The Impact of Education Reforms on Household Adult Welfare Outcomes in Ethiopia: The 1994 Free Primary Education (FPE) Reform*

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Abstract

This study examines the effect of free primary education reform on years of schooling and on various indicators of welfare in Ethiopia. Welfare is measured using multiple poverty indicators, including per adult equivalent consumption expenditure, relative deprivation in terms of consumption expenditure, and poverty gap. Using variation in individuals' dates of birth at the time of the reform as a source of exogenous variation in education, cohorts of age 14 and younger in 1994, who were either in pre-school or primary school, are presumed to be exposed to the reform, whereas those above age 14 are presumed not to be exposed. I used both difference-in-differences (DID) and instrumental variable estimation strategies to estimate the impact of the reform on education, and the causal impact of education on adult welfare outcomes. Preliminary results show that the reform led to an increase in years of schooling of 1.102 years (without controls) and 1.07 years (with controls), and increased the welfare of individuals who were age 8 or younger in 1994. Therefore, in general the reform increased the education and welfare outcomes of individuals age 8 or younger in 1994, who were likely to be in preschool or in the first cycle of primary school when the reform started.

Keywords: Free primary education, Ethiopia, Educational attainment, Welfare Outcomes, Poverty measures.

JEL Classification: O55, I25, I26, I31, I32.

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1 Introduction

Levels of education have increased sharply across sub-Saharan Africa in the last few decades (World Bank (2012)). This rise stems from policies designed to achieve universal primary education and gender parity in primary and secondary education (Goal 2, Millennium Development Goals). The elimination of school fees in many recent primary education reforms is one specific policy that has contributed to this achievement. Many sub-Saharan African countries have implemented free primary education policies including Kenya and Nigeria in the 1970's, Zimbabwe and Tanzania in the 1980's, and Ethiopia, Malawi, and Uganda in the 1990. More recently, more countries joined the campaign to implement free primary education (Deininger (2003); Kattan and Burnett (2004); Oumer (2009); UNICEF et al. (2009)). According to UNESCO, countries that fulfilled this reform (Lesotho, Mozambique, Ghana, Kenya, Ethiopia, Tanzania, Cameroon, Malawi, and Uganda) saw a surge in primary school enrollments in the following years (UNESCO (2007); Oumer (2009)).

Despite this success, many questions persist about the quality, and therefore the economic return of this education. Recent studies have examined the progress and challenges of free primary education reforms (Oumer (2009)), and its effect on different factors such as school enrolment and quality of education (Deininger (2003); Nishimura et al. (2008); Grogan (2009); Lucas and Mbiti (2012a); Chicoine (2016b), Chicoine (2016a); Snilstveit et al. (2016)), fertility (Fort et al. (2016)), HIV health outcomes (Behrman (2015)), and gender equality (Lucas and Mbiti (2012b)). However, the connection between increased school enrolment, and the welfare gains of the people is still an open question. With these considerations in mind, this paper informs the discourse by examining the degree to which free primary education affects the welfare of individuals.

This paper focuses on Ethiopia whose impact of free primary education was very remarkable because the country has had a long history of low primary school enrolment and wide disparities in education across and within the regions (Oumer (2009)). Yet, there are relatively few published studies of the impacts of free primary education in Ethiopia. The current study examines the 1994 Ethiopia free primary education reform to evaluate the effect of this reform on individual's education and welfare outcomes using three waves of a nationally

representative panel data set (the World Banks' Living Standards and Measurement Survey – Integrated Surveys on Agriculture (LSMS-ISA) survey for Ethiopia). Specifically, the paper performs two tasks: first, it estimates the impact of free primary education on individuals' completed years of schooling, and second, it estimates the impact of this increase in years of schooling on the welfare of individual households. This, then, answers the question: what is the economic return to primary schooling in Ethiopia?

Ethiopia's Sustainable Development and Poverty Reduction Program envisioned education as playing a major role in poverty reduction through universal primary education, and by creating a workforce with the required human capital skills essential for competitiveness in the global economy. This led to the inclusion of free primary education in the Ethiopia's PRSP[1] in 2002 (Cuadra and Moreno (2005); UNICEF et al. (2009); Oumer (2009)). However, the question of whether free primary education reduces poverty or otherwise increases welfare is still of concern to economists and policymakers, since the impact of this policy on poverty is unclear. In regard to this, the present paper follows the approach of Darko et al. (2018), who measure welfare using a variety of different indicators.

The welfare measures examined include annual per adult equivalent consumption expenditure, relative deprivation in terms of consumption expenditure, and poverty gap. The measure of relative deprivation simply compares the consumption expenditure of a given household to that of the mean consumption expenditure of all households that are better off than the given household in question (Stark and Taylor (1989)). Poverty gap measures how far a given household is from the poverty line of a country (Foster et al. (1984)).

The identification strategy in this study is based on the fact that exposure to the reform varies by date of birth. The population age 14 and younger in 1994 were either in pre-school or primary school (or had not yet started school) at the time of the reform, and so they were exposed to the reform, whereas those above age 14 in 1994 were not exposed to the reform. More specifically, individuals aged eight and below were almost certainly strongly affected by the reform, while those age nine to 14 were likely to be only weakly affected. This study uses difference-in-differences (DID) and instrumental variable (IV) identification strategies to

[1]Poverty Reduction Strategy Paper.

estimate the impact of the reform. It draws methodological insight from Duflo (2001), who used a similar approach to evaluate the impact of a school building program on education and earnings in Indonesia. The same identification strategy is employed in this paper to estimate the returns to education in Ethiopia, by using this exogenous variation in education by virtue of the reform to evaluate the causal effect of years of schooling on various measures of welfare. In addition to regional variation by way of schools with low and high primary school enrollment before the reform.

There is an extensive literature on the returns to education in developing countries (Psacharopoulos (1989); Psacharopoulos and Chu Ng (1994); Psacharopoulos (1994); Card and Krueger (1992); Glewwe and Jacoby (1995); Psacharopoulos and Patrinos* (2004); Peet et al. (2015)) and developed countries (Card (2001)), of which this paper contributes to the developing country literature. In terms of previous research on free primary education reform in Ethiopia, Chicoine (2016a) examined the effect of the reform on schooling and fertility. This paper extends this literature by estimating the impact of free primary education on years of schooling, and its impact on various welfare outcomes. Also, the study is relevant to the fourth Sustainable Development Goal (SDG); ensuring that all girls and boys have complete free, equitable, and quality primary and secondary education, leading to relevant and effective learning outcomes for all by 2030 (Nations (2015)).

Several studies have also estimated the causal effect of education in labor markets using instrumental variable methods (Angrist and Keueger (991a); Butcher and Case (1994); Kane and Rouse (1993); Card (1993);Card (1994); Duflo (2001); Duflo (2004)) and fixed effect methods (Angrist and Newey (1991); Ashenfelter and Krueger (1994)) estimators, as well as the conventional ordinary least squares (OLS) estimation (Glewwe and Jacoby (1995); Peet et al. (2015)). However, few studies have examined the relationship between years of schooling and various measures of welfare in extant literature using instrumental variable. This paper estimates the impact of education on various measures of welfare using instrumental variables to avoid bias due to endogenous variation in education.

The findings from this study indicate that the reform led to an increase in years of schooling by 1.102 years (without controls) and 1.07 years (with controls), and improved the

welfare of individuals aged eight and below in 1994. However, the cohort of age nine to 14, who presumably were weakly affected by the reform, were not affected. This suggests that cohorts in pre-school or in the early stages of primary school at the time of the reform were the most or only affected cohorts.

The remainder of this paper is organized as follows. Section 2 describes the relevant history of, and education reform in Ethiopia. Section 3 provides a description of the data and summary statistics. The empirical framework in Section 4 discusses the identification strategy and the empirical strategy. Section 5 reports the results and discussion, and session 6 concludes.

2 History and Education Reform in Ethiopia

Between 1974 and 1991, Ethiopia was governed under two very different political systems: military (monarchy) and communism. Then in 1991, a major political and economic transition took place that replaced the communist rule with a federal political system that divided the country into nine regions and two city administrations (Ofcansky and Berry (1993); UNICEF et al. (2009); Oumer (2009)). Following the new decentralized political order in Ethiopia, the government made some important revisions to the previous education policy. The first change, issued by Proclamation No. 41 in 1993, authorized the decentralization of primary and secondary education to each of the nine regions and two city administrations (Negash (1996); UNESCO (2007); Tewfik (2010)). The second official change was the 1994 Education and Training Policy (ETP) which eliminated school fees for students in Grades 1 to 10 in order to reduce the financial burden on parents. Additionally, the policy reduced cost of school fees for students in Grade 11 and 12, and in higher (of Ethiopia (1993); UNESCO (2007); Oumer (2009)). The ETP declaration in 1994 was implemented in these nine regions in 1995, prior to the beginning of the 1995 school year.

