The Intergenerational Effects of Increasing Parental Schooling: Evidence from Zimbabwe*

Jorge M. Agüero[†] **Maithili Ramachandran**[‡]

April 2010
Please do not cite without permission.

Abstract

After independence in 1980, the new government of Zimbabwe implemented a substantial reform to correct the racially-segregated educational system inherited from the colonial era. A key element of the reform was the elimination of restrictions to progress from primary to secondary school. Primary school graduates in 1980 entered secondary school at a rate 4 times higher than those in 1979. We exploit the *fuzzy* discontinuity implicit in this natural experiment to test primarily for mother-to-child transmission of education. We find that a one year increase in the mother's education causes an increase in the children's education by about 5 percent of a standard deviation. We show that our findings are unlikely to be driven by other confounding factors.

Keywords: Education, Intergenerational transmission, Zimbabwe.

JEL codes: I21, J13, J24.

*We would like to thank the personnel of the Central Statistical Office of Zimbabwe for making a 10% sample of the 2002 Population Census available to us, and Craig Richardson for generously sharing the rainfall data. We are grateful to Todd Sorensen, Steven Helfand, Mindy Marks and Chris Barrett for helpful comments and discussions. We have also benefitted from the comments and suggestions of participants at Cornell University's 2009 IBEPP Conference, Cal State Fullerton, PACDEV 2010 and CSAE 2010. We bear sole responsibility of this paper, which is not meant to reflect the views of any government agency.

[†]University of California, Riverside and SALDRU. Email: jorge.aguero@ucr.edu.

[‡]University of California, Riverside. Email: mrama001@student.ucr.edu.

1 Introduction

The argument for education as a route to escape poverty is long-standing in the social sciences. Education is often envisioned as a form of investment that would lift families out of constrained living circumstances and set them on a path of higher income and better health. Programs have been designed with different kinds of economic incentives, most of them intended to encourage initial enrolment and promote continued attendance through at least secondary school. Typical incentives include free primary education, mandatory attendance until a certain age, conditional cash transfers or some blend of these arrangements. The literature evaluating these programs provides reassuring evidence of their effectiveness in raising school attainment[1].

However, the effects on the *intergenerational* transmission of schooling are less clear. Parents with high levels of education often have children with high levels of education. However, this correlation may be owed partly to selection. For example, parents with more education typically earn more income, which enables them to afford more schooling for the children. Alternatively, as recipients of increased schooling, parents may come to recognize the delayed benefits it confers, thus driving them to actively seek greater education for their children. Education could very well be a behaviour-changing factor in the human-capital production function of families. The few well-designed studies on this subject have focussed on developed instead of developing countries, where policies that could break the intergenerational transmission of poverty are more vital (e.g. Behrman and Rosenzweig 2002, Black, Devereux, and Salvanes 2005). In this paper we propose a methodology to estimate the causal impacts of the intergenerational transmission of human capital in Zimbabwe.

After Independence in 1980, the first black government of Zimbabwe embarked on a large reform of its education system. A key feature of the reorganization involved the elimination of restrictions to progress to secondary education. Because of apartheid-style rules in Rhodesia, a 14 year-old graduating from primary school in 1979 had about a twenty percent probability

[1] See Glewwe (2002) for a review of the recent literature.

of advancing to secondary school. Post-reform, a child just one year younger - a 14 year-old in 1980 - had almost an eighty percent chance of attending secondary school. Thus, the reform created a *fuzzy* discontinuity in the probability of the treatment (rather than in the treatment itself). We use this discontinuity as a source of exogenous variation in the education of mothers and fathers in our data. We find that by 2002, a woman aged 14 in 1980 had accumulated 0.8 more years of education on average, compared to one who was 15 in 1980. We further find that a child born to the former mother has 0.13 more years of education (or 5 percent of a standard deviation) than a child born to the latter (even after controlling for the child's age.) Examining fathers, we find that the size of the transmission of schooling to children is almost three times as much as from mothers. We suggest some reasons for the relative strengths of the two transmissions and show that our results are robust to several confounding factors.

The remainder of the paper is organized as follows. The post-Independence reform in Zimbabwe's education system is laid out in section 2, followed by a description of the data used in the analysis. Section 3 describes a simple theoretical framework to explain the role of parents' education in children's education and surveys the recent literature testing for causality in this context. Section 5 presents the identification strategy employing fuzzy regression discontinuity. Section 7 shows the main results of the paper followed by a set of robustness tests that confirm our findings (section 8). Section 9 summarizes and closes the paper.

2 Post-Independence Schooling Reform in Zimbabwe

On April 18 1980, the Republic of Zimbabwe came into existence. Following free elections, the first black government was formed by the Zimbabwe African National UnionPatriotic Front (ZANU-PF) with Robert Mugabe as Prime Minister. The new government came to power with the clear goal of "establishing free and compulsory primary and secondary

education for all Zimbabwean children regardless of their race, sex or class" (Nhundu 1992, p.78). This was a historic break from the Apartheid-era education policies that had prevailed in Rhodesia [2].

Present-day education in Zimbabwe commences with Basic Education, which comprises Early Childhood Education and Care (ECEC) and Primary Education. The primary level is a seven-year cycle that children enter at the age of seven years [3]. Secondary Education is the next phase and the typical age of entry to secondary school is fourteen years. Secondary school is patterned as a four-year cycle, going through Forms I to IV and leading up to the O-level examinations. Depending on their performance in the O-levels, students may gain admission to an advanced two-year secondary school programme (Lower and Upper Form VI), which culminates in the A-level examinations. (See Nhundu 1992, Nherera 2000, Kanyongo 2005). Tertiary Education completes the last stage of formal education.

Apartheid had severely thwarted schooling opportunities for the black population in Rhodesia. According to Riddell (1980, cited by Nhundu), at least 25% of black school-aged children failed to enter primary school due to a lack of places. Opportunities were further restricted when the Education Plan of 1966 allowed only 50% of black primary school graduates to enter secondary school. By 1976, for every 1,000 black school-aged children, 250 never started school. Of those who did, 377 managed to graduate from Grade 7 in primary school, but only 60 of them transitioned into secondary Form I. Thereafter, 37 reached Form IV and less than 3 reached lower Form VI (Nhundu 1992, p.79). Policies were also calculated to stifle supply: between 1961 and 1972, the number of African pupils attending academic secondary schools increased from 15,640 to 23,602. Yet, legislation permitted the addition

[2]Zimbabwe was known as Southern Rhodesia until political Independence in 1980. For a history of Apartheid-Rhodesia's education system and the policies dictating the quantity and quality of schooling Africans received, see (Atkinson 1972) or (OCallaghan and Austin 1977). Nherera (2000) also provides a condensed discussion in the context of present-day globalization and livelihoods in Zimbabwe.

[3]In 1998, the official age of entry to primary school was reduced to six years. The EFA 2000 Assessment Report for Zimbabwe notes that according to the 1998 annual school census, most of the newly-admitted first-graders were over the official admission age. Further, over-age boys were more likely to be admitted to first grade than girls while the proportion of girls entering primary school cycle under-age was higher than that of boys.

of only one government African secondary school between 1967 and 1972. The number of non-government African secondary schools grew by 8 over the same period (Zvobgo 1981).

Immediately after coming to power, the new black government declared education a basic human right and embarked on a massive reform process. One of the foremost priorities was to increase access to education. The dramatic changes that ensued from the reforms have been widely documented in the literature (See for example Edwards 1995, Edwards and Tisdell 1990, Dorsey 1989). As reported in Nhundu (1992, p.80), among the key initiatives undertaken by the new government were: (1) the introduction of free and compulsory primary education; (2) the removal of age restrictions to allow over-age children to enter school; (3) community support for education and; (4) automatic grade progression, in particular from primary to secondary school [4]. An immediate impact of these steps was an enormous increase in school enrollment. Between 1979 and 1985, total enrollment rose from 885,801 to 2,698,878: a 205 percent increase (Nhundu 1992, p.82). This expansion was divided between an increase of 170 percent at the primary level, and a far bigger 628 percent in secondary schools. As Figure 2 shows, gross enrollment in secondary schools climbed from 66,215 in 1979 to 482,000 in 1985, peaking at a little over 700,000 in 1991. To accommodate the increased demand, the government built new schools and undertook extensive reconstruction and expansion of existing facilities. The increase in the supply of schools is shown in Figure 1. Between 1979 and 1983, the overall number of schools grew by 90 percent. Primary schools increased by 65 percent from about 2500 in 1979; secondary schools were more impressive, recording an increase of 575 percent from around 150 in 1979. By 1988, the growth rates were 86 percent and 1,165 percent for primary and secondary, respectively, compared to the 1979 base. These figures are consistent with an increase in the budget allocated to education. In the fiscal year of 1979-80, education's share was 11.6 percent in the national budget. It doubled in 1980-81 to 22.1 percent, and remained at about 17

[4]As our interest is in estimating the size of the intergenerational transmission of schooling, we do not attempt to untangle the relative contributions of the different initiatives, though Nhundu (1992) suggests that over-age enrollment and free primary education evoked "the nation's largest-ever Grade 1 intake in 1980".

percent until 1986-87 (Dorsey 1989). The early years of the reform focussed on opening new secondary schools especially in rural areas. The target was to provide a secondary school within walking distance of all rural pupils, especially where geographic and demographic factors were conducive.

Since secondary education represented the sphere of greatest polarization between whites and blacks in Zimbabwe, the reform spent its greatest resources to redress the imbalance in this domain. We therefore choose to analyze the reform mainly through its impact on the opportunity to obtain *secondary* education.

Mirroring the massive response in enrollments are the transition rates at the primary-secondary interface in Zimbabwe's schools. As Figure 3 shows, the transition rate from Grade 7 to Form I languished below 30% throughout the seventies. Beginning in 1980, the year of the reform, it jumped to 87%, and averaged 70% for the rest of the decade.

Since children start primary school at the age of seven, on-time completion of all primary grades would enable them to start secondary school at the age of 14. As shown in Figure 3 there is a clear discontinuity in the probability that a child would go to secondary school in 1980: a 14 year-old in 1979 had a one-in-five chance of enrolling in secondary school; however, a child only a year older, a 14 year old in 1980, was four times as likely to enrol in secondary education. Thus, the educational reform of 1980 provides a natural experiment, where for reasons exogenous to her choice, a younger child would eventually acquire more schooling. We exploit the timing of the reform to ask if the children of the parents entering school in the eighties - either late or on time - will attain more schooling than those much older.

