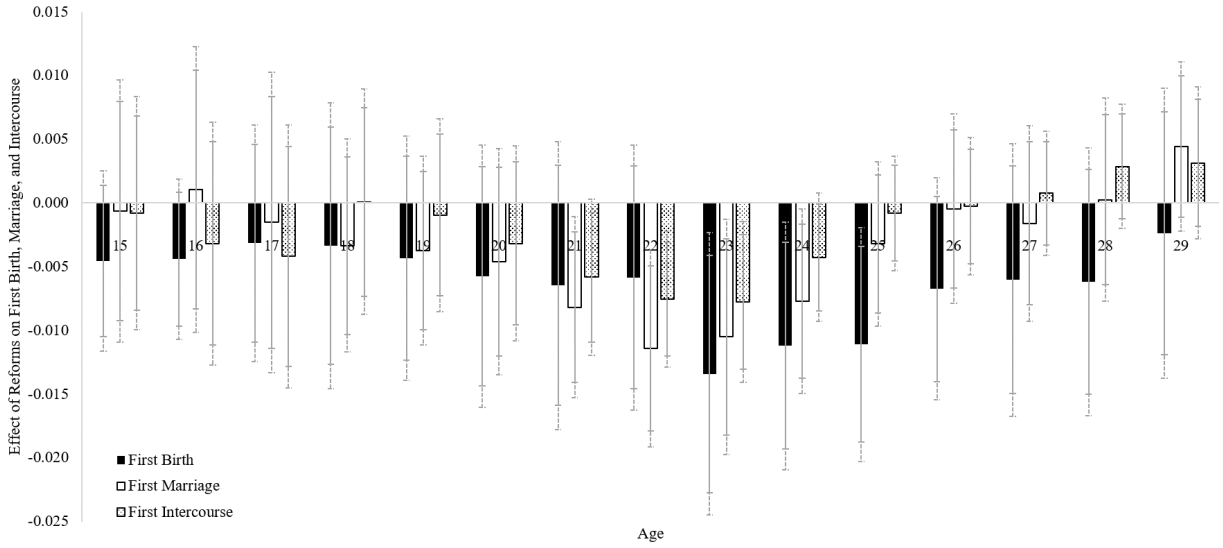


Figure C.2: Reduced form Estimates of the Effect of the Reforms on the Timing of First Birth, Marriage, and Intercourse, by Age

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (2005, 2011, and 2016).
Note: The dependent variable is an indicator that equals 1 if the first instance of the defined event occurred at or before each age. Coefficient estimates are from a reduced-form model using the combined intensity measure ΔI_{zy} and a sample of women older than the age stated. The 90 percent confidence intervals are shown with solid gray bars and the 95 percent confidence intervals with dashed gray bars.

D Alternative Samples and Specifications

D.1 Pre-Treatment Trends and Placebo Estimates

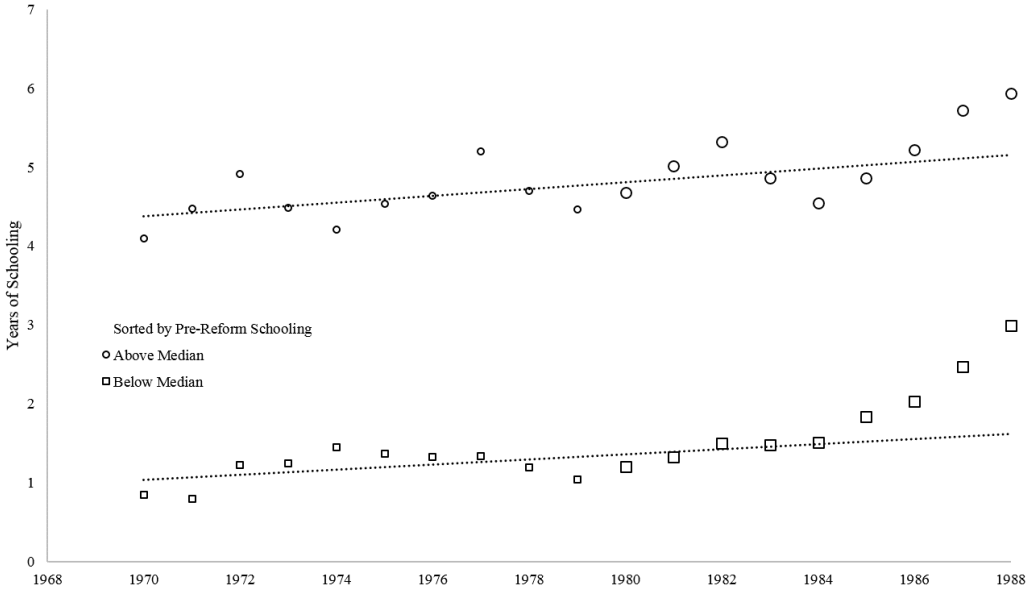


Figure D.1: Comparison of Pre-Treatment Trends in Years of Schooling, by Birth Year

Note: *Source*: Author's analysis based on data from the Ethiopian census of 2007 and the Demographic and Health Survey in years 2005, 2011, and 2016.
Note: Data in the figure are from non-MTI regions only and are sorted by zone-level pre-1970 schooling, the data used to create the free primary education (FPE) intensity measure. Above-median observations are represented by circles and below-median observations by squares. The trends are calculated using the 1970–1979 cohorts, those for which there is only a nominal change in the intensity measure seen in fig. 2 in the main article. Post-1979 cohorts are indicated by larger markers.

Table D.1: Placebo Estimates Using Pre-FPE Cohorts and Misplaced Timing of Intensity Measure

	First (Misplaced) Post-Reform Cohort				
	1979	1978	1977	1976	1975
	(1)	(2)	(3)	(4)	(5)
	A.i. Non-MTI Regions: Years of Schooling				
Add'l Years of Free Schooling (I_{zy}^{FPE})	-0.042	-0.048	-0.045	0.067	0.056
	(0.049)	(0.064)	(0.072)	(0.061)	(0.056)
	[0.396]	[0.462]	[0.540]	[0.280]	[0.327]
	A.ii. Non-MTI Regions: Number of Children Born				
Add'l Years of Free Schooling (I_{zy}^{FPE})	-0.015	-0.051	-0.004	-0.005	0.047
	(0.022)	(0.029)	(0.031)	(0.045)	(0.049)
	[0.501]	[0.093]	[0.891]	[0.915]	[0.346]
N	8,074	8,074	8,074	8,074	8,074
	B.i. National Estimates (FPE + MTI): Years of Schooling				
Add'l Years of FPE or MTI w/out Script Change (ΔI_{zy})	-0.008	-0.016	-0.009	0.057	0.042
	(0.040)	(0.039)	(0.036)	(0.045)	(0.035)
	[0.844]	[0.674]	[0.815]	[0.216]	[0.241]
	B.ii. National Estimates (FPE + MTI): Number of Children Born				
Add'l Years of FPE or MTI w/out Script Change (ΔI_{zy})	0.013	-0.020	-0.016	-0.025	-0.028
	(0.030)	(0.023)	(0.022)	(0.020)	(0.022)
	[0.657]	[0.380]	[0.458]	[0.226]	[0.208]
N	14,833	14,833	14,833	14,833	14,833

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: MTI = mother tongue instruction; FPE = free primary education. The dependent variable is years of schooling in panels A.i and B.i, and is number of births in panels A.ii and B.ii. All samples include women in birth cohorts from 1963 to 1979, the same number of cohorts as the baseline estimates but moved nine years back. In the baseline sample the first post-reform cohort is 1988, also at least a nine-cohort difference. This timing matches the period in which the FPE intensity measure (I_{zy}^{FPE}) predicts little impact of the reform, as seen in fig. 2 of the main article. All regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

D.2 Alternative Samples and Specifications

The results shown throughout Appendix Section D.2 re-estimate the output shown in the main body of the paper using a number of alternative cohort ranges, specifications, and samples. Each panel is described below, and the results in the following tables display the panels in a consistent order.