The education system used a 6-2-4 structure from 1962 to 1994, so that six years primary school were followed by two years of junior secondary school, and four years of senior secondary school. Following the 1994 ETP, the primary school official entrance age remained at seven, but the government created a new education structure of 4-4-2-2. This

structure consists of two cycles of primary education, basic education (grades 1-4) and general primary education (grades 5-8), two years of general secondary education (grades 9 and 10), and two years of preparatory secondary education (grades 11 and 12). Unlike the old structure, where national examinations were taken at the end of each cycle to determine selection of students into the next cycle, the new structure has national examinations taken only at the end of grade eight and grade ten (Cuadra and Moreno (2005); UNICEF et al. (2009); Oumer (2009)).

The identification strategy for this paper focuses on the elimination of school fees in Grades one through eight, and an accompanying law that made primary education compulsory. These changes were followed by a substantial increase in primary school enrollment, with the largest increase in Grade 1 (UNICEF et al. (2009)). Figure 1 confirms that the improvement in grade one enrollment was large compared to other grades. As seen in Figure 1, enrollment fell in the late 1970s, when Mengistu Haile Mariam took power after the overthrow of Haile Selassie in 1974. The sharp decline in enrollment in the mid-1980s was likely due to the severe famine, which caused roughly one million deaths and left many more millions destitute. Similarly, there was another fall in enrollment in the early 1990's, which may reflect the overthrow of Mengistu regime in 1991 (Cuadra and Moreno (2005)). After 1993, which are the years after the two reforms, there was a sharp increase in enrollment, as depicted in Figure 1. In terms of the additional enrollment and percent growth (45%; 28%), the largest increase in Grade 1 enrollment is in the 1993/1994 and 1995/1996 school years.

Despite these gains in enrollment, schools in Ethiopia experienced many problems. Pupil-teacher ratios increased by 40 percent between 1992 and 1995, and by 60 percent through 1996. The number of students per school also grew, by 75 percent between 1992 and 1995, and by 90 percent in 1996 (Ministry of Education (1995); Ministry of Education (1996); Ministry of Education (2000)). This resulted in overcrowded classrooms. Other problems associated with the reforms were less qualified teachers and less government budget (UNICEF et al. (2009)). These reforms were implemented without proper planning and adequate financial resources, which likely reduced the quality and efficiency of education (Oumer (2009)).

Chicoine (2016b) claims that the two reforms increased students' time in school by more than one full year, raised the rate of passing grade eight exams, and increased the literacy

rate by almost ten percent. Unlike Chicoine (2016b), Chicoine (2016b), and the other few studies that have examined the impacts of these reforms, this study will focus only on the ETP reform, specifically the elimination of primary school fees for Grades 1 to 8.

The removal of school fees took place in all primary schools across the country, and hence there is no geographic variation in the implementation of this reform. This paper exploits only the timing variation of the reform, while Chicoine (2016b) and Chicoine (2016b) focuses on both timing and geographic variation of the reform. Therefore, this paper draws methodological inspiration from Duflo (2001) and Duflo (2004), where the INPRES program was geared towards regional development with the number of schools constructed per region (district) clearly defined. Their paper explain the plausibility of using both temporal and geographic variation.

Chicoine (2016b) and Chicoine (2016a) estimated the effect of the reform geographically, and accounted for the regional timing variation using predicted data from pre-reform regional enrolment data. Nonetheless, there is no concrete information on the geographic and regional timing variation of the reform, though the first reform focuses on regional decentralization. This could result in measurement error which may produce imprecise estimates. This is why this study focuses only on ETP, in spite of the latter reform being influenced by the former. But I also included regional variation by the number of primary school enrollment before the reform to allow easy difference-in-difference estimation.

3 Data and Descriptive Statistics

This section describes the data used, gives detailed information on welfare measures, and provides descriptive statistics.

3.1 Data

I used data from the World Bank Living Standards and Measurement Survey – Integrated Surveys on Agriculture (LSMS-ISA) for Ethiopia. The data is a three-wave nationally represented panel data collected in 2011/2012, 2013/2014, and 2015/3016. The first wave survey refers to the Ethiopian Rural Socioeconomic Survey (ERSS),[2] which was collected and documented

[2]ERSS is collected in rural areas and is implemented in 290 rural and 43 small town enumeration areas (EAs). It collects data on rural and small-town households, their characteristics, welfare and their agricultural activities.

in collaboration with the Central Statistics Agency of Ethiopia (CSA) and the World Bank LSMS-ISA team. The survey was collected in three rounds of visits to each household; first (September-October 2011), second (November-December 2011), and third (January-March 2012). The household survey which is the main part of the data used for this study was collected in the third round. The total number of households interviewed is 3,969 with a response rate of 99.3 percent. Consumption expenditure aggregate data was constructed from food, non-food, and education expenses as a separate data.

The second wave, the Ethiopia Socioeconomic Survey (ESS) collects and documents the same information as the first wave. The Ethiopia Socioeconomic Survey first began with only rural areas and then expanded it to include all urban areas. This increased the number of survey areas from 333 (3,776 households) to 433 (5,262 households). The total sample for both waves is 5,262 (433 EAs), out of which 290 were rural, 43 were small towns and 100 were urban EAs. The mode of survey collection and documentation is the same for the third wave. Though data were collected in different years, the time (month) frame in each year was the same across all the three waves.

The household and consumption aggregate data were employed for the current study with a focus on intra-households. After thorough data management of the three-wave panel data, a total sample of 4,192 individuals from age 20 to 60 years was utilized for the analysis. The key variables used from the panel data were age, years of schooling, consumption expenditure, gender, religion, and region of birth.

3.2 Measures of Welfare

Welfare is measured in terms of poverty as in Darko et al. (2018). These measures include per adult equivalent consumption expenditure, relative deprivation in terms of per adult equivalent consumption expenditure, and poverty gap. The total annual consumption expenditure is the aggregate expenditure consisting of expenditure on food, non-food, and education; including 25 separates food items[3] commonly consumed in Ethiopia. The non-food[4] expenditure component

[3]Teff; wheat; barley; maize; sorghum; millet; horse beans; chick pea; field pea; lentils; haricot beans; Niger seed; linseed; onion; banana; potato; kocho and bula; meat; milk; cheese; eggs; sugar; salt; coffee; and chat/Kat.

[4]matches; batteries; candles and incense; laundry soap, omo, endod, and besana leaves; hand soap; other personal care goods; charcoal; firewood; kerosene; cigarettes, tobacco, suret, and gaya; and transport.

consists of expenditure on 11 basic household goods over the past one month, and 12 other[5] expenditure categories over the past 12 months.

Nominal per adult equivalent consumption expenditure is calculated as a variable in the consumption aggregate data. Real per adult equivalent consumption expenditure is not included in the data; but using the provided price index in the data I deflate the nominal value into real terms. Relative deprivation (RD) in terms of consumption expenditure is measured using the index as defined by Stark and Taylor (1989):

$$RD = AD(y_i) * P(y_i) \tag{1}$$

Where $AD(y_i)$ is the mean per adult equivalent consumption (real value) of household in a reference group that are richer than the household i; $P(y_i)$ is the proportion represented by these households. The reference group for this study is the total sample size of each wave data, since free primary education is a national reform, hence the need to estimate a universal representative effect. The larger the RD index for a given household, the more deprived the household is relative to other households in terms of real per adult equivalent consumption expenditure.

The Foster-Greer-Thorbeckie index (Foster et al. (1984)) is used to measure the poverty gap and severity of poverty. Mathematically is specified as;

$$FGT_\alpha = (\frac{1}{n}) \sum_{i=1}^{h} (\frac{Z - y_i}{Z})^\alpha \tag{2}$$

Where y_i is the real per adult equivalent consumption of household i; and Z is the Ethiopia national poverty line. Three poverty lines are constructed for each wave using the set national poverty line (Birr 3781 per year per adult person) based on the 2010/2011 Household Income and Consumption Expenditure Survey (HICE). The poverty line for 2011/2012, 2013/12014, and 2015/2016 were obtained by applying their respective annual GDP deflator[6] to the national set poverty line in 2010/2011 NPC (2017).

[5](clothes/shoes/fabric for men; clothes/shoes/fabric for women; clothes/shoes/fabric for boys; clothes/shoes/fabric for girls; kitchen equipment; linens; furniture; lamp and torch; ceremonial expenses; contributions to IDDIR; donations to the church; and taxes and levies)

[6]Provided by the Ministry of Finance and Economic Cooperation (MOFEC 2011-2016) of Ethiopia.

Table 5 displays the poverty lines for the three waves. Usually, FGT is a summary statistic but it is agreeable for use in a regression model by creating a household specific version of the index using the expression within the summation (Mason and Smale (2013)). FGT_1 and FGT_2, $(\alpha = 1, 2)$ denote poverty gap and severity of poverty where the latter is the squared of the former. The poverty gap and severity both take values of zero for non-poor households and a fraction for poor households. Thus, $\{FGT_1 = [0, 1]; FGT_2 = [0, 1]\}$. This paper focuses only on the poverty gap.