3 Theoretical Considerations

3.1 The Ambiguous Role of Mother's Education

To study the intergenerational transmission of education from parents to children, we develop a standard household model [5]. Our model can be extended to analyze both marriage and labour markets, but we choose to begin with a framework that is conditioned on the outcomes of those markets. Suppose the household seeks to maximize its utility $u(c, h)$ where c is a vector of consumption goods and h is the human capital of children. Mothers are endowed with a unit of time. They can divide their time between working in the labor market (L) and earning a wage w, and fostering the creation of human capital in their children ($1 - L$). The labor income (and the non-labor income) is spent buying consumption goods (c) as well as school-related "goods" (r) (e.g., books, uniforms and school fees) to increase the child's human capital. To close the model, we propose the following production function for the human capital of the children,

$$h = h(r, 1 - L, k) \tag{1}$$

where the children's human capital is a function of resources (r), the mothers' time ($1 - L$) and the mother's "knowledge" of good child-rearing practices k. Each argument is assumed to have a positive effect on the child's human capital, i.e. h is increasing in r, $1 - L$ and k.

In this simple model, an increase in the mother's education would affect h through each of its three arguments. More maternal education would contribute to the woman's capacity to better educate her children (k would increase). However, more maternal education also implies higher wages and a (possibly) higher supply of labor. If we further assume that the mother's time matters the most to the education of the children, then an increase in her

[5] Our model regards the household as a unit consisting of parents and the children, with the woman and man heading the household making decisions jointly on the intra-household allocation of resources. In this sense, our model is closer in spirit to Becker and Rosenzweig/Schultz than to later models based on intra-household bargaining, in the vein of Thomas or Pollak and Lundberg.

labor supply will have two opposing effects. On the one hand, she would be able to afford more school-related goods (i.e. more r.) On the other hand, she will have less time to spend in her child's education (i.e. more L and hence, less $1 - L$) [6]. Since h is increasing in r and $1 - L$, it is not evident if the outcome of a higher r and lower $1 - L$ is necessarily higher h. Thus, the net effect of an increase in the education of the mother on the child's human capital is ambiguous. If the elasticity of the mother's labor supply with respect to her schooling exceeds the schooling-elasticity of her improved child-rearing endowments, it could shrink the amount of human capital transmitted to her child.

Nevertheless, dimensions of child human capital that are more information-intensive, rather than time-intensive can be expected to show an unambiguous positive impact from increased mother's schooling. If health is one such dimension, even children of very busy mothers may record good nutritional improvement after their mothers acquire more schooling. (It may not matter that those mothers subsequently increased L). Thus, the net effect of a mother's education will ultimately depend on whether the child's human capital is a time- or resource-intensive output versus a knowledge-intensive one. This renders the mother-to-child transmission of education an empirical question.

The model above could be used to analyze father-to-child transmission of education, even though there can be qualitative differences between paternal and maternal inputs into the child's human capital formation. Nevertheless, studying the degree of substitutability between the mother and father's time inputs could help clarify if the child's human capital is itself a more time-intensive than knowledge-intensive output.

3.2 Evidence from Previous Studies

The principal question pre-occupying research in the intergenerational transmission of human capital is causality. The most frequently asked question is whether increased schooling of

[6]Note that mothers (and fathers as well) could have their leisure hours reduced in order to be able to expand their labor supply and human capital production. In this model, by not including leisure we are implicitly assuming that it is constant.

mothers in one generation has led to higher schooling of children in the next generation.

Some studies have used data on twins to attempt an answer. One such study comes from Behrman and Rosenzweig (2002), who use a sample of parents who are one of a pair of identical (monozygotic) twins. They find a significant and positive relationship between fathers and children's schooling. However, they also find a *negative* and significant relationship between mothers and children's education, after controlling for assortative mating, female earnings and the mother's child-rearing endowments. Antonovics and Goldberger (2005) contest some of the results believing them to be sensitive to the coding of the data. The intergenerational theme is revisited for a different question and in a different manner by Currie and Moretti (2003) and Chen and Li (2009), who explore the effects of mother's education on child health. While Currie and Moretti (2003) use an instrumental variable technique, Chen and Li (2009) use data on adopted children and biological children in China.

Plug (2004) and de Walque (2009) also use data on adoptees, examining the causal impact of parental education on child schooling in the United States and Rwanda, respectively. When adoption occurs randomly, children are matched to adopting families that are unlikely to share the same genetic characteristics. Thus, adoption filters out the nature component in child-schooling, helping to identify the link between parental nurturing and children's schooling. Plug finds a positive effect of father's education but no significant effect for mother's education. de Walque finds that both mothers and fathers' schooling exert a positive effect on the schooling outcomes of adoptee-orphans. As pointed out by Black, Devereux, and Salvanes (2005), children are not placed randomly with parents in practice, and children's education could bear the results of any unobserved parental characteristics, including patience and ability (p. 438)[7].

Oreopoulos, Page, and Stevens (2003) and Black, Devereux, and Salvanes (2005) use changes in compulsory schooling laws in the US and Norway, respectively. Both explore time and spatial variation in the implementation of the reform to identify the effects of parental

[7]Sacerdote (2002) also uses adoptees but his paper focuses on the effect of family socioeconomic background instead of the causal effect of parent's education.

education on child's education. Oreopoulos, Page, and Stevens use U.S. census data and find that increasing parental education decreases the probability that a child would repeat a grade. Black, Devereux, and Salvanes on the other hand, find that it is only the father's education that has an effect (positive) on the education of the next generation. However, a potential confound in papers exploiting regional variations is the possibility of selective migration into states or municipalities that implemented the reform early.

Aside from de Walque (2009) and Chen and Li (2009), the literature on the intergenerational transmission of human capital is largely drawn from developed countries. Of course, Duflo (2001), and Duflo (2004) provide an in-depth look at the consequences of Indonesia's 1973 primary school construction programme, and finds that an additional school per 1000 children increased male education by 0.12 to 0.19 years and male wages by 3 to 5.4%. A preliminary study on Pakistan by **?** finds significant, positive effects of mother's schooling on children's test-scores, despite seeing no impact on the extensive margin of her time spent performing household chores or paid work.

Our paper uses an instrumental variable approach, taking advantage of a dramatic education system reform implemented nation-wide in newly-independent Zimbabwe. As outlined in the previous section, Zimbabwe's reform provides us a natural experiment that permits us to implement a fuzzy regression discontinuity analysis to obtain causal estimates of parental schooling. Our large sample enables an identification strategy that compares individuals at the discontinuity, i.e. women around 14 years of age in 1980.

4 Data

We use a 10% random sample of the Zimbabwe Population Census of 2002 for our main data. To the best of our knowledge, ours is the first paper to use a sample of this census. The sample of interest is composed of children whose parents are either heads of households or the spouses of household heads. The total number of observations is 445,295. In order

to capture the appropriate "treated" and comparison cohorts, we choose children between 6 and 15 years of age at the time of Census 2002 with at least one parent aged 6 to 22 years in 1980. This leaves us with a sample of 189,263 observations. Table 1 shows the descriptive statistics for the parents and children in the sample.

The average child is 10.4 years old and has 3.6 years of schooling with a standard deviation of 2.6 (see Tables 1 and 2. Up to 95 percent of the children in the sample have attended school before Census 2002 and are currently enrolled in school. With such high rates of enrollment and attendance, we do not expect to see a large effect of parental schooling on these outcomes. Most of the effects are seen on the child's years of schooling and enrollment-delay, measured as the shortfall from expected schooling attainment for a given age. Table 2 shows the average years of schooling completed by boys and girls of different ages between 6 and 15 years. It is interesting that girls are ahead of boys at all the ages reported in the table. If children start school on time, they must complete four years of schooling by their tenth birthday and seven years of schooling by their thirteenth. From Table 2, it is clear that the average ten-year-old has about a year of schooling less than (s)he should while the average fourteen-year-old is yet to complete seven years of schooling. Delay in enrollment appears to begin early, almost from the first grade and increase with age.

To account for differences in schooling attainment due to age, we standardize years of schooling of the child as follows: let s_{ic} be the years of schooling of child i that belongs to cohort c, then

$$\tilde{s}_{ic} = \frac{s_{ic} - \mu_c}{\sigma_c}$$

where μ_c and σ_c are the average and standard deviation of the years of schooling of all children in cohort c, respectively. Thus, $\tilde{s}_{ic}$ represents standard deviations of schooling. The summary statistics for the standardized schooling attainment of children is reported separately for each sample of parents.

5 Identification Strategy

To obtain causal estimates of parental education on child schooling, we exploit the exogenous variation in parents' schooling stemming from the reforms of post-Independence Zimbabwe. Here, we describe the problems associated with OLS estimates and then present our empirical strategy that overcomes these problems as well as the assumptions needed for a causal interpretation of our results.

Consider the following relation between the mother's and children's education:[8]

$$CS_{ij} = \alpha_1 + \beta MS_{ij} + x'_{ij}\theta + e_{ij} \tag{2}$$

where CS_{ij} is a measure of the human capital of child i born to mother j. We consider four measures for CS_{ij}: the age-standardized years of schooling, the delay in schooling attainment experienced by the child, whether the child ever attended school prior to the date of the census and child enrollment in school at the time of the census. The variable MS_{ij} captures the years of schooling of the mother and β is the parameter of interest. Equation (2) includes a vector of child characteristics (x'_{ij}) such as age and sex. The primary concern is that OLS estimates of β may be biased because mother's education may be correlated with omitted variables subsumed in e_{ij}. Several reasons make this correlation likely. First, more educated women tend to have higher earnings. This association would confound the effect of other (un)observable variables that increase the education of the mother, and the education of the next generation. Typical candidates include the mother's health, her fertility, her spouse or partner's earnings, household wealth, home and community endowments. Secondly, women (and men) may self-select into higher education based on higher ability. Again, OLS would overestimate the "true" β if ability (reflected in unobservable variables like the child's aptitude for scholarly advancement or capacity for hard work) is passed on to the next generation. An ideal solution is to have a source of exogenous variation in parental

[8]The discussion here is framed in terms of the relationship between the education levels of mothers and children, but it can be extended to fathers and children.

schooling, which can be then used to test for a *causal* effect.

As described before, the 1980 reforms dramatically altered the schooling opportunities available to men and women young enough to take advantage of them. Figure 3 illustrates the sudden discontinuity in the transition rates induced by the reform allowing automatic admission to Form I after Grade 7. In itself, this implies a vastly different schooling experience for pupils aged fourteen or younger in 1980 compared to their seniors. However, the discontinuity in the probability of secondary-school enrollment is more *fuzzy* than sharp. Since the reforms also relaxed entry-age restrictions, they caused some overage enrollment at all grades of school. This would not rule out the possibility of children older than 14 in 1980 acquiring more than a primary school education. It does signify however, that among all children enrolling in secondary school in the eighties, the largest numbers were likely to be constituted by the cohort younger than 14.