Panel A – Baseline

For reference, Panel A reproduces the results used in the paper. These estimates use a sample of all Ethiopian women born between 1970 and 1988. All estimates in this section include a cubic in age, and birth year and district fixed effects. The baseline estimates use the FPE instrument, I_{zy}^{FPE}, starting age data from the 2007 census, and a district specific linear time trend.

Panels B to E – Alternative Cohort Ranges

These panels include two expanded samples, 1968 to 1992 (Panel B) and 1969 to 1989 (Panel C), and two more restrictive ranges. In Panel D, one cohort from each end of the baseline sample is removed, yielding a range from 1971 to 1987. This sample no longer includes any fully post-reform cohorts. The data are restricted to 1972 in Panel E, the final fully pre-FPE cohort. Removing additional cohorts on the later end of the range would remove significant and necessary identifying variation; therefore, the 1987 cohort remains the cutoff on the upper end of the range in Panel E.

Panel F – Matched 1984 Start Ages

Intensity measures are constructed using starting age information from the 1984 census. While the pre-reform timing of these data are ideal, the administrative boundaries are not consistent between the 1984 and post-1991 periods. Therefore, while there is starting age information contained in the 1984 census, the level two administrative information does not match with the zones used in the study. To adjust the 1984 data to the 1994 geographical boundaries, shapefiles from each time period provided by Minnesota Population Center and the Ethiopian Central Statistical Agency (2017) are overlaid, and new start values for the post-1991 boundaries are calculated as the weighted averages of the start age value from the 1984 area and the portion of the post-1991 zone that is made up of that 1984 area. Unfortunately, this requires an unrealistic assumption of a consistent distribution of population within geographic area, and introduces a significant amount of measurement error into the start age calculations.

Panel G – 1994 Start Ages

Start ages from the 1994 census are used to calculate all intensity measures. The timing of this survey is problematic in the sense that the MTI implementation had already begun at this time. This along with any anticipation of the forthcoming FPE program could alter the decision to enter school in 1994.

Panel H – Three Part Trend

The district-specific linear trends are replaced with a set of district-specific trends that are allowed to change slope at two points, in 1978 and in 1987. On time entrants are partially treated beginning with the 1978 cohort, and fully treated beginning with the 1987 cohort.

Panel I – Regional Trends

The district-specific linear trend is replaced with a region-specific linear trend.

Panel J – No Trends

All trend variables are removed from the estimating equations.

Panel K – Only Zones in All Rounds of the DHS

Data are restricted only to zones with observations in all three of the rounds of the DHS survey. This includes 25 of 30 zones in the non-MTI regions, and 48 of the 60 zones throughout Ethiopia.

Panel L – Zones with Fewer than 4,000 Organized Violence Deaths (1989 to 1991)

Data from the four zones with the highest level of pre-independence violence, three of which are in the non-MTI sample, are removed from the sample. These zones contain more than 75 percent of all deaths included in the data over this time period.

Panel M – Zones with Fewer than 500 Organized Violence Deaths (1989 to 1991)

Data from 13 zones with more than 500 deaths related to organized violence in the pre-independence period, eight of which are in the non-MTI sample, are removed from the sample. These zones contain more than 96 percent of all deaths included in the data over this time period.

Panel N – Zones without High Intensity of Famine (1985)

Areas of Ethiopia (Tigray, Afar, Somali regions or the zones of Gonder) from which over 90 percent of individuals who registered with international shelters and camps at the height of the famine are removed from the sample (USAID, 1987). This includes 15 of the 30 zones in non-MTI regions.

The following panels are included when the effect of the combined FPE and MTI reforms are studied using the national sample, in Appendix Tables D.4 and D.5.

Panel P – No Tigray

Observations from the Tigray region are dropped. Tigray is the region for which the model estimates a positive return to the MTI reform.

Panel Q – Boothe and Walker (1997) MTI Definition

In addition to the corroborated set of languages included in the paper's joint definition, Boothe and Walker (1997) also find evidence that Somaligna was introduced in the Somali region for the first six grades in 1993, during the second round of translation introduced by the Council of Representatives.

Table D.2: Additional Language(s) in Boothe and Walker (1997) Definition

				Fraction of:	
				MT Speakers	Region Speaking
Language	Year	Region	Grades	Living in Region	Language as MT
Somaligna	1993	Somali	1-6	0.96	0.95

Source: Author's summary based on information from Boothe and Walker (1997).
Note: MT = mother tongue.

A non-zero MTI measure for the Somali region is introduced in the calculation of new MTI and joint intensity measures.

Panel R – Zenebe Gebre (2014) MTI Definition

In addition to the corroborated set of languages included in the paper's joint definition, Zenebe Gebre (2014) also finds evidence of six additional languages being introduced prior to the 1995 fee removal. Three of these languages were smaller languages introduced in SNNPR in 1992 and 1993. The other three are found to be introduced in 1994, one is an expansion of Oromigna in the Amhara region, and the final two are new languages in new regions.

Table D.3: Additional Language(s) in Zenebe Gebre (2014) Definition

				Fraction of:	
				MT Speakers	Region Speaking
Language	Year	Region	Grades	Living in Region	Language as MT
Gamogna	1992	SNNPR	1-4	0.96	0.07
Goffigna	1992	SNNPR	1-4	1.00	0.02
Dawurogna	1993	SNNPR	1-4	0.88	0.03
Oromigna	1994	Amhara	1-8	0.02	0.03
Anyiwakgna	1994	Gambela	1-4	0.98	0.27
Hareriegna	1994	Harari	1-6	0.47	0.07

Source: Author's summary based on information from Zenebe Gebre (2014).
Note: MT = mother tongue; SNNPR = Southern Nations, Nationalities, and Peoples' Region.

A non-zero MTI measure for Amhara, Gambela, and Harari are introduced in the calculation of new MTI and joint intensity measures, along with the necessary adjustments to the SNNPR region.