3.3 Descriptive Statistics

Table 6 describes the variables used in obtaining the estimates of the analysis. The dependent variables are real per adult equivalent consumption expenditure, relative deprivation in terms of per adult equivalent consumption expenditure, and poverty gap. I used time invariant covariates including gender, region of birth, and religion; and I included the treatment dummy variables for cohorts who are weakly and strongly affected by the reform. Tables 7 and 8, and Figure 2 reports the descriptive and summary statistics. Summary statistics of all the variables are presented in Table 7, separately for each wave data and the pooled data. Statistics for the pooled data differs slightly from that of the wave-specific data.

Table 8 reports the frequencies and percent values of the time invariant covariates for the pooled data. Slightly more than half of the population used are female; and Oromia, Amhara and SNNP regions have the highest number of households for this study. More than 50 percent of the households belongs to an orthodox church. Figure 2 displays a graphical representation of the reform effect on years of schooling, and obviously years of schooling is higher for the strongly exposed (age 30 and below) cohorts in contrast to the weakly exposed (age 30 to 36). Also, some cohorts outside the age cut off (above age 36) may have more years of education than the weakly affected, which validates the mean difference conclusion of less marginal gain for the weakly exposed in Table 4.

The regression fitted line[7] indicates that younger cohorts are more educated than older cohorts owing to the reform exposure. This, then partly justifies the assumption of cohorts aged 8 and below in 1994 being strongly exposed to the reform. Finally, this may imply that those

[7]Regression line corresponds to the first stage restricted reduced form equation 8.

who were in second cycle or later stages of primary school when the reform was implemented benefited less or none.

4 Empirical Framework

This section is in two parts, the first part describes the identification strategy used for this study, and the second explains the empirical approach.

4.1 Identification Strategy

This paper explores how exogenous variation in education caused by the 1994 free primary education reform in Ethiopia can be used to create instrumental variables to estimate the causal impact of education on welfare. Under certain assumptions, this solves the endogeneity problem that leads to bias when estimating the impact of education on welfare. Using three waves (2011/2012, 2013/2014, 2015/2016) of a nationally representative panel survey from Ethiopia, I construct dummy variables that indicate which cohorts of individuals were affected by the reform. More specifically, individuals' ages (date of birth) were used to determine whether an individual was exposed to the reform. An individual born in 1990 or before was 4 years or older when the reform was implemented in 1994. This corresponds to the individual being 22 or older in 2012, 24 or older in 2014, and 26 or older in 2016. Table 1 describes the reform dummies using the age of an individual born in 1990 or later through to 1980. This is then matched to the corresponding age in 1994, 2012, 2014, and 2016.

The official entry age for primary school in Ethiopia is age seven, and primary education lasts for eight years (grades 1-8). Grade repetition and delayed school entry are major factors contributing to children being older than the expected age for their grade in school in most sub-Saharan African countries. This leads to wide variation in age for a given grade among enrolled children in primary school (Glewwe and Jacoby (1995); Grant and Behrman (2010); UNESCO Institute of Statistics (2012)).

Table 2 presents information on enrolment, based on the 2007 E.C (2014/2025) Education Statistics Annual Abstract, for Grades 1 to 8, and for Grade 1 only, and the population age of seven through 14 years in Ethiopia (Ministry of Education, 2016), which is the age range

associated with Grades 1-8. The Apparent Intake Rate (AIR)[8] for Grade 1 for Ethiopia as a whole is 158.4%, implying there are many children who are not age seven but are enrolled in Grade 1. This could be due to grade repetition or to students starting primary school later than age seven. The Gross Enrolment Ratio (GER)[9] for Grades 1-8 is 101%, indicating the number of students that have chance to attend primary school reach the target and are in the population age of seven to 14 years (Ministry of Education, 2016). Table 3 present the distribution of age and educational attainment in Ethiopia for individuals age 7-14, as reported in the 1994 Ethiopia Census. Tables 2 and 3 are used to set the age cutoff used in constructing the reform dummies.

In order to rule out measurement error, the paper selects an extensive possible age cutoff[10] from age four and below through age 14. The official age for preschool in Ethiopia is four to six. Any individual in this age in 1994 is expected to be fully exposed to the reform. In contrast, individuals of age 15 and older in 1994, based on Tables 3 are considered to be too old to have been exposed to the reform. The age cutoff in 1994 were then matched to the age of the individual households in the three-wave nationally represented panel data (2011/2012, 2013/2014, 2015/2016). In summary, individuals of age 14 and below in 1994 were partially or fully exposed to the reform, whereas those above age 14 in 1994 were not exposed to the reform.

More specifically, three categories of reform dummy variables were constructed.

Category 1: Individuals who were eight or younger in 1994, who were strongly affected by the reform because those individuals were either in pre-school or in early stages (first cycle) of primary school when the reform was implemented in 1994. Possibly, some of these individuals were also infants.

Category 2: Individuals in the age range of nine to 14 in 1994 are likely to have been only partially affected by the reform, since these individuals were either finished with the first cycle or in the second cycle of primary school in 1994.

[8]The Apparent Intake Rate (AIR) is the percentage of new entrants irrespective of their age examined in contrast with the population age of school admission age in Ethiopia.

[9]The Gross Enrolment Ratio (GER) shows the total number of children enrolled in grade 1-8 irrespective of their age as a proportion of the school age population in Ethiopia.

[10]Age (years) in 1994: 4 and below, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14.

Category 3: Individuals age 15 and older in 1994, who had little or no exposure to the reform since at that age range an individual were either finishing up or no longer in primary school in 1994.

The paper uses both difference-in-differences (DID) and instrumental variable (IV) estimators. DID is used to estimate the impact of the reform on education, and IV is used to estimate the impact of education on household welfare.[11] The treatment reform dummy variables in Table 1 were used as instrumental variables to provide exogenous variation in years of schooling, and thus exogenous variation was used to estimate the causal effect of years of schooling on welfare. Also, I utilize regional data as presented in Table 13 on the number of primary school enrollment over the past five years before the reform came into force to create regional variation. This allows to generate data on individuals born in regions with low school enrollment and those born in regions with high school enrollment. Intuitively, this may suggest that children born into regions with low school enrollment may get more education after the reform than those born into high school enrollment regions. From Table 13, I assume all regions with primary school enrollment below 100,000 were low in enrollment before the reform, and those above 100,000 are considered high enrollment regions. The identification assumptions underlying this strategy are the different assumptions stated in the three categories of dummy variables above. Justification for the exclusion restriction and instrument condition are explained in Section 5

Thus, Table 4 presents a rough tabulation of the DID estimator explaining the identification strategy and assumptions. However, these results are imprecise and uncertain, and so the rest of this paper explains a more detailed and precise regression estimation. The results of the weakly affected is likely to be caused by the sharp decline in enrollment in the mid 1980's, and perhaps this was due to the severe famine that occurred in Ethiopia between 1983-1985.

After grouping individuals by date of birth, I then reclassified these individuals based on whether the household head was affected by the reform or not. So, if the household head is affected by the reform, then all individuals in the household are also affected by it

[11]Reform dummies were used as treatment variable in the DID estimation, not as IV, and these treatment dummies were used as IV in estimating the impact of education on welfare. See Duflo (2001) pages 797-802 for more details on method.

regardless of whether they were affected or not in the first grouping. I did this to avoid inaccurate results of the program's impact on welfare. The main aim of this paper is to examine the effect of education on welfare, which means comparing individual welfare based on the household consumption expenditure will not disentangle the welfare impact of those affected and not affected. This is because the program affects other household members' incomes, and households inevitably share their incomes, at least to some extent, with all other household members.

4.2 Empirical Strategy

To estimate the effect of the reform on education and individual welfare in Ethiopia, I conduct difference-in-differences (DID) estimation in a regression framework using the exogenous variation in the date of birth and regional variation by enrollment. The DID estimator is used to predict the impact of the reform on education; and is then used as the first stage equation in a two-stage least squares (2SLS) estimation of the return to education.

The structural model (OLS) estimating the direct linkage between welfare and education is written as;

$$W_{ij} = \beta_0 + \beta_i S_{ij} + \boldsymbol{\theta} \boldsymbol{X_{ij}} + \mu_{ij} \tag{3}$$

Where W_{ij} is various measures of welfare of individual i in cohort j; β, $\boldsymbol{\theta}$ are coefficients, $\boldsymbol{X_{ij}}$ is a vector of time invariant control variables of individual i in cohort j; S_{ij} is the years of schooling of individual i in cohort j; μ_{ij} is the residual.

4.2.1 Effect of Free Primary Education Reform on Years of Schooling

Two models of DID (first stage equations) were used to estimate the impact of the reform on years of endogenous schooling. The first is a restricted estimation, and the second is an unrestricted estimation. Restricted estimation categorizes strongly (age 4 and below to age 8 in 1994) and weakly (age 9 to 14 in 1994) affected cohorts separately into two different treatment dummies; whereas the unrestricted uses individual-specific reform dummies (ages: 4 and below, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14) as a set of treatment dummy variables without imposing any groupings. The latter is to disentangle the individual-specific effect of the reform dummies on years of schooling and welfare.