Post-Independence Zimbabwe thus witnessed the emergence of a generation that obtained more schooling, at least partly due to the timing of their birth. This timing provides the source of exogenous variation in parental schooling so essential to establish the amount of intergenerational transmission of education. Accordingly, our estimation strategy compares the schooling attainment of children born to parents aged about 14 in 1980 to the schooling attainment of children born to older parents. As in van der Klaauw (2002), the indicator for the age cut-off serves as an excluded instrument in our Two-Stage Least-Squares (TSLS) regressions.

Formally, equation (2) could be modified as follows:

$$CS_{ij} = \alpha_1 + \beta E[MS_{ij}|A_{ij}, x_{ij}] + f(A_{ij}) + x'_{ij}\theta + e_{ij} \quad (3)$$

$$E[MS_{ij}|A_{ij}, x_{ij}] = \alpha_2 + \delta[1\{A_{ij} \leq \overline{A}\}] + g(A_{ij}) + x_{ij}\gamma \quad (4)$$

where A_{ij} is the age of mother j with child i, $1\{\cdot\}$ is an indicator function that takes the value of one if the mother was not older than the cutoff $\overline{A} = 14$ in 1980 and zero otherwise;

and the functions $f(\cdot)$ and $g(\cdot)$ are flexible functions of the mother's age (in 1980.)

According to Hahn, Todd, and Van der Klaauw (2001), a consistent estimation of β by TSLS relies on two assumptions. First, the mother's education must be discontinuous at the cut-off. This is testable. Second, it requires $f(\cdot)$ and $g(\cdot)$ to be locally continuous at the age cut-off. When the functions $f(\cdot)$ and $g(\cdot)$ are correctly specified, they will capture all other potential effects of age on mother's education and children's school-related outcomes far away from the cut-offs. Then, the cut-off indicator can be used as an excluded instrument to achieve a consistent estimate of β.

Following van der Klaauw (2002), the functions $g(\cdot)$ and $f(\cdot)$ could be represented by a piece-wise linear approximation[9]. Thus, $f(A_{ij}) = \psi_1 A_{ij} + \psi_2(\overline{A} - A_{ij}) * 1\{A_{ij} \leq \overline{A}\}$ and a similar expression for $g(\cdot)$[10].

6 Impact of the Reform on Parental Schooling

An unbiased estimator of β requires an exogenous source of variation in parental schooling. We use the discontinuity in the probability of attending secondary school (our "treatment") as an instrument for parental schooling. Figure 6 and Figure 7 show this discontinuity for mothers and fathers respectively. We plot the average years of schooling of mothers by their age in 1980 as reported in the 2002 Census. The scatterplot shows that for women aged 14 or less, the years of schooling remained relatively constant around 9.2. However, for those aged 14 or more, there is a clear decline in the years of schooling by age. Those aged 15 in 1980 had an average of 8.2 years of schooling compared to 7.5 for those aged 17. In fact, the decline observed in years of schooling with increasing age is a well-documented fact. Schultz (2004) shows that in several African countries there has a been a slow (but "continuous") progress in educational attainment. Schultz uses household data from South Africa,

[9] See Ferraz and Finan (2009) for an example in other contexts.

[10] A more flexible approximation is given by $f(A_{ij}) = \sum_{k=1}^{K} \psi_{1k} A_{ij}^k + \sum_{k=1}^{K} \psi_{2k}(\overline{A} - A_{ij})^k 1\{A_{ij} \leq \overline{A}\}$ with $K > 1$. Our basic results were insensitive to approximations where $K > 1$ for $f(\cdot)$ and $g(\cdot)$

Nigeria, Côte d'Ivoire, Kenya, Burkina Faso and Ghana and finds a steady improvement in the education of women over time. Thus, the educational reform in Zimbabwe altered the educational attainment of women (who were young enough) more strikingly than in other African countries.

Further arguments for using 14 years of age in 1980 as cut-off point in treatment come from Figures 4a and 4b. Figure 4a displays the distribution of schooling attainment for mothers belonging to four different ages in 1980: fourteen, fifteen, sixteen and seventeen years respectively. Each distribution is bimodal, the modes occurring at seven years (signifying completion of primary school) and eleven years (referring to graduation from Form IV). In turn, each younger cohort shows a declining proportion of students who complete schooling up to Grade 7, and a rising proportion that advances just up to the O-levels. Compare these trends to Figure 4b, which also displays the four distributions of schooling, but this time for mothers in the ages of eighteen to twenty-one in 1980. It is interesting that the distributions in Figure 4b are hardly different from each other. They suggest that, absent the reforms, mothers in the younger ages of fourteen to seventeen would have probably behaved like the older group of eighteen to twenty-one in 1980.

The bimodal nature of the schooling attainment distributions is a consequence of Zimbabwe's reforms. While these reforms eased transition to secondary school from Grade 7 by waiving entrance-tests, it retained the O-level exam to determine if a student would qualify for the advanced leg of secondary school.

The counterpart graphs for fathers, Figures 5a and 5b show distributions that behave as for mothers: virtually identical to one another for the ages of eighteen to twenty-one in 1980, the mode at eleven years of schooling becomes more pronounced for every younger cohort in Figure 5a.

Figure 7 presents the mean schooling of fathers in the sample, together with a pair of kernel regressions. In the sub-sample of fathers aged 15 or younger in 1980, mean schooling is around 10.5 years; in the older sub-sample, it declines steadily with age. Figure 7 also hints

that the point of discontinuity in treatment occurs at 15 years of age in 1980. There may be different reasons why the cut-off for fathers is higher than for mothers. Greater delay in starting school, more frequent grade-repetitions, even flexible social expectations (in terms of how long males took to complete primary school or wished to continue their education) could have all had a role. The fuzzy discontinuity in the schooling attainment within the sample of fathers in Figure 7 is less striking than pictured for the the aggregate in Figure 3. Nevertheless, the mean years of schooling are clearly affected by the reform so that at the cut-off age, younger men have little more than a third of an extra year of schooling.

Similarly, Figure 6 shows the mean schooling of mothers by age in 1980 with nonparametric regressions on either side of the cut-off age of 14 years in 1980. Again, a clear discontinuity emerges. At the discontinuity, women have roughly an extra half-year of education. This result is twice as large as the effect the Indonesian school construction program created on male education during the 1970's Duflo (2001) and Duflo (2004).

Table 5 presents the regression counterpart to Figures 6 and 7. In the table, we show the results of regressing the mother's education (as observed in the 2002 census) on the cut-off and a piece-wise linear specification for function $f()$. Column (1) shows that at the discontinuity, women to the left of the cut-off point had about three-fourths of an extra year of education compared to those who where just a few years older than 14 in 1980 (those to the right of the cutoff). This effect is statistically significant at 1%. Thus, the cutoff age has a very strong effect on the mother's education allowing us to rule it out as a possible weak instrument. The significance is sustained although the magnitude declines to about half-a-year in column (3) where a shorter age-span of 10 to 20 years in 1980 is considered. For men, the initial size of the discontinuity predicted by the cut-off is nearly two-thirds of an extra schooling-year, but this also declines to about one-half of an additional year in the shorter age-span under column (4). When the data is sliced by the sex of the child, the first-stage regressions are still strong and produce comparable estimates of the instrument's effect on the parent's schooling.

7 Intergenerational Transmission of Education

7.1 OLS Results

In Table 3, odd-numbered columns show the estimates for β as described in equation (2). The variables representing child's education are regressed against the mother's education and controls for child's age. The OLS results show a positive association between mother's education and all four schooling outcomes of the children. For example, in column (1) an additional year of education of the mother is associated with an increase in the child's years of education equivalent to 9% of a standard deviation above the mean. This is equivalent to an increase of 0.234 ($= .09 \times 2.60$) years of schooling of the child. Further, an additional year of education for the mother is also associated with a decline of 0.11 years in schooling delay. Current enrollment at the time of the census also increases but by 0.48 percentage points (column 3). This smaller effect is explained by the high levels of school enrollment for the children under study (aged between 6 to 15) as mentioned before.

The positive associations between mother's and children's education, despite the statistical significance, cannot be considered as causal effects because of the issues described earlier.

7.2 Two-Stage Least-Squares Estimates

We can now estimate β using TSLS methods as described in equation (3). Our four variables measuring school outcomes of children are regressed against the child's age, the mother's education and a piece-wise linear approximation on the mother's age in 1980. We instrument mother's education with the cut-off point at age 14 in 1980. To show the intuition behind this approach, we compute the Wald estimator for this effect using the raw data as follows:

$$\beta_{\text{Wald}} = \frac{\overline{CS}(z=1) - \overline{CS}(z=0)}{\overline{MS}(z=1) - \overline{MS}(z=0)} = \frac{0.1031 - 0.0627}{8.411 - 7.613} = 0.0506$$

where $\overline{CS}$ and $\overline{MS}$ are the average years of schooling of children and mothers, respectively and $z = 1$ if the mother's age was 14 or 13 in 1980 and $z = 0$ if she was 15 or 16 in 1980. The Wald estimate suggests a positive effect, whereby an additional unit of education of the mother increases the (standardized) years of education of the child by 5 percent of a standard deviation or approximately 0.13 years.

The results in the columns headed "TSLS" in Table 3 confirm this finding. The effect of the mother's education on the child's (standardized) years of schooling is positive and significant. As expected, the coefficient is smaller than the OLS estimate indicating that part of the observed association between mother's schooling and the child's education included unobserved variables that affected *both* positively. This suggests that part of the intergenerational transmission in maternal education might be due to transmission across generations in genetic make-up, including ability. However, our results indicate that one additional year in mother's education, generated exogenously by policies after 1980, still has a positive and significant impact on the child's schooling Z-score, and a negative and significant effect on delay. Thus, the observed effect on the child's schooling Z-score (0.04) is equivalent to an increase in 0.1 years of education of the child. Thus, a child born to a mother with a high school diploma will have close to an additional year of education compared to a child born to a mother who only completed a year of primary education. Shortfall in the child's schooling attainment is lowered by 0.05 years by every additional year of mother's schooling.

School enrollment at the time of the Census is no longer statistically different from zero. The value is also much smaller than the OLS estimates and very close to zero (last four columns in Table 3). Overall, the results still imply a positive transmission of education from mothers to children.