Table D.4: Effect of FPE and MTI Reforms on Years of Schooling:
Alternative Samples and Specifications - Analysis of First Stage Results from Table 2

	A	B	C	D	E	G	H	I	J	K	L	M	N	O
		1968	1969	1971	1972	Start Ages			Trends		Consistent	< 4000	< 500	No Main
	Baseline	1990	1989	1987	1987	1984	1994	Three-Part	Regional	None	Zones	Deaths	Deaths	Famine Zones
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	I. Non-MTI Regions Only - Effect of FPE													
	i. Census + DHS													
Add'l Years of Free Schooling (I_{zy}^{FPE})	0.131	0.164	0.149	0.116	0.117	0.146	0.100	0.139	0.102	0.259	0.134	0.129	0.135	0.185
	(0.034)	(0.045)	(0.039)	(0.028)	(0.030)	(0.043)	(0.059)	(0.047)	(0.052)	(0.046)	(0.034)	(0.034)	(0.034)	(0.035)
	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]	[0.002]	[0.101]	[0.006]	[0.056]	[0.000]	[0.001]	[0.001]	[0.001]	[0.000]
F-Statistic	14.80	13.36	14.34	17.21	14.94	11.54	2.86	8.77	3.93	31.36	15.28	14.53	15.87	28.05
N	83,005	101,702	95,469	76,674	74,694	83,005	83,005	83,005	83,005	83,005	78,149	66,143	45,162	55,208
	ii. DHS Only													
Add'l Years of Free Schooling (I_{zy}^{FPE})	0.112	0.146	0.122	0.106	0.097	0.141	0.082	0.181	0.082	0.244	0.116	0.109	0.126	0.170
	(0.046)	(0.053)	(0.048)	(0.045)	(0.048)	(0.057)	(0.075)	(0.043)	(0.066)	(0.053)	(0.046)	(0.050)	(0.048)	(0.056)
	[0.021]	[0.010]	[0.016]	[0.027]	[0.055]	[0.019]	[0.286]	[0.000]	[0.224]	[0.000]	[0.018]	[0.038]	[0.015]	[0.009]
F-Statistic	5.93	7.54	6.51	5.44	3.99	6.16	1.18	17.98	1.54	21.47	6.44	4.77	6.95	9.26
N	13,922	16,481	15,108	12,299	11,967	13,922	13,922	13,922	13,922	13,922	13,638	12,819	9,913	10,161

Table D.4: *(... continued)* Effect of FPE and MTI Reforms on Years of Schooling: Alternative Samples and Specifications - Analysis of First Stage Results from Table 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
		1968	1969	1971	1972	Start Ages			Trends		Consistent	< 4000	< 500	No Main	No	BW (1997)	TZG (2014)
	Baseline	1990	1989	1987	1987	1984	1994	Three-Part	Regional	None	Zones	Deaths	Deaths	Famine Zones	Tigray	Definition	Definition
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	II. National Sample - Effect of FPE and MTI (Separate Instruments)																
	i. Census + DHS																
Add'l Years of Free Schooling (I_{zy}^{FPE})	0.115	0.149	0.130	0.108	0.111	0.116	0.098	0.132	0.082	0.236	0.132	0.114	0.099	0.150	0.113	0.114	0.114
	(0.044)	(0.046)	(0.046)	(0.033)	(0.033)	(0.057)	(0.053)	(0.062)	(0.057)	(0.073)	(0.039)	(0.044)	(0.052)	(0.048)	(0.044)	(0.047)	(0.044)
	[0.011]	[0.002]	[0.007]	[0.002]	[0.001]	[0.045]	[0.072]	[0.038]	[0.155]	[0.002]	[0.001]	[0.011]	[0.065]	[0.003]	[0.012]	[0.019]	[0.012]
Add'l Year of MTI No Script Change (I_{zy}^{MTI-T})	0.183	0.226	0.204	0.134	0.130	0.162	0.173	0.222	0.154	0.271	0.190	0.194	—	—	—	0.186	0.185
	(0.070)	(0.060)	(0.062)	(0.066)	(0.062)	(0.087)	(0.051)	(0.077)	(0.067)	(0.056)	(0.071)	(0.088)	—	—	—	(0.071)	(0.071)
	[0.012]	[0.000]	[0.002]	[0.046]	[0.041]	[0.068]	[0.001]	[0.005]	[0.025]	[0.000]	[0.010]	[0.032]	—	—	—	[0.011]	[0.011]
Add'l Year of MTI with Script Change (I_{zy}^{MTI})	-0.119	-0.108	-0.097	-0.163	-0.182	-0.086	-0.054	-0.151	-0.114	-0.072	-0.114	-0.110	-0.101	-0.105	-0.120	-0.100	-0.106
	(0.052)	(0.044)	(0.042)	(0.058)	(0.062)	(0.064)	(0.063)	(0.066)	(0.047)	(0.040)	(0.053)	(0.058)	(0.076)	(0.061)	(0.052)	(0.050)	(0.052)
	[0.025]	[0.016]	[0.022]	[0.007]	[0.005]	[0.189]	[0.387]	[0.025]	[0.018]	[0.076]	[0.037]	[0.063]	[0.191]	[0.093]	[0.025]	[0.052]	[0.044]
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$	-0.008	-0.014	-0.013	-0.005	-0.005	-0.009	0.000	-0.017	-0.009	-0.011	-0.009	-0.008	—	—	—	-0.009	-0.009
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.009)	(0.009)	(0.006)	(0.005)	(0.006)	(0.008)	—	—	—	(0.006)	(0.006)
	[0.169]	[0.023]	[0.030]	[0.419]	[0.400]	[0.170]	[0.962]	[0.067]	[0.120]	[0.039]	[0.136]	[0.337]	—	—	—	[0.154]	[0.169]
$I_{zy}^{FPE} \times I_{zy}^{MTI}$	0.001	0.001	0.000	0.005	0.004	-0.001	-0.002	0.008	0.001	0.002	0.001	0.002	0.003	-0.002	0.002	0.000	0.001
	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.009)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
	[0.767]	[0.792]	[0.999]	[0.247]	[0.312]	[0.899]	[0.727]	[0.390]	[0.789]	[0.783]	[0.851]	[0.699]	[0.599]	[0.664]	[0.743]	[0.995]	[0.818]
F-Statistic	14.09	14.64	13.93	13.46	13.39	5.19	6.46	6.91	11.88	14.48	15.61	13.39	7.94	11.60	10.67	13.63	13.41
N	205,141	249,768	235,691	190,989	186,219	205,141	205,141	205,141	205,141	205,141	198,667	184,888	141,172	164,252	192,049	205,141	205,141