Restricted estimation:

I estimate the first stage equation by imposing a group restriction on the reform dummies, stated as;

$$\begin{aligned} S_{ij} =& \alpha_0 + age_i + \alpha_1 agesq_i + \gamma_1 T_{1i} + \gamma_2 T_{2i} \\ &+ \lambda R_j + \delta_1 (T_{1i} * R_j) + \delta_2 (T_{2i} * R_j) + \boldsymbol{\theta X_{ij}} + \epsilon_{ij} \end{aligned} \tag{4}$$

Where T_{1i} is a "treatment dummy" indicating whether an individual belongs to the strongly affected cohort (age 4 and below to 8 in 1994); T_{2i} "treatment dummy" indicates whether the individual belongs to the weakly affected cohort (age 9 to 14 in 1994); age_i and $agesq_i$ account for long term trends in the determinants of years of schooling. age_i is the age of individual households between the ages of 20 to 60; $agesq_i$ is the squared of age_i that explains the non-linear component of the trend; ϵ_{ij} is the residual of individual i in cohort j ; and α's, γ_1, γ_2, λ, δ_1, δ_2, $\boldsymbol{\theta}$'s are coefficients. The comparison (control) group for this estimation is the unaffected cohorts (age above 14 in 1994). R_j denotes the intensity of the reform in the region of birth. The assumptions for the first stage equation are $\mathbb{E}[T_1, X_{ij}] \neq 0$ and $\mathbb{E}[T_2, X_{ij}] \neq 0$

Second, I estimate the reduced form equation as;

$$\begin{aligned} W_{ij} =& \pi_0 + age_i + \pi_1 agesq_i + \pi_2 T_{1i} + \pi_3 T_{2i} \\ &+ \pi_4 R_j + \pi_5 (T_{1i} * R_j) + \pi_6 (T_{2i} * R_j) + \boldsymbol{\phi X_{ij}} + \omega_{ij} \end{aligned} \tag{5}$$

Where π's, $\boldsymbol{\phi}$'s are coefficients and ω_{ij} is the residual of individual i in cohort j. The strongly affected treatment dummy has a full treatment effect whereas the weakly affected has a partial treatment effect.

Unrestricted estimation:

Here, the first stage equation is specified as the relationship between years of schooling of an individual i born in year k, and their respective degree of exposure to the reform.

$$\begin{aligned} S_{ij} =& \alpha_0 + age_i + \alpha_1 agesq_i + \sum_{K=4}^{14} \gamma_{ik} T_{ik} + \\ & \lambda R_j + \sum_{k=4}^{14} (T_{ik} * R_j) \delta_1 + \boldsymbol{\theta X_{ij}} + \epsilon_{ij} \end{aligned} \tag{6}$$

Where T_{ik} is a set of treatment dummy variables indicating whether individual i is of age k in

1994, $k =< 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14$; γ_{ik} is the coefficient of treatment dummy which estimates the impact of the reform on a given cohort. The same omitted group as the restricted estimation is used (unaffected cohorts, age above 14 in 1994). This estimates the impact of each of the reform dummies (created in Table 1) on education.

The reduced form equation is estimated as;

$$W_{ij} = \pi_0 + age_i + \pi_1 agesq_i + \sum_{K=4}^{14} \pi_2 T_{ik} + \quad \pi_3 R_j + \sum_{K=4}^{14} \pi_4 (T_{ik} * R_j) + \boldsymbol{\phi X_{ij}} + \omega_{ij} \qquad (7)$$

Unlike the restricted estimation, there are five full treatment (<4, 5, 6, 7, 8) effects and 6 partial treatment (9, 10, 11, 12, 13, 14) effects of each reform dummy.

4.3 Effect of Free Primary Education Reform on Welfare (2SLS of Returns to Education)

The returns to education are estimated for both the restricted and unrestricted models using 2SLS.

Restricted estimation:

The 2SLS restricted estimation of return to education is expressed as;

$$W_{ij} = \pi_7 + age_i + \pi_8 agesq_i + \pi_9 \hat{S_{ij}} + \boldsymbol{\sigma X_{ij}} + \rho_{ij} \qquad (8)$$

Where $\hat{S_{ij}}$ is the predicted years of schooling from equation (2); ρ_{ij} is the residual; π's, σ are coefficients. This model estimates the impact of the predicted years of schooling on poverty measures of welfare

Unrestricted estimation:

Finally, I replaced the predicted years of schooling in equation 6 with that of equation 4 to estimate the 2SLS returns to education for the unrestricted model. The model specification is the same as the restricted except for the different predicted years in schooling.

4.3.1 Choice of Estimation

The most relevant estimations are the first stage equation that estimates the impact of the reform on education, and the 2SLS estimating the returns to education. The reduced form equations are for robustness check of the 2SLS and OLS estimation.

5 Results and Discussion

This section discusses the results of both restricted and unrestricted models.

5.1 Restricted estimation

The discussion here is in two parts. First, I discuss the reform's effect on years of schooling, and then I discuss this year of schooling's impact on welfare outcomes.

5.1.1 Effect of reform on education (DID estimation) and welfare outcomes

Table 9 show the coefficient estimates of the reduced form restricted models for education and all poverty measures. Coefficients for the strongly exposed treatment dummy were significantly greater than zero for education, and consumption expenditure;[12] whereas that of relative deprivation and poverty gap produce significant negative estimates. This means the reform is expected to increase years of schooling (1.1, 1.07) [13] and log consumption expenditure (0.276, 0.27) of individuals that are strongly exposed to the reform; and reduce the levels of relative deprivation (0.11, 0.11) and poverty gap (0.095, 0.094). The first stage equation coefficients for consumption expenditure and relative deprivation are the same due to the same sample size. Simply put, educational achievement of the strongly exposed cohorts' increases by 1.1 and 1.07 with and without covariates, and similar explanation applies to the various welfare measures. The coefficient for the interaction term, DID show insignificant results for both strongly and weakly affected cohorts.

The treatment dummy for the weakly exposed produces insignificant negative estimates for education, and significant estimates for consumption expenditure, relative deprivation, and poverty gap. This suggest the weakly exposed cohorts are possibly unaffected by the reform since this insignificant estimates reduces educational level. Regardless of this, it decreases relative deprivation and poverty gap; and increases consumption expenditure. Thus, weakly affected cohorts are either better off in the absence of the reform or not affected by it. In summary, the results of the reduced form restricted estimations justify the findings of the mean difference in Table 4 and the graphical representation in Figure 2. The first stage reduced form confirms the reform does affect years of schooling of individuals who are age eight and

[12] Consumption expenditure and relative deprivation are all logged.

[13] First percent value is without covariates and second is with covariates, this represent first stage equation estimates for consumption expenditure and relative deprivation first stage.

younger (category 1 in section 4.1).

As a robustness check I dropped the treatment dummy variable for the weakly affected and constructed a new reduced form restricted model with only the strongly exposed treatment dummy variable. The omitted group is now formed of individuals aged nine and above in 1994. The coefficient estimates were not robust and consistent with the direction of the strongly exposed treatment estimates in equation 4 and 5, and are slightly less significant than the estimates in equation 4 and 5. However, the predicted values differ from the first estimation with larger estimates for education, and smaller estimates for consumption expenditure, relative deprivation, and poverty gap. This may imply the implementation of the reform affected the population age of eight and younger who were either in pre-school (or possibly infants) or in the first cycle of primary school at the time of the reform. Overall, the results of the DID and reduced form for the restricted estimation satisfies the identification assumptions described in section 4.1. I did not report the Tables for only the strongly affected as an instrument in the appendix because the results are similar.

5.1.2 Returns to education of welfare outcomes

The direction of the coefficients of OLS and 2SLS is the same as that of the reduced form equation 5 that estimates the direct relationship between the two restricted treatment dummies and the various measures of welfare. The reduced form equation serves as a robustness check for the OLS and 2SLS. Similarly, the estimates on returns to education for both OLS and 2SLS were significantly greater than 0 for consumption expenditure, whiles negatively significant for the OLS estimates of relative deprivation and poverty gap. However, the magnitude of the 2SLS estimates were larger than the OLS estimates; and the robust standard errors for the 2SLS were slightly larger than the OLS standard errors. Table 10 presents these estimates. The relatively high explanatory power of the instruments as explained by the F-statistics in the first stage estimation confirms the validity of these instruments. Therefore, the OLS estimates may be biased downwards possibly due to measurement errors and reverse causality. 2SLS estimator may be better in explaining the causal relationship between education and welfare outcomes, only if perhaps the weakly exposed treatment dummy is dropped as an instrument or is redefined. This is because it may be correlated with the error term or the strongly exposed

treatment variable due to its poor explanatory power in the first stage, making 2SLS estimates biased towards the OLS.

The OLS minimize the estimate of the variance of errors, so is expected to have smaller standard errors than the 2SLS. Further, the 2SLS estimates with only one instrument (strongly exposed treatment dummy) produce very similar estimates as the former but slightly larger estimates, and all estimates were significant unlike the former. This method maybe more precise since the weakly exposed instrument explain the exogenous variation in education poorly and is likely to be wrongly defined. The larger F-statistic of the model with only strongly exposed instrument explain the overall significance of maybe using only the strongly exposed treatment dummy variable.