As with mothers, the transmission of paternal education is estimated using the program-generated discontinuity in the probability of male secondary school enrollment in 1980. The sample of fathers included in this analysis are also aged 28 to 44 years (6 to 22 years in 1980). Table 1 shows that the mean male in this sample is aged about 37 years in 2002; his

mean schooling is 9.5 years. This is 1.5 years of schooling more than that for mothers in the same age-group (compare panels on Mothers and Fathers within Table 1). The descriptive statistics for the children in the father's sample shows that they are in the ages of 6 and 15 in Census 2002 and their mean schooling Z-score is 0.083 with a standard deviation of 0.94.

Table 3 presents the regression estimates of four different child-schooling outcomes on father's schooling. The OLS coefficients cannot be interpreted as causal estimates again but father's schooling is strongly, positively associated with the child's Z-score of education, likelihood of enrollment and probability of ever attending school. It is also negatively associated with delay. The size of the coefficients are comparable to that for mothers. One extra year of schooling for the father translates to an additional (0.089×2.51) 0.22 years of schooling for the child.

The two-stage least-squares estimates for the quantity of paternal schooling transmitted to the child are in contrast to the TSLS results for mother's schooling, larger than the OLS estimates. Child-schooling rises by about 12% of a standard deviation for every additional year of father's schooling. The effect on school enrollment is not significant after instrumenting for father's education by the cut-off age in 1980 but probability of ever-attendance still shows a significant rise of 3 percentage points. Father's schooling also affect delay in child schooling significantly by a magnitude of 0.12 years.

Effects by Child's Sex

In Table 4 we explore the effects of the mother- and father-to-child transmission by the sex of the child. The transmission of schooling from mothers to sons is positive and marginally significant but seems stronger for daughters (columns (1) and (3) in first two-rows of the Table). The results with the shorter age-span reverse for sons and daughters and mothers are seen to exert less of an influence on the education of their daughters. An extra year of mother's schooling increases the son's standardized schooling score by as much as 8%. Thus, there is initially a slightly significant effect on the schooling Z-score for boys and girls

in Panel A, varying between 4% and 5% of a standard deviation. These are not sustained, however, when a shorter age-span is considered: an additional year of education for the mother increases the education of her son by 8% of a standard deviation but dwindles to 2.6% for girls, which is not statistically different from zero. This could be due to girls and boys differing in the blend of inputs they need for their human capital and/or some preferential treatment for boys over girls. Whether this is pure evidence of preferences or a reaction to the labor market or other institutional arrangements remains to be explored in future versions of this paper.

Interestingly, the transmission of father's schooling to sons and daughters are both very strong and significant. An extra year of schooling for the father moves the son's Z-score on schooling up by 15 to 18% while raising a daughter's by 9% of a standard deviation.

8 Robustness Checks

Cohort Effects

Our empirical strategy requires that parents a few years older and younger than the cut-off age in 1980 do not differ in observable and unobservable characteristics that could explain the schooling outcomes of the children. If they are indeed different, the exclusion restriction for the TSLS estimates will be violated. While it is never possible to exhaust the set of observable (even less unobservable) characteristics, we show below that our results are unlikely to be driven by cohort effects.

We start by restricting the two samples of parents closer to their respective cut-off ages in 1980. Our first set of results in Table 3 compared children with mothers or fathers in the ages of 6 and 22 in 1980. As explained in section 5 the piece-wise specification for function $f()$ allows us to control for factors affected by differences between parents far from the cutoff point. However, if our piece-wise function is not linear, the mis-specification could be in part by shortening the span of women's (or men's) age included in the analysis. We present the

results by sex of the child in Table 4 when mothers or fathers are restricted to age-range of 10 and 20 in 1980.

It may be noted that restricting the sample does not affect the validity of our first-stage. Columns (3) and (4) of Table 5 show the first-stage results for the restricted sample. The effect of the cut-off on the mother's years of education is still positive and significant but, as expected, has a lower magnitude of around 0.54 while it is about 0.52 for fathers.

As discussed previously, Table 4 shows the effects of an additional year of mother's education. While the effect is strong and positive for sons, it is weak for daughters while the father's transmission of schooling has an even higher effect in the restricted sample, especially for sons. Shortening the span of our analysis does not alter the main result. The effect of either parent's schooling is sustained in the shorter age-span; delay in child schooling is also reduced significantly for every one year of father's schooling.

Rainfall

A second way to evaluate an un-modeled cohort effect is to explore whether the discontinuity at the cut-off age in 1980 coincides with other characteristics of these women. One possibility is that younger women were born in "better" years than those born a few years before. If that is the case, the cut-off point could have an alternate *direct* channel of influence on child's education instead of having an *indirect* impact felt only through increased mother's schooling.

Figure 8 shows rainfall between 1959 and 1985 from an average of 38 stations across the country. The data is displayed as deviations from the mean and it is standardized by the standard deviation (both moments were calculated based on the 1959-2001 period.) Women aged 14 in 1980 are likely to have been born in 1966. This year shows an average rainfall. However, years priors to that (corresponding to those older than 14 in 1980) were below-average in rainfall. But so were the few years after 1966. Thus, it is possible that being born in a relatively good rainfall year could have important effects on the mother's

education that could also be transmitted to the next generation. Richardson (2007), for example, documents the strong association between rainfall and GDP per capita growth in Zimbabwe during this period. Alderman, Hoddinott, and Kinsey (2006) analyzing the effect of a drought in Zimbabwe shows that it has negative effects on child's health which translate to poorer health in adulthood, lower years of education and a delay in the start of school. Hoddinott (2006) also shows that droughts have an adverse impact on household assets. Thus, the effect attributed to mother's education could be driven in part, by the circumstance of being born during a better rainfall year.

We re-estimate the first-stage regression including rainfall in the mother and father's years of birth. We find that it leaves the instrument unaltered in significance and strength for both parents (Table 5, second panel). (Rainfall itself was not significant.) Table 6 shows the results of re-estimating equation (3) by TSLS for the shorter span (parents are aged 10 to 20 in 1980) and including rainfall at the time of birth. Despite its insignificance in the first stage, the inclusion of rainfall turns out to have significant positive and negative associations with delay and the Z-score of child schooling respectively. It does not affect the estimates for transmission of parental schooling to sons but causes the effects for daughters to mostly vanish. Compared to the estimates produced in Table 4 where rainfall is absent from the regressions, the estimates in Table 6 are not different. Overall, the observed intergenerational transmission of education from mothers or fathers to sons is unaffected by cohort effects.

Afrobarometer

Young men and women in 1980 were not only exposed to the change in educational policies in 1980 but also to a new political and social environment. Independence brought about the abolition of apartheid-type laws and raised the political power of black Zimbabweans. Exposure to the new environment could have differentiated effects on pre-teenagers (those 14 and younger) than their older counterparts[11]. Thus, young pupils in 1980 could have

[11]Marx, Ko, and Friedman (2009) show that the White-Black disparity in a verbal exam found during the summer of 2008 vanishes for those taking the exam right after President Obama's nomination acceptance

been exposed to a "combined treatment": more schooling but also a different (and possibly higher) sense of citizenship.

Ideally, one would like to test if the sense of citizenship exhibits a discontinuity similar to the one observed for years of schooling. In that scenario, our estimates could be capturing this combined treatment and possibly biasing our results upwards. The Population Census does not collect information that could help us test for this case. However, in the past ten years, a new set of nationally representative surveys gathering information about individual's views and values about democracy and other citizenship-related questions have been implemented in several African countries: the Afrobarometer. Zimbabwe has participated in all four rounds (surveys were conducted in 1999, 2003, 2005 and 2009). This version of the paper uses data from the 1999 survey.

The Afrobarometer is a non-partisan and independent project conducted in different African nations, where it seeks to gauge the social, economic and political atmosphere of the countries[12]. The project has conducted four rounds of surveys so far, beginning in 1999. Zimbabwe was surveyed all four times but we are currently using only the first survey. The 1999 Zimbabwean survey was conducted just months before political turmoil mounted over the national parliamentary elections of 2000. The survey was administered to a nationally representative sample of 1200 individuals from the universe of over-18 and eligible-to-vote adults. The survey gathered data on the popular understandings of and attitudes toward democracy, economic life, the quality of governance, engagement in civil society, and citizenship. We extracted information on the political values, community participation and questions of identity of Zimbabwean men and women aged 6 to 22 in 1980.

Figures 9 and 10 each illustrate how indicators of citizenship and political involvement in 1999 vary respectively by the woman and man's age in 1980. The five (binary) indicators are: (a) strongly agreeing with the statement "Proud to be Zimbabwean;" (b) would never

speech and just after his election victory.

[12]The Afrobarometer Network is led jointly by the Institute for Democracy in South Africa (IDASA), the Centre for Democracy and Development in Ghana (CDD-Ghana), and Michigan State University (MSU).

attend a demonstration or a protest march; (c) voting in the 1996 elections; (d) being close to any political party and (e) being close to the ruling party (ZANU-PF) conditional on being close to some party. The graphs show small-to-no discontinuities at the cut-off age in 1980. None of the variables really exhibit a clear trend by age. Tables 7 and 8 confirm these findings. Regressing each indicator against the cutoff point at the 1980-age of 14 for women and 15 for men together with a piece-wise linear function for age reveals no discontinuities at the cutoff. The F-statistics also show that the instrument has no power with regard to these covariates of parental schooling. Thus, it is unlikely that our findings on the intergenerational transmission of schooling outcomes could be driven by other factors related to views and values of the younger cohort.

District Fixed Effects

As a final check, we employ district fixed effects to examine if the causal effects of parental schooling continue to hold up. Within our Census sample, there are 137 districts in Zimbabwe, classified into urban, rural and town councils. We employ a fixed effect for each of these districts. In Table 9, the results of including these fixed effects are shown for mothers in the first three panels and for fathers in the next three. In the panels with mothers and all children, the effect is positive and slightly significant. The coefficient in the regression of child schooling Z-score is estimated as 0.03. There is no transmission of maternal schooling to sons after controlling for across-district trends while daughters still exhibit some residual effect. By contrast, the transmission of father's schooling is strong and positive, as seen in all three bottom panels, with the point estimates dropping slightly compared to Table 3 or Table 4.

8.1 Mechanisms

Quantity and quality of education

So far we have only considered the effect of the quantity of education. However, if the quality of education also increased after 1980 then the observed effect is a combination of both on the child's (quantity of) education. Most studies tend to suggest a decline in quality after independence[13].