Table D.4: *(... continued)* Effect of FPE and MTI Reforms on Years of Schooling: Alternative Samples and Specifications - Analysis of First Stage Results from Table 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
		1968	1969	1971	1972	Start Ages			Trends		Consistent	< 4000	< 500	No Main	No	BW (1997)	TZG (2014)
	Baseline	1990	1989	1987	1987	1984	1994	Three-Part	Regional	None	Zones	Deaths	Deaths	Famine Zones	Tigray	Definition	Definition
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	II. National Sample - Effect of FPE and MTI (Separate Instruments)																
	ii. DHS Only																
Add'l Years of Free Schooling (I_{zy}^{FPE})	0.115	0.155	0.124	0.110	0.107	0.116	0.111	0.178	0.093	0.239	0.137	0.117	0.098	0.152	0.113	0.112	0.114
	(0.053)	(0.050)	(0.052)	(0.049)	(0.050)	(0.070)	(0.064)	(0.074)	(0.065)	(0.070)	(0.049)	(0.056)	(0.065)	(0.063)	(0.053)	(0.057)	(0.054)
	[0.035]	[0.003]	[0.020]	[0.028]	[0.036]	[0.105]	[0.085]	[0.019]	[0.157]	[0.001]	[0.008]	[0.043]	[0.143]	[0.020]	[0.039]	[0.053]	[0.040]
Add'l Year of MTI No Script Change (I_{zy}^{MTI-T})	0.175	0.222	0.202	0.105	0.095	0.141	0.177	0.223	0.143	0.268	0.184	0.175	—	—	—	0.179	0.179
	(0.087)	(0.071)	(0.075)	(0.082)	(0.081)	(0.111)	(0.069)	(0.090)	(0.082)	(0.054)	(0.087)	(0.105)	—	—	—	(0.087)	(0.087)
	[0.049]	[0.003]	[0.009]	[0.207]	[0.246]	[0.207]	[0.013]	[0.017]	[0.086]	[0.000]	[0.038]	[0.103]	—	—	—	[0.045]	[0.045]
Add'l Year of MTI with Script Change (I_{zy}^{MTI})	-0.128	-0.112	-0.094	-0.210	-0.237	-0.082	-0.042	-0.190	-0.124	-0.079	-0.122	-0.111	-0.104	-0.115	-0.130	-0.107	-0.111
	(0.073)	(0.063)	(0.063)	(0.090)	(0.093)	(0.089)	(0.086)	(0.090)	(0.062)	(0.053)	(0.075)	(0.082)	(0.108)	(0.086)	(0.074)	(0.071)	(0.074)
	[0.085]	[0.077]	[0.140]	[0.023]	[0.014]	[0.360]	[0.626]	[0.038]	[0.051]	[0.143]	[0.109]	[0.182]	[0.341]	[0.192]	[0.086]	[0.138]	[0.136]
$I_{zy}^{FPE} \times I_{zy}^{MTI-T}$	-0.010	-0.016	-0.016	-0.006	-0.006	-0.010	-0.002	-0.021	-0.011	-0.012	-0.011	-0.008	—	—	—	-0.010	-0.010
	(0.008)	(0.007)	(0.007)	(0.009)	(0.009)	(0.008)	(0.012)	(0.013)	(0.008)	(0.007)	(0.008)	(0.011)	—	—	—	(0.008)	(0.008)
	[0.239]	[0.025]	[0.038]	[0.518]	[0.504]	[0.238]	[0.875]	[0.105]	[0.195]	[0.114]	[0.201]	[0.472]	—	—	—	[0.239]	[0.242]
$I_{zy}^{FPE} \times I_{zy}^{MTI}$	-0.001	-0.001	-0.003	0.007	0.006	-0.004	-0.005	0.010	0.000	0.000	-0.001	0.000	0.002	-0.004	0.000	-0.001	-0.001
	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)	(0.012)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
	[0.930]	[0.861]	[0.659]	[0.325]	[0.400]	[0.627]	[0.524]	[0.382]	[1.000]	[0.955]	[0.868]	[0.975]	[0.855]	[0.573]	[0.962]	[0.860]	[0.910]
F-Statistic	6.91	20.55	11.63	7.53	6.56	2.07	3.34	5.82	5.27	12.43	8.00	5.72	4.41	5.83	6.18	6.39	6.33
N	24,898	29,547	27,106	22,023	21,390	24,898	24,898	24,898	24,898	24,898	24,478	23,188	17,942	18,739	22,500	24,898	24,898

Table D.4: *(... continued)* Effect of FPE and MTI Reforms on Years of Schooling: Alternative Samples and Specifications - Analysis of First Stage Results from Table 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
		1968	1969	1971	1972	Start Ages			Trends		Consistent	< 4000	< 500	No Main	No	BW (1997)	TZG (2014)
	Baseline	1990	1989	1987	1987	1984	1994	Three-Part	Regional	None	Zones	Deaths	Deaths	Famine Zones	Tigray	Definition	Definition
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
III. National Sample - Effect of FPE and MTI (Combined Instrument)																	
i. Census + DHS																	
Add'l Years of FPE or MTI	0.109	0.130	0.118	0.105	0.111	0.096	0.075	0.139	0.095	0.129	0.114	0.107	0.098	0.132	0.113	0.106	0.106
w/out Script Change	(0.018)	(0.021)	(0.018)	(0.019)	(0.021)	(0.024)	(0.022)	(0.027)	(0.020)	(0.028)	(0.017)	(0.019)	(0.023)	(0.026)	(0.025)	(0.017)	(0.018)
(ΔI_{zy})	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
F-Statistic	38.28	38.79	41.97	29.36	28.81	16.14	11.12	25.56	22.05	20.67	43.86	32.37	18.69	25.66	20.58	37.05	35.49
N	205,141	249,768	235,691	190,989	186,219	205,141	205,141	205,141	205,141	205,141	198,667	184,888	143,377	164,252	192,049	205,141	205,141
ii. DHS Only																	
Add'l Years of FPE or MTI	0.115	0.138	0.123	0.111	0.121	0.096	0.078	0.160	0.104	0.136	0.121	0.107	0.097	0.141	0.122	0.109	0.110
w/out Script Change	(0.026)	(0.026)	(0.024)	(0.021)	(0.033)	(0.033)	(0.030)	(0.037)	(0.027)	(0.029)	(0.026)	(0.028)	(0.032)	(0.043)	(0.039)	(0.025)	(0.026)
(ΔI_{zy})	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.005]	[0.012]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.004]	[0.002]	[0.003]	[0.000]	[0.000]
F-Statistic	19.56	27.76	26.44	14.09	13.31	8.67	6.77	18.47	14.31	21.77	21.91	14.22	9.17	11.05	9.69	18.39	17.86
N	24,898	29,547	27,106	22,023	21,390	24,898	24,898	24,898	24,898	24,898	24,478	23,188	18,396	18,739	22,500	24,898	24,898

Source: Author's analysis based on data from the Ethiopian census of 2007 and the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: FPE = free primary education; MTI = mother tongue instruction; BW (1997) = Boothe and Walker (1997); TZG (2014) = Zenebe Gebre (2014). The dependent variable is years of schooling. All sample and specification definitions can be found in Section D.2 of this supplementary online appendix. Unless otherwise noted, all regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Panel I includes only observations from non-MTI regions; all regions are included in panels II and III. Estimates in each column and panel are from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table D.5: Effect of Years of Schooling on Number of Children Born:
Alternative Samples and Specifications - Analysis of Results from Table 2