The restricted instruments used were tested for its strength using Olea and Pflueger (2013) robust test for weak instrument; and shows the worst-case bias in the estimator is less than the critical value at 5% (tau) leading to a rejection[14] of the null hypothesis of weak instrument. Hence the instruments are strong in all estimations. The validity of the instruments is tested based on the relevance and exogeneity condition. The relevance condition holds in the case of consumption expenditure and relative deprivation since all the endogeneity tests show years of schooling is indeed an endogenous regressor, but fails in the case of poverty gap. However, dropping the weakly exposed treatment variable corrected it. Also, the OLS estimates not being the same as the 2SLS estimates validates the relevance condition.

The test for over-identifying restriction fails in most cases which could possibly be due to either a misspecification of the model or correlation of instruments with the error term, probably the weakly exposed treatment dummy variable. Nonetheless, most studies (Angrist and Pischke (2009); Parente and Silva (2012)) indicates this test gives minimal information on whether instruments are correlated with the errors in case validity holds or not. The exogeneity condition cannot be tested but it holds based on the assumption that the instruments constructed are uncorrelated with the error term, strictly only when the weakly exposed treatment instrument is dropped or redefined since it may not be orthogonal.

In general, the results agree with most previous studies (Card (1993); Card (1994); Card

[14]Since F statistics was greater than the critical values of worst-case bias.

(1999); Butcher and Case (1994); Ashenfelter and Zimmerman (1997)) finding that IV estimates are larger than OLS estimates.

5.2 Restricted estimation

5.2.1 Effect of reform on education (DID estimation) and welfare outcomes

Table 11 reports the unrestricted coefficient estimates for DID. Estimates of the first stage produce statistically strong significance for cohorts aged five to seven. The reduced form unrestricted models generate inconsistent estimates, since at the worst case of no significant effect on education, almost all the estimates on welfare measures were strongly significant. The results here may not be precise and is not consistent with the restricted estimation results. The purpose of the unrestricted estimation is to disentangle the individual-specific effect of the reform dummies on years of schooling and welfare. However, using this approach produces unstable and unreliable estimates of years of schooling and welfare measures. Also, the low F-statistic explain the very poor explanatory power of this estimation.

5.2.2 Returns to education of welfare outcomes

Table 12 presents the coefficient estimates of OLS and 2SLS for the unrestricted estimation. The OLS estimates is smaller than the 2SLS estimates. The 2SLS estimates maybe imprecise and inconsistent possibly due to potential sample bias, measurement error, and simultaneity bias. This makes the 2SLS bias towards the OLS which leads to upward bias estimation. Potential sample and simultaneity bias may be due to the use of many weakly correlated instruments since the test for weak instruments failed in this estimation. Using the same test of Olea and Pflueger (2013) led to the failure to reject the null hypothesis of weak instrument implying the instruments are not strong. However, the endogeneity test holds in all cases. The assumption for the exclusion restriction (exogeneity) may not hold in this case because is possible the instruments are correlated with the error term due to the nature of the results generated. In short, the instruments used in the unrestricted estimation might not be valid leading to bias and imprecise results. Therefore, the restricted estimation is likely to be the best approach for this study with the caveat of using only the strongly exposed dummy as a treatment variable.

The estimates on log consumption expenditure means the reform positively impact on education which produces a gain in the welfare of individuals. Whereas, the estimates on

log relative deprivation and poverty gap implies the reform increased years of schooling and improved welfare via the reduction of poverty.

6 Conclusion

This article examines the impact of free primary education reform on years of schooling, and then estimates the effect on various welfare outcomes. Welfare outcomes are measured in terms of poverty using per adult equivalent consumption expenditure, relative deprivation, and poverty gap. The results indicate that the reform increased primary school enrollment, which in turn improved the welfare of households. Thus, the study provides evidence that free primary education positively impacts the welfare of households in Ethiopia. Also, the assumption that cohorts aged eight and below in 1994 are strongly affected by the reform is justified by the results of this study.

The positive estimates of education on strongly exposed cohorts aged eight and younger in 1994, indicates the reform affects younger individuals in pre-school (or possibly infants) or in early stages of the first cycle of primary education. The findings on the weakly exposed cohorts aged nine to 14 could also mean such individuals are either not affected or weakly affected by the reform. This suggests cohorts in the second cycle or late stages of primary school at the time of the reform maybe comparable to unaffected cohorts above age 14 in 1994 (likely not in primary school). The result of the weakly affected individuals is also likely to be caused by the severe famine[15] that occurred in Ethiopia in 1983-1985. The estimates of the economic returns to education on the poverty measures indicates the welfare of individuals affected by the reform improved. This then suggests that free primary education reform led to welfare gains for people of Ethiopia.

The paper presents an identification strategy using a national level data to estimate the extent of free primary education on years of schooling and welfare gains in Ethiopia. The estimates generated indicates reform led to increase primary school enrollment and welfare gains of the people of Ethiopia. However, I examined this study using only temporal

[15]Therefore, I need to control for the severe famine using weather and political instability data, since the famine was mostly ascribed to drought, climatic phenomena, and political instability. I am still working on these confounders using weather data from NOAA and conflict data from UCDP/PRIO Armed Conflict dataset. The approach I am using to capture the weather on all individuals is "weather shock approach" as by Maccini and Yang (2009). The final paper will contain modified results with the confounders included.

variation and pseudo regional variation, future extension of this work can consider using both temporal and geographic variation. Extending the study to other SSA countries with free primary education will also be a good idea for future studies. Policy makers, economist, and Ethiopia Ministry of education may consider these results as a guide in decision making, and implementing or amending future education reforms.