Nhundu (1992) documents a decline in quality after 1984. First, citing documents from the Ministry of Education, the school enrollment during the 1980s occurred "faster than classrooms and teacher's houses could be built" (p. 87). As mentioned above, a significant number of secondary schools were built as extensions for existing primary schools. Also, several schools adopted "hot seating" (double- or multiple-shift schooling) practices. That is, the school day was divided into morning and afternoon sessions allowing schools to incorporate more students with the same infrastructure. This practice could lower the quality of teaching as the length of the school day is reduced to accommodate a larger number of students (p. 88.)

Dorsey (1989) and Nhundu (1992) show that after independence the growth in enrollment was not matched by the growth of teachers. Not only there were higher student-teacher ratios but the proportion of qualified teachers also declined. In 1980 36.1% of teachers were untrained with more than 98% of them teaching at primary schools. In 1984, there were 41.9% of untrained teachers with 83.2% of them working at primary schools. By 1988 40.5% were untrained and now 27.8% of them were teaching at secondary schools.

A more direct measurement of the lower quality is student performance. As documented by Nhundu (1992) and Mackenzie (1988), the reform guaranteed to all students who enter Grade 1 in Zimbabwe 11 years of education. Thus, the 'O' Level examination at the end of Form IV (the 11th year of schooling) serves as a viable measure of quality. In order to

[13]Edwards (1995) concludes that by 1984 the educational system had not witnessed a deterioration in the quality of education - at least in primary education. However, that seems to be the last year with "good" quality outcomes.

pass this exam students needed to pass five or more "O"-level courses or subjects (English language included). In 1981 (where exam takers started secondary school before independence) the passing rate was 70.8% and 2.0% of the failing group did not even pass a single course. In 1984, when the first post-independence cohort took the test, only 22.2% passed all five subjects. For those who failed, 38.1% failed in all subjects. In 1988, the last year analyzed by Nhundu (1992), only 10.2% passed the ''O'-level exam and 42.6% of the failing group failed all subjects. Thus, while the growth of ''O'-level takers grew by 2,253% between 1981 and 1988, the failure rate increased by 7,220% (p. 88) during the same period. All this evidence suggest a sharp decline in the quality of education. Thus, our findings that education of mother's is transmitted to the next generation occurs *despite* the lower quality of education received by younger women.

Pathways for the transmission of parental schooling

What are the mechanisms behind the intergenerational transmission of education from mothers to children? Possible avenues explored in the literature include female employment, fertility decisions and the marriage market. Women with more education could increase their labor force participation and their hours of work as their opportunity cost increases with higher wages. There is plenty of evidence from time series and cross-sectional data supporting these mechanisms. However, most of the evidence is based on correlations. The Population Census used in this paper contains information about women's employment at the time of the census as well as their marital status including the schooling years of their partners. The age-at-first-birth and the number of children ever born to women is also available. Thus, it is possible to use our discontinuity approach to test for the causal effect of women's education on these three main outcomes to shed some light about the possible mechanisms for the mother-to-child transmission of education.

Table 10 reports two-stage least-squares regressions results for a pair of fertility outcomes, the age-at-first-birth and the total number of children ever-born to the mother. Column (1)

shows that an additional year of mother's schooling increases the age-at-first-birth by 0.35 years, a coefficient significant at the 1% level (the mean age at which mothers in the sample gave their first birth was 19.5). The estimate grows to 0.4 (see column (2)) when the age-span is shortened to 10-20 years in 1980. Columns (3) and (4) of the same Table follow up with the impact of mother's education on the number of children she chooses to have. The mean number of children born to women in the sample is 4.75. In column (3), the coefficient of mother's schooling is -0.13; in column (4), it is -0.12 with the shorter age-span. The coefficient is also highly significant. It indicates that a mother who graduates from Form IV is likely to have one child fewer than a mother who only completes four grades of primary school. Lastly. more educated women are also extremely likely to marry more educated men, as shown in columns (5) and (6). Thus, assortative mating is one of the channels through which maternal education is transmitted to children in Zimbabwe.

9 Conclusions

Despite the common view that educating women is a viable mechanism for economic development, there are few studies that explore the increase in the human capital of the next generation. Most of these studies also tend to focus on developed countries. This paper uses the dramatic changes in the educational policies in Zimbabwe after its Independence in 1980. Impressive rates of school construction mainly in secondary education together with the elimination of racial barriers and school fees led to a massive increase in enrollment rates at all levels. Moreover, we show that the timing of the reforms created a discontinuity in the probability of being "treated". By eliminating the barriers to entering secondary education, the transition rate from primary to secondary education increased several times between the primary graduating class of 1980 and 1981. Thus, girls (boys) aged 14 (15) or more in 1980 had a much lower probability of entering secondary education compared to those aged 14 (15) or less in 1980.

The Census of 2002 allows us to observe the accumulated levels of education of these cohorts and of their children. We exploit the fuzzy discontinuity design to instrument for parent-to-child transmission of education. Our results show that children born to more educated mothers (or fathers) have more education after we instrument for their parent's education. These results are important in light of the current discussion about policies that can break the intergenerational transfer of poverty.

In particular, conditional cash transfer (CCT) are policies that condition the transfer of money to parents if they send their children to school. In most countries, these transfers are higher if parents send girls to school. Given the gender disparity in the parent-to-offspring transmission of schooling, a strong case can be made for CCTs in Zimbabwe. A conditional cash transfer also promises returns over more than one generation of children. To truly complete the story of intergenerational transmissions of schooling, it will be necessary to consider how other dimensions of human capital come into play as well. It will be intriguing to see, for instance, if the Behrman, Murphy, Quisumbing, and Yount (2009) finding in Guatemala on the mother's cognitive ability affecting the children's holds up in Zimbabwe too. Identifying the effect and mechanisms of mother's education on the overall human capital accumulation of children is a line of research that should be further explored.

References

Alderman, H., J. Hoddinott, and B. Kinsey (2006): "Long term consequences of early childhood malnutrition," *Oxford Economic Papers*, 58(3), 450–474.

Antonovics, K. L., and A. S. Goldberger (2005): "Does Increasing Women's Schooling Raise the Schooling of the Next Generation? Comment," *American Economic Review*, 95(5), 1738–1744.

Atkinson, N. (1972): *Teaching Rhodesians: A History of Educational Policy in Rhodesia.* Longman, London.

Behrman, J. R., A. Murphy, A. R. Quisumbing, and K. Yount (2009): "Are returns to mothers' human capital realized in the next generation?: The impact of mothers' intellectual human capital and long-run nutritional status on children's human capital in Guatemala," Discussion paper.

Behrman, J. R., and M. R. Rosenzweig (2002): "Does Increasing Women's Schooling Raise the Schooling of the Next Generation?," *American Economic Review*, 92(1), 323–334.

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

Chen, Y., and H. Li (2009): "Mother's education and child health: Is there a nurturing effect?," *Journal of Health Economics*, 28(2), 413 – 426.

Currie, J., and E. Moretti (2003): "Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings," *The Quarterly Journal of Economics*, 118(4), 1495–1532.

de Walque, D. (2009): "Parental Education and Children's Schooling Outcomes: Evidence from Recomposed Families in Rwanda," *Economic Development and Cultural Change*, 57(4), 723–746.

Dorsey, B. J. (1989): "Educational Development and Reform in Zimbabwe.," *Comparative Education Review*, 33(1), 40–58.

Duflo, E. (2001): "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment," *American Economic Review*, 91(4), 795–813.

——— (2004): "The medium run effects of educational expansion: evidence from a large school construction program in Indonesia," *Journal of Development Economics*, 74(1), 163–197.

Edwards, G. (1995): "Rapid educational expansion and primary school efficiency in Zimbabwe, 1983-9," *Development Southern Africa*, 12(1), 87–95.

Edwards, G., and C. Tisdell (1990): "Post-independence Trends in Education in Zimbabwe," *South African Journal of Economics*, 58(4), 298–307.

Ferraz, C., and F. Finan (2009): "Motivating Politicians: The Impacts of Monetary Incentives on Quality and Performance," NBER Working Papers 14906, National Bureau of Economic Research, Inc.

Glewwe, P. (2002): "Schools and Skills in Developing Countries: Education Policies and Socioeconomic Outcomes," *Journal of Economic Literature*, 40(2), 436–482.

Hahn, J., P. Todd, and W. Van der Klaauw (2001): "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design," *Econometrica*, 69(1), 201–09.

Hoddinott, J. (2006): "Shocks and their consequences across and within households in Rural Zimbabwe," *The Journal of Development Studies*, 42(2), 301–321.

Kanyongo, G. Y. (2005): "Zimbabwes Public Education System Reforms: Successes and Challenges.," *International Education Journal*, 6(1), 65–74.

Mackenzie, C. G. (1988): "Zimbabwe's educational miracle and the problems it has created," *International Review of Education*, 34(3), 337–353.

Marx, D. M., S. J. Ko, and R. A. Friedman (2009): "The "Obama Effect": How a salient role model reduces race-based performance differences," *Journal of Experimental Social Psychology*, 45(4), 953–956.

Nherera, C. M. (2000): "Globalisation, Qualifications and Livelihoods: the case of Zimbabwe.," *Assessment in Education: Principles, Policy and Practice*, 7(3), 335–362.

Nhundu, T. J. (1992): "A Decade of Educational Expansion in Zimbabwe: Causes, Consequences, and Policy Contradictions.," *Journal of Negro Education*, 61(1), 78–98.

OCallaghan, M., and R. Austin (1977): *Southern Rhodesia: The Effects of a Conquest Society on Education, Culture and Information.* Syndenhams Printers, Dorset.

Oreopoulos, P., M. E. Page, and A. H. Stevens (2003): "Does Human Capital Transfer from Parent to Child? The Intergenerational Effects of Compulsory Schooling," NBER Working Papers 10164, National Bureau of Economic Research, Inc.

Plug, E. (2004): "Estimating the Effect of Mother's Schooling on Children's Schooling Using a Sample of Adoptees," *American Economic Review*, 94(1), 358–368.

Richardson, C. J. (2007): "How much did droughts matter? Linking rainfall and GDP growth in Zimbabwe," *African Affairs (London)*, 106(424), 463–478.

Riddell, A. R., and L. M. Nyagura (1991): "What causes differences in achievement in Zimbabwe's secondary schools?," Policy Research Working Paper Series 705, The World Bank.

Riddell, R. (1980): *Education for employment*. Mambo Press, Gweru, Zimbabwe.

Sacerdote, B. (2002): "The Nature and Nurture of Economic Outcomes," *American Economic Review*, 92(2), 344–348.