	Non-MTI Regions Only Effect of FPE		National Sample Effect of FPE and MTI (Separate Instruments)		National Sample Effect of FPE and MTI (Combined Instrument)	
	Census + DHS	DHS Only	Census + DHS	DHS Only	Census + DHS	DHS Only
	(1)	(2)	(3)	(4)	(5)	(6)
	A. Baseline					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.437	-0.529	-0.273	-0.365	-0.257	-0.321
	(0.090)	(0.165)	(0.109)	(0.147)	(0.117)	(0.156)
	[0.000]	[0.001]	[0.012]	[0.001]	[0.028]	[0.040]
First Stage F-Statistic	14.796	5.93	14.09	6.91	38.28	19.56
N	69,083	13,922	205,141	24,898	205,141	24,898
	B. Cohorts: 1968 - 1990					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.422	-0.406	-0.212	-0.178	-0.198	-0.178
	(0.092)	(0.115)	(0.101)	(0.117)	(0.109)	(0.133)
	[0.000]	[0.000]	[0.035]	[0.131]	[0.069]	[0.181]
First Stage F-Statistic	13.36	7.54	14.64	20.55	38.79	27.76
N	101,702	16,481	249,768	29,547	249,768	29,547
	C. Cohorts: 1969 - 1989					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.429	-0.455	-0.189	-0.142	-0.188	-0.168
	(0.095)	(0.149)	(0.106)	(0.123)	(0.113)	(0.141)
	[0.000]	[0.002]	[0.074]	[0.250]	[0.096]	[0.235]
First Stage F-Statistic	14.34	6.51	13.93	11.63	41.97	26.44
N	95,469	15,108	235,691	27,106	235,691	27,106
	D. Cohorts: 1971 - 1987					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.427	-0.489	-0.359	-0.472	-0.280	-0.364
	(0.105)	(0.184)	(0.113)	(0.147)	(0.112)	(0.150)
	[0.000]	[0.008]	[0.001]	[0.001]	[0.013]	[0.015]
First Stage F-Statistic	17.21	5.44	13.46	7.53	29.36	14.09
N	76,674	12,299	190,989	22,023	190,989	22,023
	E. Cohorts: 1972 - 1987					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.380	-0.413	-0.326	-0.422	-0.230	-0.313
	(0.099)	(0.174)	(0.124)	(0.175)	(0.121)	(0.157)
	[0.000]	[0.017]	[0.009]	[0.016]	[0.049]	[0.046]
First Stage F-Statistic	14.94	3.99	13.39	6.56	28.81	13.31
N	74,694	11,967	186,219	21,390	186,219	21,390

Table D.5: *(... continued)* Effect of Years of Schooling on Number of Children Born: Alternative Samples and Specifications - Analysis of Results from Table 2

	Non-MTI Regions Only Effect of FPE		National Sample Effect of FPE and MTI (Separate Instruments)		National Sample Effect of FPE and MTI (Combined Instrument)	
	Census + DHS	DHS Only	Census + DHS	DHS Only	Census + DHS	DHS Only
	(1)	(2)	(3)	(4)	(5)	(6)
	F. Using 1984 Census Matched Start Ages					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.539	-0.580	-0.261	-0.314	-0.257	-0.270
	(0.144)	(0.187)	(0.123)	(0.172)	(0.139)	(0.188)
	[0.000]	[0.002]	[0.035]	[0.068]	[0.065]	[0.150]
First Stage F-Statistic	11.54	6.16	5.19	2.07	16.14	8.67
N	83,005	13,922	205,141	24,898	205,141	24,898
	G. Using 1994 Census Start Ages					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.550	-0.719	-0.224	-0.298	-0.231	-0.218
	(0.196)	(0.416)	(0.111)	(0.137)	(0.166)	(0.218)
	[0.005]	[0.084]	[0.043]	[0.030]	[0.163]	[0.317]
First Stage F-Statistic	2.86	1.18	6.46	3.34	11.12	6.77
N	83,005	13,922	205,141	24,898	205,141	24,898
	H. Three-Part District Trends					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.480	-0.372	-0.303	-0.367	-0.292	-0.368
	(0.111)	(0.143)	(0.112)	(0.129)	(0.115)	(0.140)
	[0.000]	[0.009]	[0.007]	[0.004]	[0.011]	[0.009]
First Stage F-Statistic	8.77	17.98	6.91	5.82	25.56	18.47
N	83,005	13,922	205,141	24,898	205,141	24,898
	I. Regional Trends					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.667	-0.822	-0.317	-0.371	-0.331	-0.358
	(0.307)	(0.530)	(0.137)	(0.188)	(0.147)	(0.191)
	[0.030]	[0.121]	[0.021]	[0.048]	[0.024]	[0.060]
First Stage F-Statistic	3.93	1.54	11.88	5.27	22.05	14.31
N	83,005	13,922	205,141	24,898	205,141	24,898
	J. No Trends					
Years of $\widehat{\text{Schooling}}_{izy}$	-0.837	-0.963	-0.336	-0.351	-0.187	-0.216
	(0.092)	(0.152)	(0.224)	(0.238)	(0.165)	(0.176)
	[0.000]	[0.000]	[0.134]	[0.139]	[0.258]	[0.219]
First Stage F-Statistic	31.36	21.47	14.48	12.43	20.67	21.77
N	83,005	13,922	205,141	24,898	205,141	24,898

Table D.5: *(... continued)* Effect of Years of Schooling on Number of Children Born: Alternative Samples and Specifications - Analysis of Results from Table 2

	Non-MTI Regions Only Effect of FPE		National Sample Effect of FPE and MTI (Separate Instruments)		National Sample Effect of FPE and MTI (Combined Instrument)	
	Census + DHS	DHS Only	Census + DHS	DHS Only	Census + DHS	DHS Only
	(1)	(2)	(3)	(4)	(5)	(6)
K. Only Zones in All DHS Rounds (25 of 30; 48 of 60)						
Years of $\widehat{\text{Schooling}}_{izy}$	-0.425	-0.499	-0.260	-0.343	-0.230	-0.303
	(0.087)	(0.157)	(0.104)	(0.135)	(0.113)	(0.149)
	[0.000]	[0.001]	[0.013]	[0.011]	[0.035]	[0.042]
First Stage F-Statistic	15.28	6.44	15.61	8.00	43.86	21.91
N	78,149	13,638	198,667	24,478	198,667	24,478
L. Less than 4,000 Organized Violence Deaths: 1989 to 91						
Years of $\widehat{\text{Schooling}}_{izy}$	-0.456	-0.550	-0.264	-0.342	-0.254	-0.312
	(0.103)	(0.200)	(0.119)	(0.156)	(0.124)	(0.169)
	[0.000]	[0.006]	[0.027]	[0.028]	[0.040]	[0.064]
First Stage F-Statistic	14.53	4.77	13.39	5.72	32.37	14.22
N	66,143	12,819	184,888	23,188	184,888	23,188
M. Less than 500 Organized Violence Deaths: 1989 to 91						
Years of $\widehat{\text{Schooling}}_{izy}$	-0.508	-0.515	-0.436	-0.394	-0.336	-0.345
	(0.186)	(0.252)	(0.184)	(0.268)	(0.178)	(0.238)
	[0.006]	[0.041]	[0.018]	[0.142]	[0.060]	[0.148]
First Stage F-Statistic	15.87	6.95	7.94	4.41	18.69	9.17
N	45,162	9,913	141,172	17,942	143,377	18,396
N. No Regions of Highest Famine Concentration						
Years of $\widehat{\text{Schooling}}_{izy}$	-0.334	-0.374	-0.341	-0.442	-0.380	-0.510
	(0.079)	(0.118)	(0.139)	(0.201)	(0.150)	(0.209)
	[0.000]	[0.002]	[0.014]	[0.027]	[0.011]	[0.015]
First Stage F-Statistic	28.05	9.26	11.60	5.83	25.66	11.05
N	55,208	10,161	164,252	18,739	164,252	18,739

	National Sample Effect of FPE and MTI (Separate Instruments)		National Sample Effect of FPE and MTI (Combined Instrument)	
	Census + DHS	DHS Only	Census + DHS	DHS Only
	(3)	(4)	(5)	(6)
O. No Tigray				
Years of $\widehat{\text{Schooling}}_{izy}$	-0.443	-0.565	-0.419	-0.564
	(0.152)	(0.237)	(0.154)	(0.223)
	[0.004]	[0.017]	[0.006]	[0.012]
First Stage F-Statistic	10.67	6.18	20.58	9.69
N	192,049	22,500	192,049	22,500
P. Boothe and Walker (1997) Definition				
Years of $\widehat{\text{Schooling}}_{izy}$	-0.211	-0.303	-0.201	-0.276
	(0.109)	(0.142)	(0.119)	(0.159)
	[0.053]	[0.033]	[0.091]	[0.081]
First Stage F-Statistic	13.63	6.39	37.05	18.39
N	205,141	24,898	205,141	24,898
Q. Zenebe Gebre (2014) Definition				
Years of $\widehat{\text{Schooling}}_{izy}$	-0.264	-0.344	-0.250	-0.312
	(0.110)	(0.145)	(0.119)	(0.161)
	[0.016]	[0.018]	[0.036]	[0.053]
First Stage F-Statistic	13.41	6.33	35.49	17.86
N	205,141	24,898	205,141	24,898

Source: Author's analysis based on data from the Ethiopian census of 2007 and the Demographic and Health Survey (DHS) in years 2005, 2011, and 2016.