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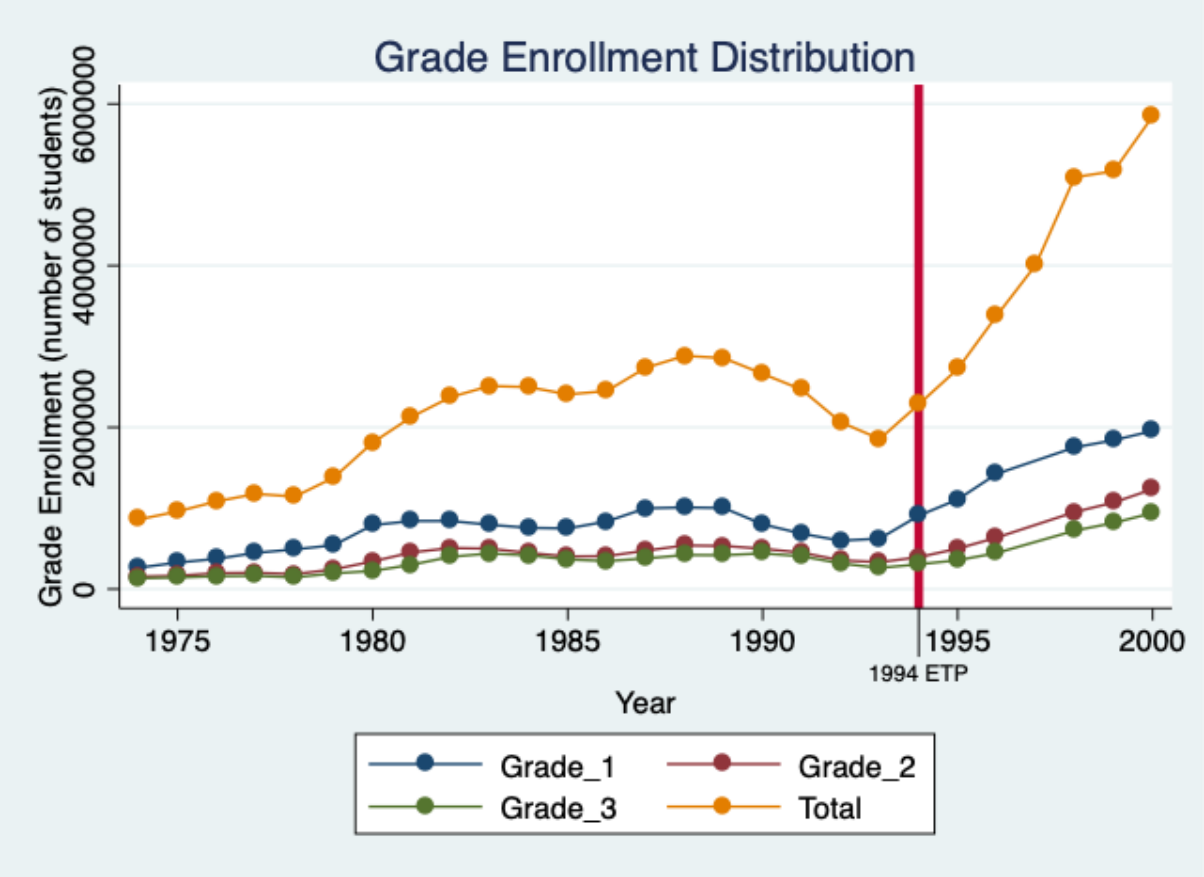
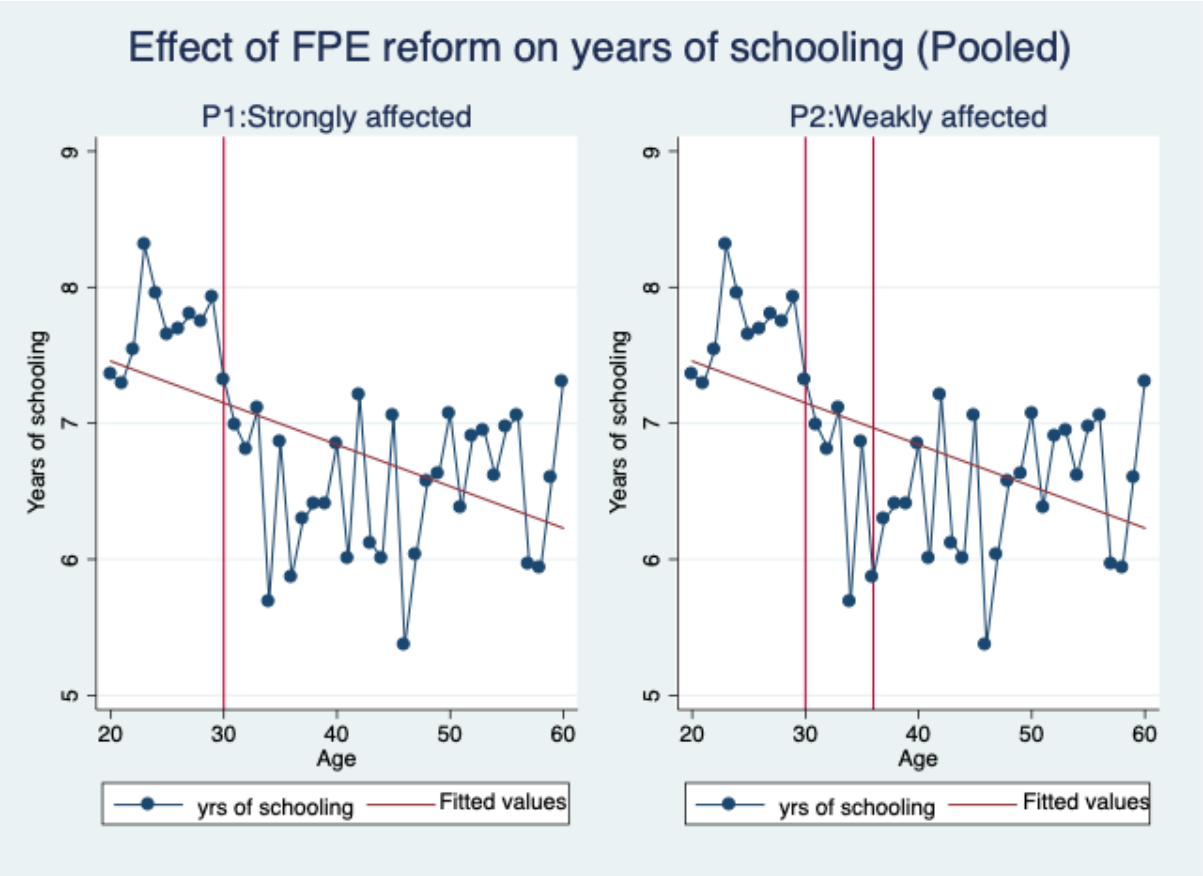
Appendix A: Figures

Figure 1: Grade 1 Enrolment Compared to Other grades and Total Enrolment.



Source: UNESCO Institute for Statistics. 1994 ETP refers to the Education and Training Policy implemented in 1994. Increase in grade 1 enrolment was greater than the increase in other grades and before the ETP implementation.

Figure 2: Effect of FPE Reform on Years of Schooling



Source: LSMS-ISA data. Individuals age 30 and below are strongly affected by the reform compared to those between age 30 and 36 that are weakly affected by the reform. The fitted line shows years of education increase with decreasing age. Weakly affected is comparable to the unaffected individuals.

Appendix B: Tables

Table 1: The 1994 FPE Reform Dummy Variables Matched with Age in the LSMS Data

Birth Year	Age (1994)	Age (2012)	Age (2014)	Age (2016)	Degree of FPE Effect
<=1990	<=4	<=22	<=24	<=26	Strong
1989	5	23	25	27	Strong
1988	6	24	26	28	Strong
1987	7	25	27	29	Strong
1986	8	26	28	30	Strong
1985	9	27	29	31	Weak
1984	10	28	30	32	Weak
1983	11	29	31	33	Weak
1982	12	30	32	34	Weak
1981	13	31	33	35	Weak
1980	14	32	34	36	Weak
>1980	>14	>32	>34	>36	No effect

Age is measured in years. Cohorts in age range <4 to 8 are strongly affected whereas those of 9 to 14 range are weakly exposed to the reform. Cohorts above age 14 are not affected by the reform.

Table 2: AIR and GER of School Population Age and Grade Enrolment

	Grade 1-8 Enrolment			Grade 1 Enrolment		
Region	**School Age Population (7-14)**	**Enrolment First cycle (G1-8)**	**GER%**	**Population Age 7**	**Enrolment to G1**	**AIR %**
Tigray	996,976	1,102,593	110.6	123,342	181,339	147.0
Afar	288,288	218,963	76.0	42,923	33,409	77.8
Amhara	3,883,527	4,282,146	110.3	531,981	747,830	140.6
Oromiya	7,384,614	6,841,930	92.7	943,455	1,528,032	162.0
Somali	882,125	711,941	80.7	155,050	266,560	171.9
SNNP	3,990,378	4,273,580	107.1	487,899	897,385	183.9
Benishangul-Gumuz	206,002	214,877	104.3	26,875	43,359	161.3
Gambella	75,077	104,327	139.0	9,571	18,574	194.1
Harari	40,618	41,336	101.8	5,176	9,158	176.9
Addis Ababa	342,525	505,914	147.7	50,511	46,484	92.0
Dire Dawa	101,170	67,068	66.3	11,086	9,327	84.1
National (Total)	**18,191,299**	**18,364,675**	**101.0**	**2,387,870**	**3,781,457**	**158.4**

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Table 3: Weighted Distribution of Age and Educational Attainment of Individuals in Ethiopia

	Age in 1994 (years)											
	5		6		7		8		9		10	
Education level in 1994	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
no education	211,508	45.90%	175,499	33.30%	201,078	24.90%	185,130	16.40%	149,352	12.90%	178,381	10.20%
literate or literacy program	8,038	1.70%	13,853	2.60%	21,394	2.60%	25,569	2.30%	22,868	2.00%	30,771	1.80%
non-regular education	7,243	1.60%	14,259	2.70%	15,214	1.90%	15,402	1.40%	10,183	0.90%	15,820	0.90%
pre-school	224,684	48.80%	273,037	51.80%	326,318	40.40%	248,852	22.00%	168,727	14.60%	176,641	10.10%
basic education, grade 1	6,871	1.50%	45,650	8.70%	210,767	26.10%	453,743	40.20%	366,932	31.70%	443,227	25.30%
basic education, grade 2	231	0.10%	3,554	0.70%	27,512	3.40%	167,333	14.80%	302,045	26.10%	419,283	23.90%
basic education, grade 3	0	0.00%	10	0.00%	3,720	0.50%	28,803	2.50%	108,564	9.40%	316,368	18.10%
basic education, grade 4	0	0.00%	0	0.00%	20	0.00%	3,873	0.30%	25,030	2.20%	129,251	7.40%
basic education, grade 5	0	0.00%	0	0.00%	0	0.00%	0	0.00%	3,481	0.30%	34,544	2.00%
basic education, grade 6	0	0.00%	10	0.00%	0	0.00%	10	0.00%	10	0.00%	5,795	0.30%
basic education, grade 7	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	450	0.00%
basic education, grade 8	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	120	0.00%
basic education, grade 9	10	0.00%	0	0.00%	0	0.00%	0	0.00%	10	0.00%	100	0.00%
basic education, grade 10	0	0.00%	0	0.00%	20	0.00%	10	0.00%	0	0.00%	0	0.00%
basic education, grade 11	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	60	0.00%
basic education, grade 12	10	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	40	0.00%
certificate or diploma	0	0.00%	0	0.00%	0	0.00%	10	0.00%	0	0.00%	50	0.00%
bachelor, incomplete	0	0.00%	0	0.00%	0	0.00%	0	0.00%	10	0.00%	10	0.00%
bachelor, complete	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
graduate, incomplete	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
graduate, masters	0	0.00%	0	0.00%	10	0.00%	0	0.00%	0	0.00%	10	0.00%
graduate, doctorate	0	0.00%	10	0.00%	10	0.00%	0	0.00%	0	0.00%	10	0.00%
unknown	1,732	0.40%	1,344	0.30%	1,534	0.20%	1,262	0.10%	908	0.10%	980	0.10%
Total weight	460,327	100.00%	527,226	100.00%	807,597	100.00%	1,129,996	100.00%	1,158,120	100.00%	1,751,911	100.00%
Obs (actual)	27,588		30,187		44,500		58,521		60,619		91,466	

Source: IPUMS International, 1994 Ethiopian Census.Frequency and percent values were adjusted with the household weight in the data.