Schultz, T. P. (2004): "Evidence of Returns to Schooling in Africa from Household Surveys: Monitoring and Restructuring the Market for Education," *Journal of African Economies*, 13(02), ii95–ii14.

van der Klaauw, W. (2002): "Estimating the Effect of Financial Aid Offers on College Enrollment: A Regression-Discontinuity Approach," *International Economic Review*, 43(4), 1249–1287.

Zvobgo, C. J. M. (1981): "African Education in Zimbabwe: The Colonial Inheritance of the New State, 1899-1979," *Issue: A Journal of Opinion*, 11(3/4), 13–16.

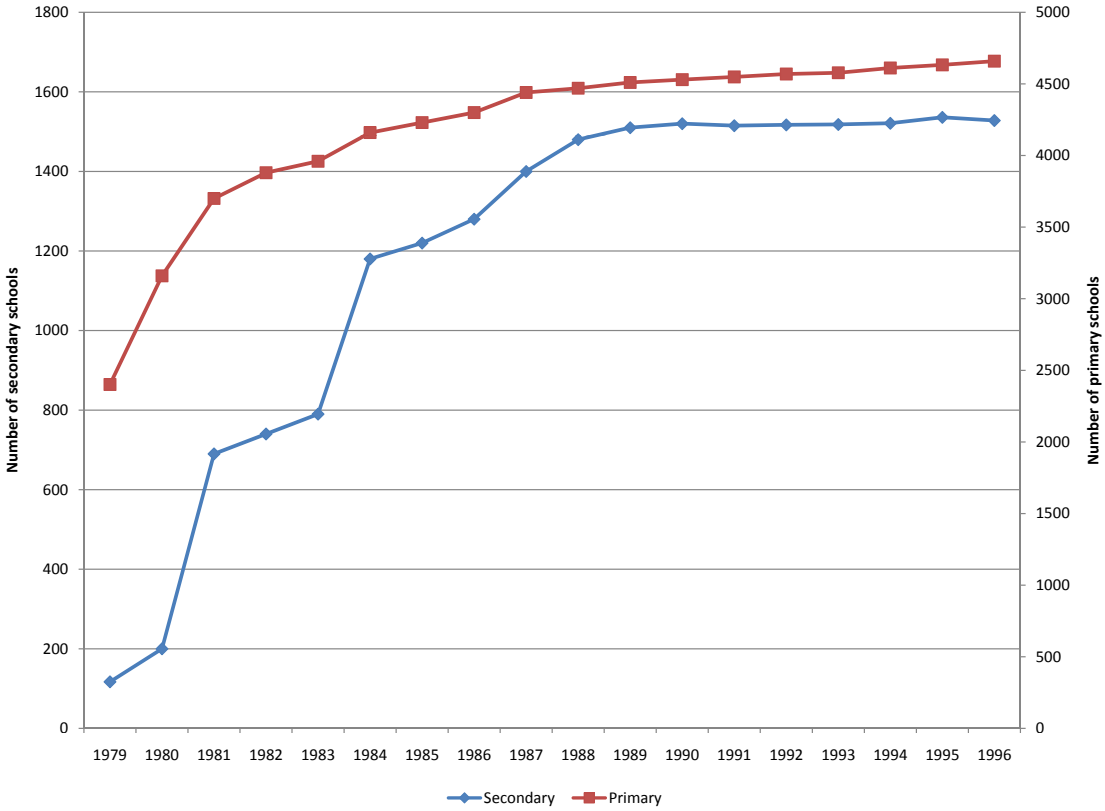


Figure 1: Trends in School Construction by Level, 1979-1996

Source: Zimbabwe Ministry of Education, Culture and Sports. *Annual Education Report.*

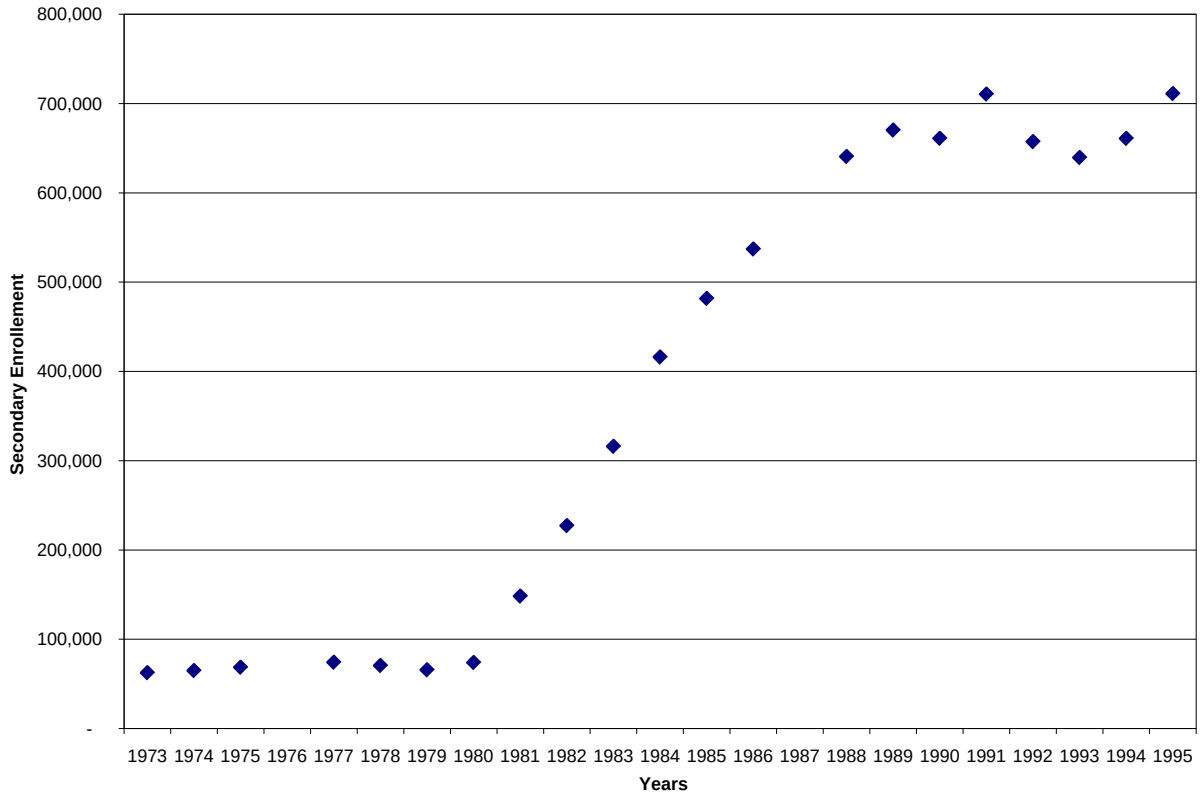


Figure 2: Secondary School Enrollments in Zimbabwe: 1973-1995

Source: United Nations, *Statistical Yearbook*, 1975, 1980, 1982, 1984, 1985-1989, 1992, 1994, 1995, and 1997.

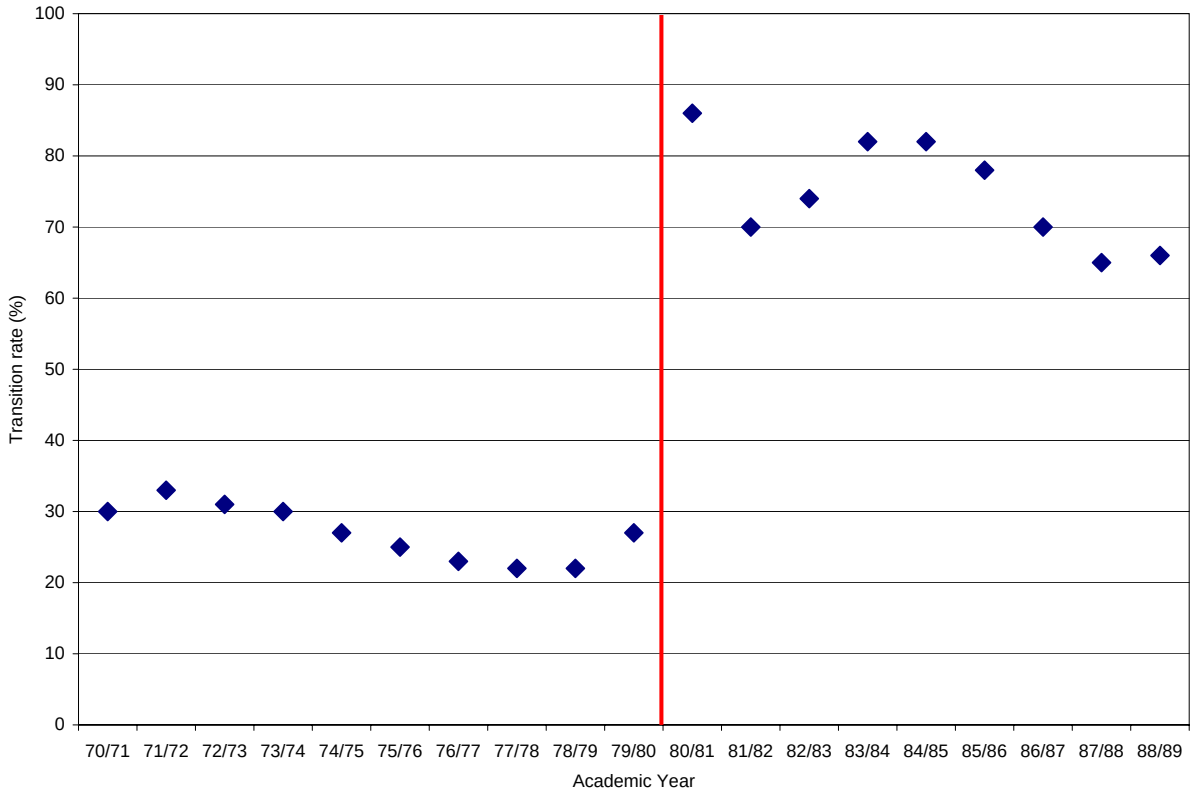
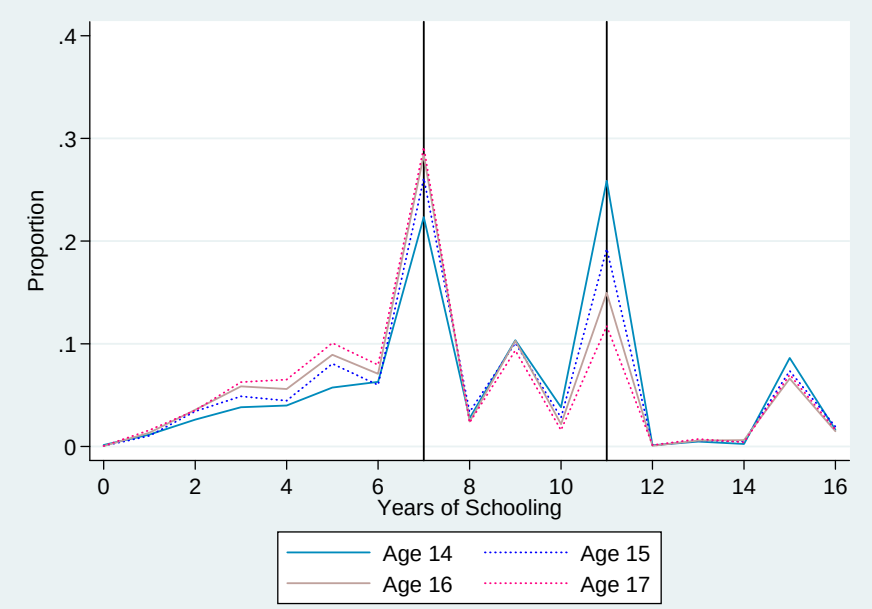
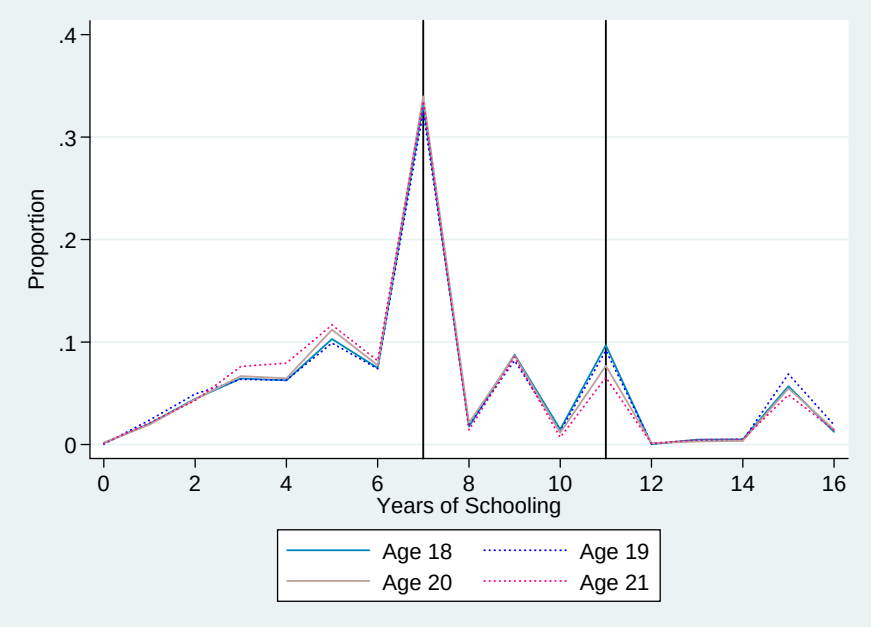