Note: FPE = free primary education; MTI = mother tongue instruction. The dependent variable is the number of births. In columns 1 and 2, Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling instrumented with the FPE intensity measure I_{zy}^{FPE}; in columns 3 and 4 additional instruments include two MTI intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred. In columns 5 and 6, the joint intensity measure ΔI_{zy} is used. All sample and specification definitions can be found in Section D.2 of this supplementary online appendix. Unless otherwise noted, all regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. The first two columns include only observations from non-MTI regions; all regions are included in the final four columns. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table D.6: Effect of Years of Schooling on Knowledge and Health in non-MTI Regions: Alternative Samples and Specifications - Analysis of Results from Table 3

	Literacy	Read about Fam. Planning	Know about Fam. Planning	BMI (z-score)	Height (z-score)	Acceptable Reasons for Domestic Violence (of 5)	Use Modern Contraception	Use Hidden Contraception
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				A. Baseline				
Years of $\widehat{\text{Schooling}}_{izy}$	0.092	0.048	-0.013	0.316	-0.271	-0.361	-0.018	-0.035
	(0.028)	(0.029)	(0.024)	(0.355)	(0.302)	(0.211)	(0.051)	(0.042)
	[0.001]	[0.097]	[0.594]	[0.374]	[0.369]	[0.087]	[0.721]	[0.402]
First Stage F-Statistic	6.10	5.92	5.93	1.91	2.22	5.67	5.93	5.93
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922
				B. Cohorts: 1968 - 1990				
Years of $\widehat{\text{Schooling}}_{izy}$	0.107	0.031	-0.011	0.211	-0.121	-0.35	-0.001	-0.023
	(0.018)	(0.016)	(0.016)	(0.205)	(0.166)	(0.179)	(0.038)	(0.034)
	[0.000]	[0.047]	[0.499]	[0.304]	[0.467]	[0.051]	[0.987]	[0.492]
First Stage F-Statistic	7.86	7.54	7.54	3.54	3.77	7.41	7.54	7.54
N	16,157	16,471	16,481	12,962	13,286	15,848	16,481	16,481
				C. Cohorts: 1969 - 1989				
Years of $\widehat{\text{Schooling}}_{izy}$	0.105	0.034	-0.015	0.285	-0.178	-0.424	0.002	-0.026
	(0.026)	(0.021)	(0.020)	(0.289)	(0.233)	(0.229)	(0.050)	(0.042)
	[0.000]	[0.110]	[0.450]	[0.324]	[0.443]	[0.064]	[0.966]	[0.546]
First Stage F-Statistic	7.05	6.50	6.51	2.55	2.64	6.46	6.51	6.51
N	14,832	15,098	15,108	11,802	12,086	14,528	15,108	15,108
				D. Cohorts: 1971 - 1987				
Years of $\widehat{\text{Schooling}}_{izy}$	0.095	0.056	-0.034	0.152	-0.271	-0.216	-0.052	-0.072
	(0.028)	(0.033)	(0.033)	(0.285)	(0.334)	(0.191)	(0.052)	(0.042)
	[0.001]	[0.086]	[0.294]	[0.592]	[0.418]	[0.259]	[0.322]	[0.086]
First Stage F-Statistic	5.37	5.41	5.44	1.36	1.76	4.40	5.44	5.44
N	12,078	12,292	12,299	9,653	9,888	11,872	12,299	12,299
				E. Cohorts: 1972 - 1987				
Years of $\widehat{\text{Schooling}}_{izy}$	0.079	0.059	-0.038	0.290	-0.420	-0.173	-0.041	-0.078
	(0.031)	(0.036)	(0.038)	(0.436)	(0.550)	(0.207)	(0.054)	(0.040)
	[0.010]	[0.101]	[0.320]	[0.507]	[0.445]	[0.405]	[0.456]	[0.054]
First Stage F-Statistic	3.92	3.97	3.99	1.02	1.15	3.13	3.99	3.99
N	11,751	11,960	11,967	9,375	9,608	11,548	11,967	11,967
				F. Using 1984 Census Matched Start Ages				
Years of $\widehat{\text{Schooling}}_{izy}$	0.083	0.045	-0.028	0.139	-0.206	-0.251	0.017	-0.002
	(0.026)	(0.030)	(0.022)	(0.224)	(0.294)	(0.125)	(0.062)	(0.050)
	[0.002]	[0.123]	[0.212]	[0.536]	[0.485]	[0.044]	[0.783]	[0.970]
First Stage F-Statistic	6.14	6.14	6.16	1.46	1.72	5.85	6.16	6.16
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922
				G. Using 1994 Census Start Ages				
Years of $\widehat{\text{Schooling}}_{izy}$	0.096	0.038	-0.019	0.267	0.055	-0.217	-0.060	-0.084
	(0.033)	(0.029)	(0.033)	(0.528)	(0.285)	(0.232)	(0.070)	(0.086)
	[0.004]	[0.181]	[0.562]	[0.614]	[0.848]	[0.351]	[0.392]	[0.328]
First Stage F-Statistic	1.20	1.18	1.18	0.49	0.49	0.84	1.18	1.18
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922
				H. Three-Part District Trends				
Years of $\widehat{\text{Schooling}}_{izy}$	0.079	0.049	-0.003	0.171	-0.124	-0.322	-0.011	-0.002
	(0.023)	(0.020)	(0.023)	(0.163)	(0.212)	(0.181)	(0.052)	(0.046)
	[0.001]	[0.016]	[0.886]	[0.296]	[0.558]	[0.076]	[0.827]	[0.958]
First Stage F-Statistic	17.48	17.68	17.98	8.53	8.54	11.35	17.98	17.98
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922

Table D.6: *(... continued)* Effect of Years of Schooling on Knowledge and Health: Alternative Samples and Specifications - Analysis of Results from Table 3