Table 3: Weighted Distribution of Age and Educational Attainment of Individuals in Ethiopia

	Age in 1994 (years)								Weighted Value Total		Actual Obs.
	11		12		13		14				
Education level in 1994	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	
no education	69,729	7.30%	124,035	6.80%	70,691	5.50%	65,025	4.90%	1,430,428	12.70%	144,550
literate or literacy program	14,342	1.50%	30,069	1.70%	19,356	1.50%	19,339	1.40%	205,598	1.80%	20,114
non-regular education	7,552	0.80%	14,707	0.80%	9,233	0.70%	9,697	0.70%	119,310	1.10%	9,285
pre-school	59,587	6.20%	97,230	5.40%	44,841	3.50%	36,563	2.70%	1,656,481	14.70%	30,831
basic education, grade 1	185,974	19.40%	316,132	17.40%	165,804	12.80%	139,124	10.40%	2,334,224	20.80%	121,588
basic education, grade 2	208,179	21.70%	354,187	19.50%	216,040	16.70%	182,775	13.60%	1,881,139	16.70%	88,209
basic education, grade 3	183,770	19.10%	311,437	17.20%	204,204	15.70%	184,074	13.70%	1,340,950	11.90%	64,833
basic education, grade 4	144,141	15.00%	254,738	14.00%	183,705	14.20%	175,401	13.10%	916,160	8.10%	46,380
basic education, grade 5	64,191	6.70%	195,937	10.80%	165,674	12.80%	171,565	12.80%	635,392	5.70%	34,959
basic education, grade 6	18,742	2.00%	87,305	4.80%	134,050	10.30%	157,659	11.80%	403,581	3.60%	23,052
basic education, grade 7	3,170	0.30%	24,382	1.30%	64,719	5.00%	126,577	9.50%	219,298	2.00%	14,269
basic education, grade 8	90	0.00%	3,362	0.20%	16,100	1.20%	55,403	4.10%	75,075	0.70%	5,999
basic education, grade 9	50	0.00%	50	0.00%	1,712	0.10%	13,802	1.00%	15,734	0.10%	1,667
basic education, grade 10	10	0.00%	20	0.00%	10	0.00%	1,958	0.10%	2,028	0.00%	221
basic education, grade 11	20	0.00%	30	0.00%	0	0.00%	50	0.00%	160	0.00%	16
basic education, grade 12	20	0.00%	40	0.00%	10	0.00%	10	0.00%	130	0.00%	13
certificate or diploma	30	0.00%	10	0.00%	20	0.00%	0	0.00%	120	0.00%	12
bachelor, incomplete	30	0.00%	10	0.00%	0	0.00%	0	0.00%	60	0.00%	6
bachelor, complete	10	0.00%	0	0.00%	0	0.00%	0	0.00%	10	0.00%	1
graduate, incomplete	30	0.00%	0	0.00%	0	0.00%	10	0.00%	40	0.00%	4
graduate, masters	0	0.00%	10	0.00%	10	0.00%	10	0.00%	50	0.00%	5
graduate, doctorate	20	0.00%	30	0.00%	0	0.00%	0	0.00%	80	0.00%	8
unknown	390	0.00%	544	0.00%	362	0.00%	250	0.00%	9,306	0.10%	922
Total weight	960,077	100.00%	1,814,266	100.00%	1,296,539	100.00%	1,339,292	100.00%	11,245,352	100.00%	606,944
Obs (actual)	52,030		96,838		71,331		73,864		606,944		

Source: IPUMS International, 1994 Ethiopian Census.Frequency and percent values were adjusted with the household weight in the data.

Table 4: Mean of Years of Schooling and Welfare measures (Consumption)

	Years of Schooling School enrollment level in region of birth			Log Consumption Expenditure School enrollment level in region of birth		
	High	Low	Difference	High	Low	Difference
Outcome Means: Strongly vs Weakly						
Strongly affected (age >4 to 8 in 1994)	0.490	0.512	-0.022	0.965***	1.226***	-0.261***
	(.0279)	(.0603)	(.0648)	(.0334)	(.0771)	(.0786)
Weakly affected (age 9 to 14 in 1994)	0.426***	0.281***	0.144***	1.064	1.102	0.037
	(.0236)	(.0395)	(.0526)	(.0349)	(.0717)	(.0803)
Difference	0.916	0.794	0.122	2.067**	2.291*	-0.223**
	(.0357)	(.0708)	(.0816)	(.0449)	(.0971)	(.1043)

Source: LSMS Data. Consumption expenditure is measured in annual per adult equivalence. Standard errors are in parenthesis.

Table 5: Poverty Lines (Birr per year per adult person)

Year	GDP Deflator index	Poverty line (Birr/year/adult)
2011/2012	1.34 (2012)	5067
2013/2014	1.6 (2014)	6050
2015/2016	1.9 (2016)	7184

GDP deflator of each year is multiplied by the Ethiopia national poverty line (Birr 3781/year/adult) set in 2010/2011.

Table 6: Definition of Variables in Model Estimations

Variables	Definition
Dependent variables (Poverty Measures of Welfare)	
Real per adult equivalent consumption expenditure	Expenditure on food and non-food consumption (birr) adjusted to real terms
Relative deprivation in terms of consumption expenditure	Stark and Taylor's 1989 index (birr)
Poverty gap	Foster-Greer-Thorbecke (FGT) 1984 index [0,1]
Severity of poverty	Foster-Greer-Thorbecke (FGT) 1984 index [0,1]
Wealth index	1st principal component analysis of assets owned by household (normalized)
Covariates	
Education (Highest grade)	Years of schooling
Age	Age of individual (years)
Age sqaured	Squared of the age of individual in household
Gender	Female = 2 and male = 1
Region of birth	Region in which individual was born
Religion	Main religion of individual
Treatment dummy (strongly affected)	Individual of 8 years old and below in 1994 = 1, otherwise = 0
Treatment dummy (weakly affected)	Individual in age range 9 to 14 years in 1994 = 1, otherwise = 0

Table 7: Descriptive Statistics of Dependent Variables and Covariates

	Wave 3: 2015/2016			Wave 2: 2013/2014			Wave 1: 2011/2012			Pooled
Variables	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**	**Median**	**SD**	**Mean**
Dependent variables (Poverty Measures of Welfare)										
Real Per adult equivalent consumption expenditure	7,964	7,964	7,181	6,905	6,905	5,325	5,965	5,965	5,469	6,261
Relative Deprivation in terms of consumption expenditure	5,491	5,491	1,512	4,605	4,605	1,466	3,944	3,944	1,128	5,879
Severity of poverty	0.119	0.119	0.175	0.0980	0.0980	0.154	0.0957	0.0957	0.150	0.152
Poverty gap	0.229	0.229	0.259	0.201	0.201	0.240	0.198	0.198	0.238	0.285
Covariates										
Age(years)	34.90	34.90	10.97	33.90	33.90	10.82	30.35	30.35	9.209	35.65
Education (Highest grade)	8.382	8.382	4.706	8.340	8.340	4.643	8.143	8.143	3.907	7.027
Age squared	1,339	1,339	834.6	1,266	1,266	815.1	1,006	1,006	646.7	1,396
Age in 1994	13.05	13.05	10.78	13.90	13.90	10.82	12.35	12.35	9.209	13.85
Treatment 1 (strong)										0.402
Treatment 2 (weak)										0.153
Observations	5,636	5,636	5,636	5,808	5,808	5,808	2,758	2,758	2,758	4,194

Table 8: Pooled Distribution of Covariates

Variables	Frequency	Percent
Gender		
Male	1,959	46.77
Female	2,230	53.23
Region of birth		
Tigray	434	10.66
Afar	111	2.73
Amhara	891	21.88
Oromia	932	22.89
Somalie	155	3.81
Benshagul Gumuz	70	1.72
SNNP	1,174	28.83
Gambella	99	2.43
Harari	86	2.11
Addis Ababa	4	0.1
Diredawa	109	2.68
Outside of Ethiopia	7	0.17
Religion		
Orthodox	1,778	43.74
Catholic	59	1.45
Protestant	988	24.31
Muslim	1,205	29.64
Traditional	10	0.25
Pegan	8	0.2
Wakefeta	5	0.12
Other	12	0.3

Table 9: Effect of Free Primary Education Reform on Education and Welfare (First stage and Reduced form restricted models)