Figure 3: Grade 7 to Form 1 Transition Rates: 1970/71-1988/89

Source: Riddell and Nyagura (1991) Table 1.1. Note: Grade 7 is the last year of primary education and Form I is the first year of secondary education.



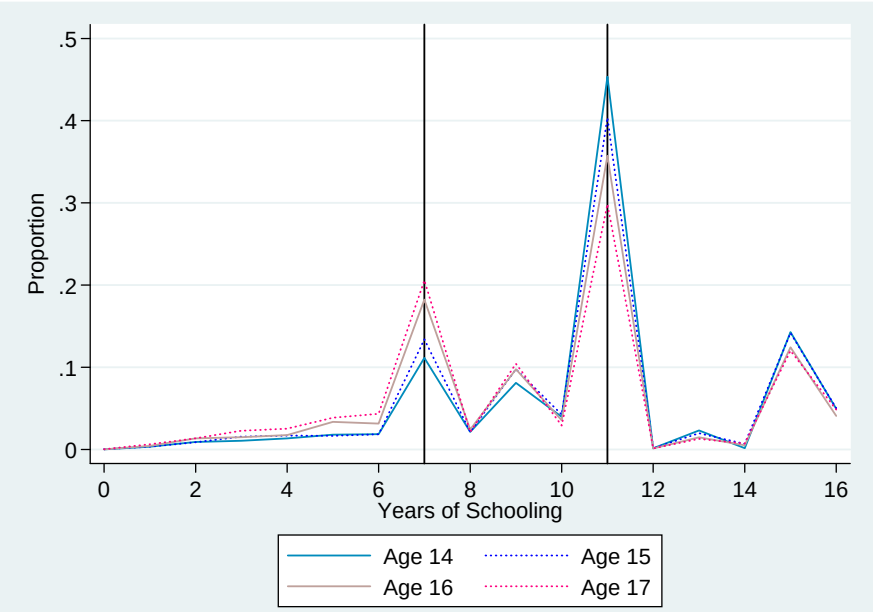
(a) Ages 14 to 17 in 1980



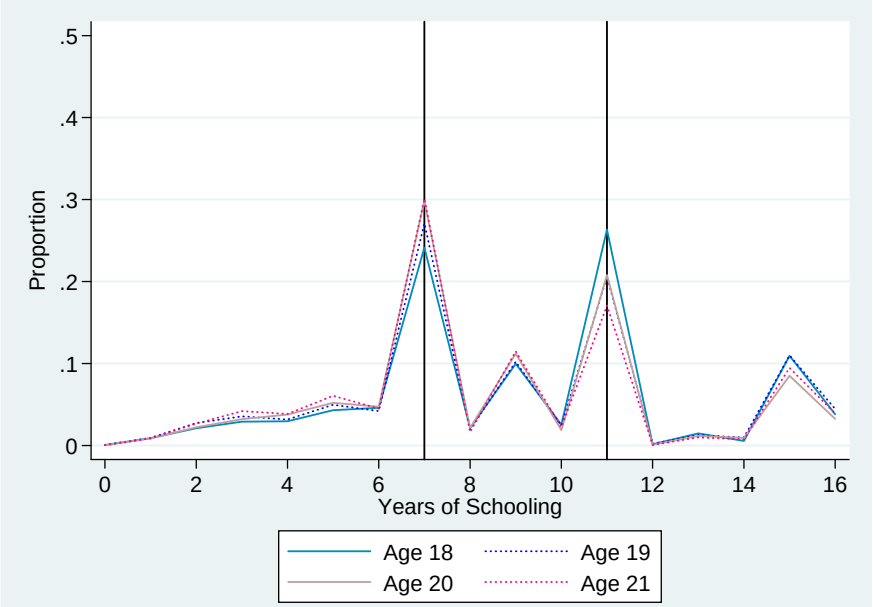
(b) Ages 18 to 21 in 1980

Figure 4: Impact of the Treatment Discontinuity on Mother's Schooling

Notes: Each graph plots the proportions of women completing different amounts between one and sixteen years of schooling. Notice how the proportion of women with eleven years of schooling (up to Form IV) spikes higher for the younger ages in the top graph but shows very little variation between adjacent age-years in the bottom graph.



(a) Ages 14 to 17 in 1980



(b) Ages 18 to 21 in 1980

Figure 5: Impact of the Treatment Discontinuity on Father's Schooling

Notes: The graphs display the proportion of males completing different levels of schooling by age in 1980. The top graph illustrates the distributions for the ages of 14 through 17 while the bottom compares ages 18 through 21.

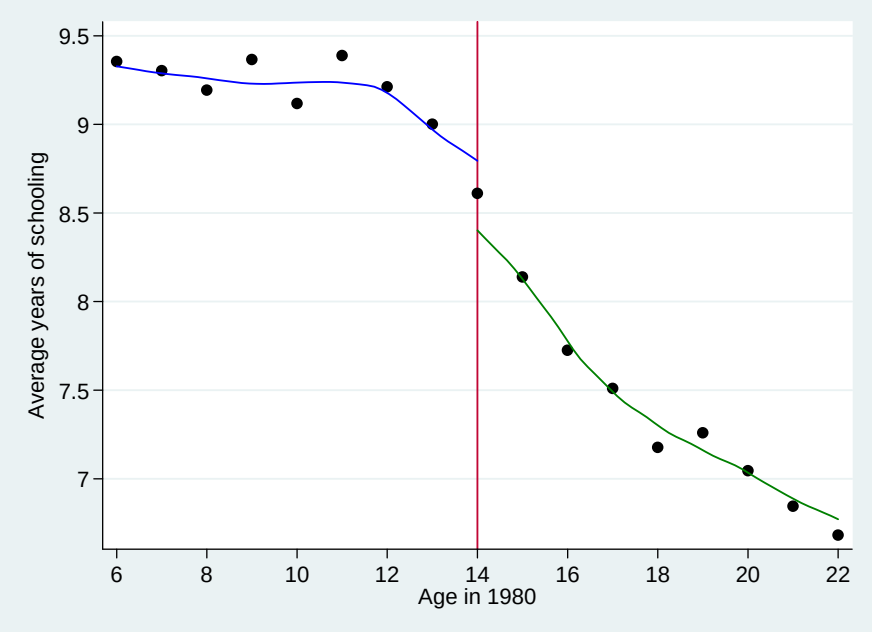


Figure 6: Mother's Years of Schooling by Age in 1980

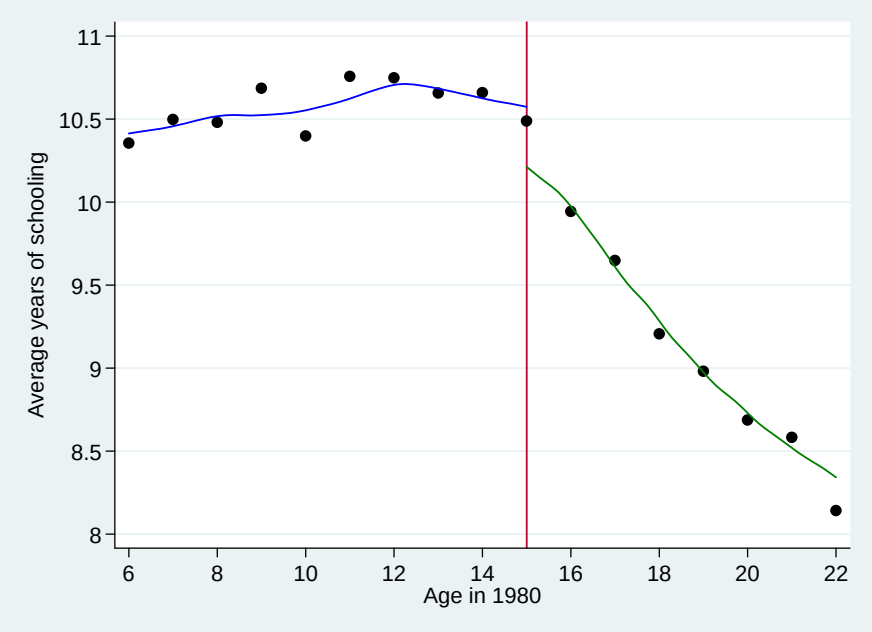


Figure 7: Father's Years of Schooling by Age in 1980

Note: In each graph, circles show the sample mean years of schooling for women/men who were between 6 and 22 years of age in 1980 with children aged 6 through 15 in Census 2002. The vertical line represents the cut-off for treatment, on either side of which appear a pair of nonparametric regressions.