	Literacy	Read about Fam. Planning	Know about Fam. Planning	BMI (z-score)	Height (z-score)	Acceptable Reasons for Domestic Violence (of 5)	Use Modern Contraception	Use Hidden Contraception
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	I. Regional Trends							
Years of $\widehat{\text{Schooling}}_{izy}$	0.102	0.072	-0.026	0.329	-0.426	-0.388	-0.038	-0.050
	(0.034)	(0.066)	(0.035)	(0.778)	(1.072)	(0.329)	(0.053)	(0.049)
	[0.003]	[0.275]	[0.467]	[0.673]	[0.691]	[0.238]	[0.467]	[0.313]
First Stage F-Statistic	1.60	1.55	1.54	0.25	0.25	1.45	1.54	1.54
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922
	J. No Trends							
Years of $\widehat{\text{Schooling}}_{izy}$	0.075	0.032	-0.010	0.432	-0.066	-0.167	0.006	-0.013
	(0.007)	(0.009)	(0.007)	(0.138)	(0.057)	(0.036)	(0.014)	(0.013)
	[0.000]	[0.000]	[0.158]	[0.002]	[0.248]	[0.000]	[0.682]	[0.308]
First Stage F-Statistic	21.87	21.57	21.47	8.15	7.83	19.77	21.47	21.47
N	13,672	13,912	13,922	10,941	11,207	13,405	13,922	13,922
	K. Only Zones in All DHS Rounds (25 of 30; 48 of 60)							
Years of $\widehat{\text{Schooling}}_{izy}$	0.089	0.046	-0.015	0.276	-0.240	-0.338	-0.023	-0.040
	(0.028)	(0.027)	(0.023)	(0.292)	(0.268)	(0.186)	(0.046)	(0.038)
	[0.002]	[0.085]	[0.515]	[0.345]	[0.370]	[0.070]	[0.618]	[0.296]
First Stage F-Statistic	6.57	6.43	6.44	2.11	2.44	6.13	6.44	6.44
N	13,391	13,628	13,638	10,667	10,933	13,121	13,638	13,638
	L. Less than 4,000 Organized Violence Deaths: 1989 to 91							
Years of $\widehat{\text{Schooling}}_{izy}$	0.082	0.055	-0.021	0.249	-0.166	-0.344	-0.022	-0.049
	(0.029)	(0.032)	(0.026)	(0.303)	(0.219)	(0.196)	(0.056)	(0.048)
	[0.005]	[0.084]	[0.403]	[0.411]	[0.448]	[0.079]	[0.703]	[0.306]
First Stage F-Statistic	4.82	4.74	4.77	1.73	1.75	4.24	4.77	4.77
N	12,569	12,810	12,819	10,085	10,335	12,357	12,819	12,819
	M. Less than 500 Organized Violence Deaths: 1989 to 91							
Years of $\widehat{\text{Schooling}}_{izy}$	0.077	0.041	0.010	0.214	-0.258	-0.272	-0.008	-0.021
	(0.030)	(0.021)	(0.023)	(0.248)	(0.339)	(0.152)	(0.046)	(0.040)
	[0.011]	[0.055]	[0.670]	[0.389]	[0.447]	[0.073]	[0.868]	[0.607]
First Stage F-Statistic	6.97	7.00	6.95	2.55	2.00	8.59	6.95	6.95
N	9,677	9,908	9,913	7,826	8,020	9,539	9,913	9,913
	N. No Regions of Highest Famine Concentration							
Years of $\widehat{\text{Schooling}}_{izy}$	0.114	0.030	-0.010	0.203	-0.095	-0.203	-0.041	-0.054
	(0.021)	(0.020)	(0.024)	(0.174)	(0.154)	(0.111)	(0.036)	(0.032)
	[0.000]	[0.128]	[0.694]	[0.244]	[0.534]	[0.069]	[0.262]	[0.092]
First Stage F-Statistic	9.14	9.19	9.26	3.73	3.51	6.53	9.26	9.26
N	9,951	10,155	10,161	7,871	8,064	9,826	10,161	10,161

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: BMI = body mass index. The dependent variable is described at the top of each of the eight columns. In columns 1–3, 7, and 8 it is an indicator that equals 1 if true; in columns 4 and 5 it is a standardized value of the described outcome; and in column 6 it is the count from 0 to 5 of acceptable reasons for domestic violence (going out without permission, neglecting children, arguing with husband, refusing sex, burning food). Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling, instrumented with the free primary education (FPE) intensity measure, I_{zy}^{FPE}. All sample and specification definitions can be found in Section D.2 of this supplementary online appendix. Unless otherwise noted, all regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. Each estimate is from a unique regression. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.

Table D.7: Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference: Alternative Samples and Specifications - Analysis of Results from Table 4

		Sector of Work					
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children	Ideal Number of Children	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Non-MTI Regions – FPE Only					*National*	
						(Separate)	*(Combined)*
	A. Baseline						
Years of $\widehat{\text{Schooling}}_{izy}$	0.093	0.059	0.064	-0.048	-0.786	-0.923	-0.902
	(0.058)	(0.028)	(0.047)	(0.031)	(0.468)	(0.658)	(0.493)
	[0.107]	[0.033]	[0.169]	[0.116]	[0.093]	[0.160]	[0.068]
First Stage F-Statistic	6.06	6.63	6.63	6.63	6.63	6.60	19.37
N	13,909	13,755	13,755	13,755	13,789	24,649	24,649
	B. Cohorts: 1968 - 1990						
Years of $\widehat{\text{Schooling}}_{izy}$	0.076	0.052	0.040	-0.044	-0.661	-0.883	-0.834
	(0.039)	(0.023)	(0.031)	(0.030)	(0.567)	(0.400)	(0.320)
	[0.052]	[0.023]	[0.196]	[0.146]	[0.244]	[0.027]	[0.009]
First Stage F-Statistic	7.68	7.61	7.61	7.61	7.66	21.26	27.72
N	16,465	16,276	16,276	16,276	16,323	29,253	29,253
	C. Cohorts: 1969 - 1989						
Years of $\widehat{\text{Schooling}}_{izy}$	0.110	0.057	0.058	-0.032	-0.790	-0.839	-0.837
	(0.056)	(0.029)	(0.042)	(0.030)	(0.737)	(0.565)	(0.440)
	[0.050]	[0.050]	[0.166]	[0.288]	[0.284]	[0.138]	[0.057]
First Stage F-Statistic	6.67	7.20	7.20	7.20	6.76	12.01	26.80
N	15,093	14,927	14,927	14,927	14,963	26,832	26,832
	D. Cohorts: 1971 - 1987						
Years of $\widehat{\text{Schooling}}_{izy}$	0.115	0.081	0.071	-0.049	-1.073	-1.144	-1.110
	(0.082)	(0.043)	(0.058)	(0.048)	(0.708)	(0.583)	(0.506)
	[0.158]	[0.060]	[0.221]	[0.305]	[0.130]	[0.050]	[0.028]
First Stage F-Statistic	3.47	3.99	3.99	3.99	3.64	7.56	13.80
N	13,195	13,045	13,045	13,045	13,084	21,802	21,802
	E. Cohorts: 1972 - 1987						
Years of $\widehat{\text{Schooling}}_{izy}$	0.158	0.109	0.081	-0.061	-1.087	-0.950	-0.944
	(0.107)	(0.058)	(0.067)	(0.055)	(1.848)	(0.582)	(0.571)
	[0.140]	[0.062]	[0.229]	[0.269]	[0.556]	[0.103]	[0.098]
First Stage F-Statistic	2.70	3.19	3.19	3.19	2.88	6.56	13.07
N	12,863	12,715	12,715	12,715	12,754	21,177	21,177