	Education (1st stage for CE and RD)		Log consumption expenditure (CE)		Log relative deprivation (RD)		Education (1st stage for PG)		Poverty gap (PG)	
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
Age(years)	-0.17***	-0.161***					-0.15***	-0.14***		
	(0.039)	(0.039)					(0.038)	(0.038)		
Age squared	0.002***	0.002***					0.002***	0.002***		
	(0.001)	(0.001)					(0.0004)	(0.0004)		
age <=4 to 8 in 1994	1.102***	1.072***	0.276***	0.271***	-0.110***	-0.109***	1.093***	1.06***	-0.095***	-0.094***
	(0.227)	(0.227)	(0.020)	(0.020)	(0.009)	(0.009)	(0.221)	(0.221)	(0.008)	(0.008)
age 9 to 14 in 1994	-0.743***	-0.758***	0.109***	0.111***	-0.045***	-0.046***	-0.781***	-0.799***	-0.040***	-0.041***
	(0.213)	(0.212)	(0.023)	(0.023)	(0.011)	(0.011)	(0.207)	(0.206)	(0.010)	(0.010)
Regional enrollment level	-0.82***	-0.584***					-0.89***	-0.607***		
	(0.192)	(0.218)					(0.189)	(0.214)		
DID (strong)	0.714	0.707					0.790	0.767		
	(0.488)	(0.488)					(0.486)	(0.486)		
DID (weak)	0.469	0.437					0.512	0.496		
	(0.532)	(0.531)					(0.528)	(0.527)		
Constant	12.815***	13.307***	8.364***	8.438***	8.414***	8.392***	12.473***	13.068***	0.329***	0.304***
	(0.811)	(0.832)	(0.079)	(0.077)	(0.040)	(0.039)	(0.794)	(0.814)	(0.028)	(0.028)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	No	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes
Observations	3,917	3,912	7,865	7,851	7,865	7,851	4,155	4,150	8,310	8,295
R-squared	0.0429	0.0497	0.035	0.044	0.063	0.069	0.0422	0.0491	0.023	0.028
F-statistic	21.91	18.53					22.83	19.41		
P-value	0	0					0	0		

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parenthesis. Welfare is measured in terms of poverty. F-statistics test the overall significance of the first stage equation.

Table 10: Effect of Education on Welfare Outcomes (OLS and 2SLS restricted estimations)

	Log consumption expenditure (CE)				Log relative deprivation (RD)				Poverty gap (PG)			
Variables	**OLS**	**OLS**	**2SLS**	**2SLS**	**OLS**	**OLS**	**2SLS**	**2SLS**	**OLS**	**OLS**	**2SLS**	**2SLS**
Education	0.037***	0.036***	0.165***	0.158***	-0.017***	-0.016***	-0.064***	-0.062***	-0.012**	-0.011**	-0.051***	-0.049***
	(0.003)	(0.003)	(0.026)	(0.026)	(0.001)	(0.001)	(0.011)	(0.011)	(0.005)	(0.005)	(0.010)	(0.010)
Age(years)			0.025***	0.023**			-0.010**	-0.009**			-0.006*	-0.005
			(0.010)	(0.010)			(0.004)	(0.004)			(0.004)	(0.004)
Age squared			-0.000***	-0.000**			0.000***	0.000**			0.000*	0.000
			(0.000)	(0.000)			(0.000)	(0.000)			(0.000)	(0.000)
Constant	8.454***	8.485***	6.713***	6.838***	8.352***	8.337***	8.997***	8.954***	-0.634***	-0.697***	0.782***	0.751***
	(0.079)	(0.093)	(0.405)	(0.416)	(0.045)	(0.051)	(0.164)	(0.169)	(0.121)	(0.134)	(0.149)	(0.155)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	4,028	3,916	3,917	3,912	4,028	3,916	3,917	3,912	4,270	4,154	4,155	4,150
R-squared	0.058	0.062			0.125	0.125			0.035	0.037		

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parenthesis. Welfare is measured in terms of poverty.

Table 11: Effect of Free Primary Education Reform on Education (First stage unrestricted models)

	Education (1st stage for CE and RD)		Education (1st stage for PG)	
Variables	**(1)**	**(2)**	**(7)**	**(8)**
Age(years)	-0.150***	-0.132***	-0.115***	-0.113***
	(0.040)	(0.041)	(0.039)	(0.040)
Age squared	0.002***	0.001***	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
age 4/below	1.075***	0.622	0.526	0.532
	(0.411)	(0.406)	(0.396)	(0.397)
age 5	1.862***	1.768***	1.596***	1.564***
	(0.578)	(0.567)	(0.557)	(0.555)
age 6	0.786	1.614***	2.016***	1.836***
	(0.527)	(0.526)	(0.516)	(0.515)
age 7	1.238**	1.306**	0.912*	0.870*
	(0.558)	(0.543)	(0.510)	(0.508)
age 8	0.224	0.441	0.208	0.159
	(0.446)	(0.456)	(0.439)	(0.437)
age 9	0.617	1.051	0.289	0.329
	(0.687)	(0.685)	(0.641)	(0.639)
age 10	-0.590	-0.782*	-0.876**	-0.911**
	(0.450)	(0.445)	(0.440)	(0.439)
age 11	-1.499**	-0.155	-0.084	-0.058
	(0.590)	(0.583)	(0.543)	(0.541)
age 12	-1.786***	-1.725***	-1.752***	-1.758***
	(0.486)	(0.508)	(0.493)	(0.492)
age 13	-0.799*	-0.043	-0.360	-0.330
	(0.466)	(0.479)	(0.465)	(0.463)
age 14	-0.983**	-0.603	-0.932**	-0.946**
	(0.470)	(0.440)	(0.419)	(0.418)
Constant	12.470***	12.997***	11.971***	12.890***
	(0.821)	(0.837)	(0.792)	(0.814)
Regional enrollment level	-1.011**	-0.317	-0.575	-0.374
	(0.394)	(0.438)	(0.411)	(0.434)
Year FE	Yes	Yes	Yes	Yes
Control	No	Yes	No	Yes
Observations	3,917	3,858	4,109	4,101
R-squared	0.052	0.063	0.054	0.063
F-statistic	7.88	8.3	8.3	8.8
P-value	0	0	0	0

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parenthesis. Welfare is measured in terms of poverty. F-statistics test the overall significance of the first stage equation.

Table 12: Effect of Education on Welfare Outcomes (OLS and 2SLS unrestricted estimations)

	Log consumption expenditure (CE)				Log relative deprivation (RD)				Poverty gap (PG)			
Variables	**OLS**	**OLS**	**2SLS**	**2SLS**	**OLS**	**OLS**	**2SLS**	**2SLS**	**OLS**	**OLS**	**2SLS**	**2SLS**
Education	0.037***	0.036***	0.142***	0.140***	-0.017***	-0.016***	-0.058***	-0.058***	-0.012**	-0.011**	-0.039***	-0.039***
	(0.003)	(0.003)	(0.020)	(0.020)	(0.001)	(0.001)	(0.008)	(0.008)	(0.005)	(0.005)	(0.007)	(0.008)
Age(years)			0.019**	0.020**			-0.011***	-0.011***			-0.004	-0.004
			(0.008)	(0.008)			(0.003)	(0.004)			(0.003)	(0.003)
Age squared			-0.000**	-0.000**			0.000***	0.000***			0.000	0.000
			(0.000)	(0.000)			(0.000)	(0.000)			(0.000)	(0.000)
Constant	8.454***	8.485***	7.012***	6.972***	8.352***	8.337***	8.988***	8.998***	-0.634***	-0.697***	0.646***	0.655***
	(0.079)	(0.093)	(0.307)	(0.330)	(0.045)	(0.051)	(0.128)	(0.138)	(0.121)	(0.134)	(0.115)	(0.125)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	4,028	3,916	3,866	3,858	4,028	3,916	3,866	3,858	4,270	4,154	4,109	4,101
R-squared	0.058	0.062			0.125	0.125			0.035	0.037		

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parenthesis. Welfare is measured in terms of poverty.

Table 13: Before Reform: Number of Primary (Grade: 1-8) Enrolment Over the Past Five Years

Regions	**1988**	**1989**	**1990**	**1991**	**1992**	**Level of enrolment**
Tigray	318,234	327,216	397,943	425,668	472,834	high
Afar	14,792	14,792	14,791	16,943	22,088	low
Amhara	707,240	910,714	1,060,086	1,274,646	1,507,124	high
Oromia	1,211,156	1,465,948	1,710,918	1,997,695	2,341,195	high
Somalie	61,837	61,837	61,837	61,837	66,834	low
Benshagul Gumuz	46,615	54,194	72,725	80,267	89,777	low
snnp	1,010,971	1,196,954	1,331,193	1,401,489	1,504,351	high
Gambella	21,875	29,488	32,572	35,578	37,421	low
Harari	16,137	19,891	20,828	23,757	25,207	low
Addis Ababa	356,124	358,395	357,729	352,843	362,921	high
Diredawa	22,938	28,865	30,048	31,510	32,751	low
Total	3,787,919	4,468,294	5,090,670	5,702,233	6,462,503	

Education Statistics Annual Abstract 1992 E.C. (1999-2000). Assumption: If primary school enrolment number is greater 100, 000, then enrolment is high, otherwise is low.