Table D.7: *(... continued)* Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference: Alternative Samples and Specifications - Analysis of Results from Table 4

		Sector of Work					
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children	Ideal Number of Children	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						National (Separate)	*National (Combined)*
				F. Using 1984 Census Matched Start Ages			
Years of $\widehat{\text{Schooling}}_{izy}$	0.071	0.027	0.088	-0.061	-0.345	-1.116	-1.198
	(0.051)	(0.014)	(0.026)	(0.036)	(0.518)	(0.933)	(0.472)
	[0.160]	[0.057]	[0.001]	[0.089]	[0.505]	[0.232]	[0.011]
First Stage F-Statistic	6.22	5.79	5.79	5.79	6.30	1.99	6.74
N	13,909	13,755	13,755	13,755	13,789	24,649	24,649
				G. Using 1994 Census Start Ages			
Years of $\widehat{\text{Schooling}}_{izy}$	0.083	0.014	0.112	-0.028	-1.326	-1.333	-1.605
	(0.056)	(0.029)	(0.048)	(0.045)	(2.144)	(0.675)	(0.794)
	[0.139]	[0.613]	[0.020]	[0.531]	[0.536]	[0.048]	[0.043]
First Stage F-Statistic	1.23	1.36	1.36	1.36	1.49	3.45	18.70
N	13,909	13,755	13,755	13,755	13,789	24,649	24,649
				H. Three-Part District Trends			
Years of $\widehat{\text{Schooling}}_{izy}$	0.082	0.090	0.020	-0.008	-0.648	-0.728	-0.746
	(0.060)	(0.024)	(0.046)	(0.033)	(0.446)	(0.618)	(0.426)
	[0.171]	[0.000]	[0.670]	[0.806]	[0.146]	[0.239]	[0.080]
First Stage F-Statistic	17.90	16.29	16.29	16.29	17.91	5.89	18.70
N	13,909	13,755	13,755	13,755	13,789	24,649	24,649
				I. Regional Trends			
Years of $\widehat{\text{Schooling}}_{izy}$	0.133	0.078	0.083	-0.063	-1.163	-1.032	-0.946
	(0.107)	(0.065)	(0.057)	(0.066)	(0.768)	(0.715)	(0.561)
	[0.217]	[0.229]	[0.144]	[0.344]	[0.130]	[0.149]	[0.092]
First Stage F-Statistic	1.60	1.57	1.57	1.57	2.06	4.95	14.49
N	13,909	13,755	13,755	13,755	13,789	24,649	24,649
				J. No Trends			
Years of $\widehat{\text{Schooling}}_{izy}$	0.048	0.042	0.015	-0.026	-0.711	-0.675	-0.950
	(0.016)	(0.011)	(0.011)	(0.016)	(0.220)	(0.245)	(0.311)
	[0.002]	[0.000]	[0.185]	[0.107]	[0.001]	[0.006]	[0.002]
First Stage F-Statistic	21.77	21.00	21.00	21.00	23.08	13.20	21.45
N	13,909	13,755	13,755	13,755	13,789	24,649	24,649

Table D.7: *(... continued)* Effect of Years of Schooling on Labor Market Outcomes and Fertility Preference: Alternative Samples and Specifications - Analysis of Results from Table 4

		Sector of Work					
	Working	Skilled / Professional	Service / Sales	Agriculture / Unskilled Manual	Ideal Number of Children	Ideal Number of Children	Ideal Number of Children
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						National (Separate)	*National (Combined)*
	K. Only Zones in All DHS Rounds (25 of 30; 48 of 60)						
Years of $\widehat{\text{Schooling}}_{izy}$	0.099	0.059	0.069	-0.047	-0.801	-0.920	-0.955
	(0.058)	(0.027)	(0.044)	(0.030)	(0.633)	(0.572)	(0.477)
	[0.090]	[0.032]	[0.115]	[0.116]	[0.206]	[0.108]	[0.045]
First Stage F-Statistic	6.57	7.17	7.17	7.17	6.63	7.73	21.68
N	13,625	13,473	13,473	13,473	13,507	24,232	24,232
	L. Less than 4,000 Organized Violence Deaths: 1989 to 91						
Years of $\widehat{\text{Schooling}}_{izy}$	0.113	0.045	0.067	-0.043	-0.315	-0.891	-0.728
	(0.065)	(0.028)	(0.036)	(0.041)	(0.692)	(1.486)	(0.587)
	[0.079]	[0.113]	[0.064]	[0.292]	[0.649]	[0.549]	[0.215]
First Stage F-Statistic	4.86	5.12	5.12	5.12	5.07	5.44	14.04
N	12,806	12,661	12,661	12,661	12,710	22,982	22,982
	M. Less than 500 Organized Violence Deaths: 1989 to 91						
Years of $\widehat{\text{Schooling}}_{izy}$	0.125	0.014	0.077	0.005	-0.069	-0.377	-0.693
	(0.038)	(0.026)	(0.046)	(0.041)	(0.403)	(0.675)	(1.059)
	[0.001]	[0.595]	[0.094]	[0.912]	[0.864]	[0.576]	[0.513]
First Stage F-Statistic	7.12	7.32	7.32	7.32	7.57	4.51	9.68
N	9,904	9,782	9,782	9,782	9,859	18,262	18,262
	N. No Regions of Highest Famine Concentration						
Years of $\widehat{\text{Schooling}}_{izy}$	0.127	0.042	0.082	-0.053	-0.531	-0.432	-0.604
	(0.052)	(0.018)	(0.035)	(0.032)	(0.422)	(1.466)	(0.596)
	[0.015]	[0.023]	[0.019]	[0.101]	[0.208]	[0.768]	[0.311]
First Stage F-Statistic	9.43	9.71	9.71	9.71	10.73	6.02	11.87
N	10,152	10,022	10,022	10,022	10,068	18,562	18,562

Source: Author's analysis based on data from the Ethiopian Demographic and Health Survey (in years 2005, 2011, and 2016). *Note*: MTI = mother tongue instruction; FPE = free primary education. The dependent variable is described at the top of each of the five columns. In columns 1–4 it is an indicator that equals 1 if true, and in columns 5–7 it is the ideal number of children. Skilled/Professional jobs include professional, clerical, and skilled manual job groups; the other categories exactly describe the occupation groups included. Ideal number of children is censored at 20; no women in the Demographic and Health Survey report having more than 18 children, and non-numerical responses are assigned the maximum value. In columns 1–5, Years of $\widehat{\text{Schooling}}_{izy}$ is the predicted level of schooling instrumented with the FPE intensity measure I_{zy}^{FPE}; in column 6 additional instruments include two MTI intensity measures $I_{zy}^{\text{MTI-T}}$ and I_{zy}^{MTI}, which denote the measures for MTI regions without and with script change, respectively, and the interactions for regions in which two interventions occurred; in column 7 the joint intensity measure ΔI_{zy} is used. All sample and specification definitions can be found in Section D.2 of this supplementary online appendix. Unless otherwise noted, all regressions include birth year and zone fixed effects, zone-specific linear trends, and a cubic for age. The first five columns include only observations from non-MTI regions; all regions are included in the final two columns. Each estimate is from a unique regression, and the second-stage estimate in column 5 is generated using a tobit model. Standard errors are clustered at the zone level and shown in parentheses; p-values are shown in square brackets.