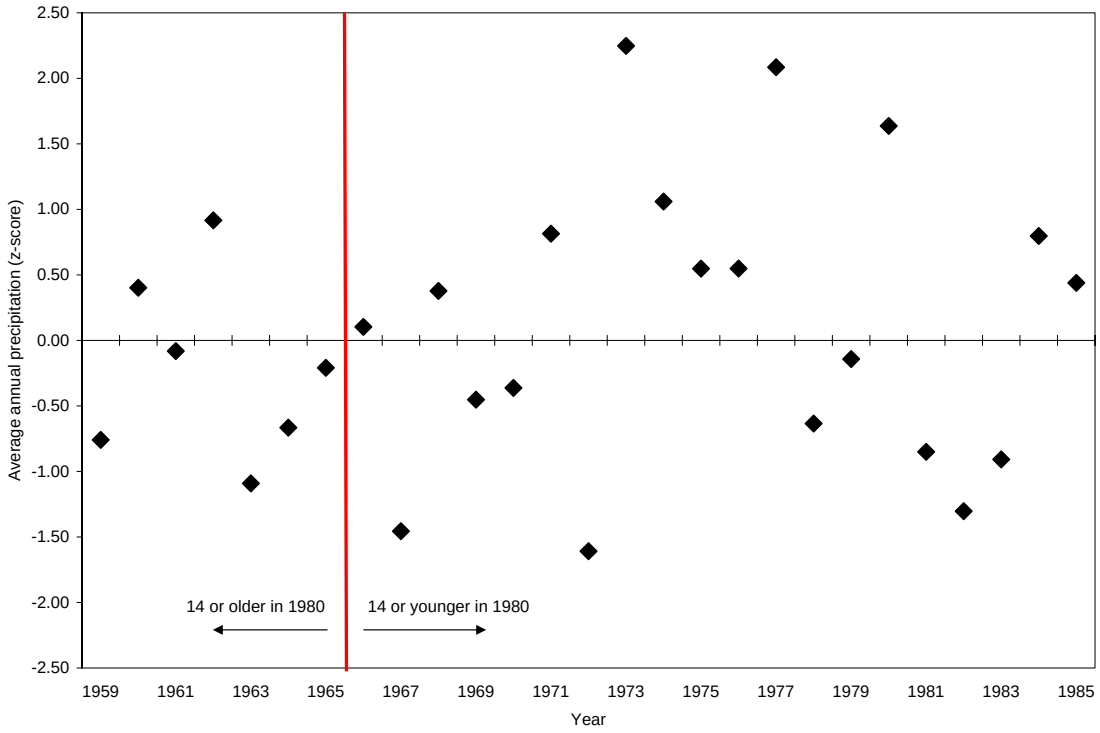
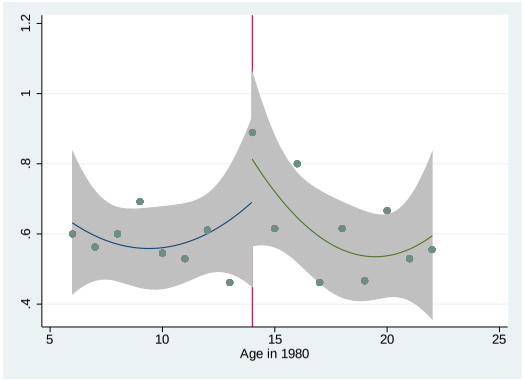
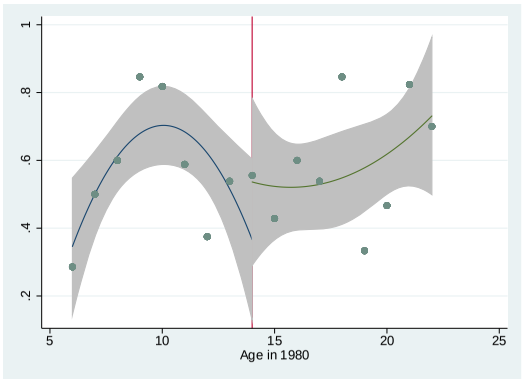


Figure 8: Annual rainfall: 1959-1985

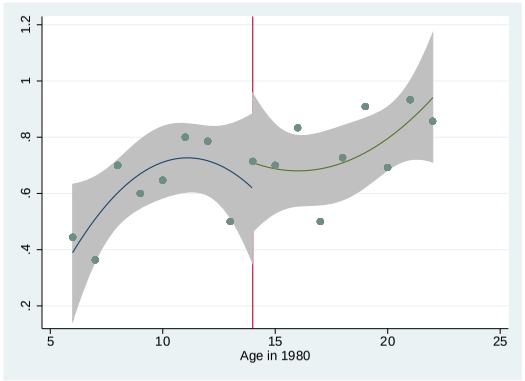
Source: Zimbabwe Meteorological Service Department. Note: Annual rainfall comes from a sample of 38 rainfall stations across the country; data was provided by Craig Richardson. A given year, such as 1970, refers to the 1970-1971 crop-year. It is measured as deviations from the mean relative to the standard deviation. Both moments were obtained from the 1959-2001 series.



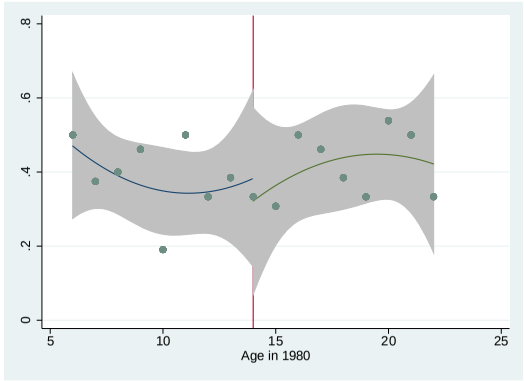
(a) Proud of being Zimbabwean



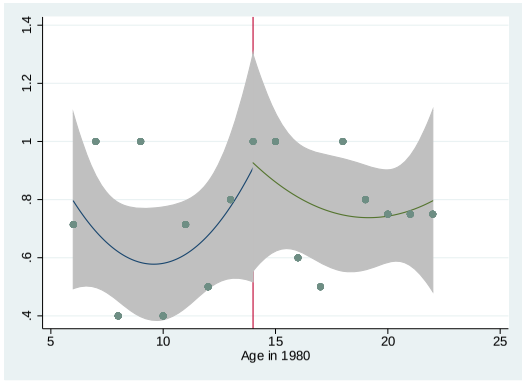
(b) Would never attend a demonstration



(c) Voted in last elections



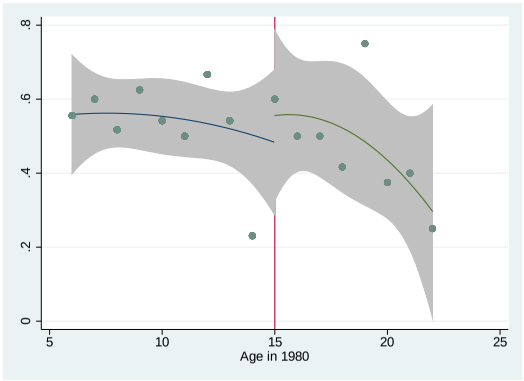
(d) Close to a political party



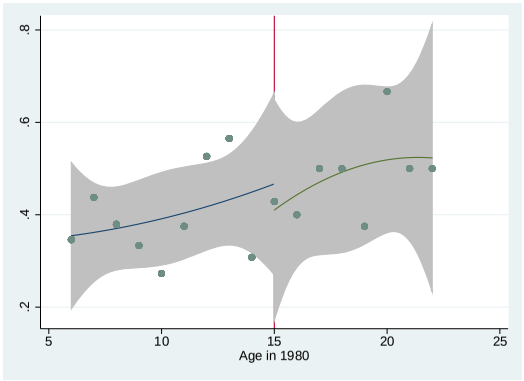
(e) Close to ZANU-PF

Figure 9: Values and political affiliations by age in 1980

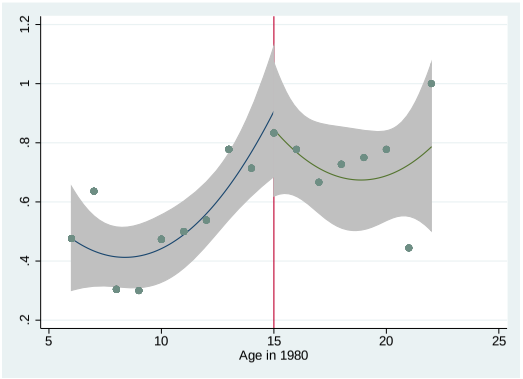
Source: 1999 Zimbabwean Afrobarometer. Note: In each figure the circles show the average values for women by their age in 1980 along with a quadratic regression from each side of the cutoff and the 95% confidence intervals. The cutoff point is represented by the vertical line. All variables are binary and figure (a) refers to who strongly agree with the statement "Proud to be Zimbabwean."



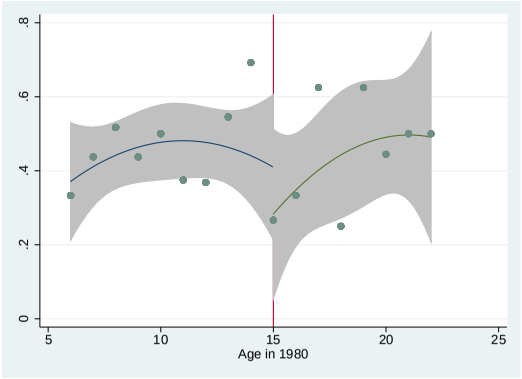
(a) Proud of being Zimbabwean



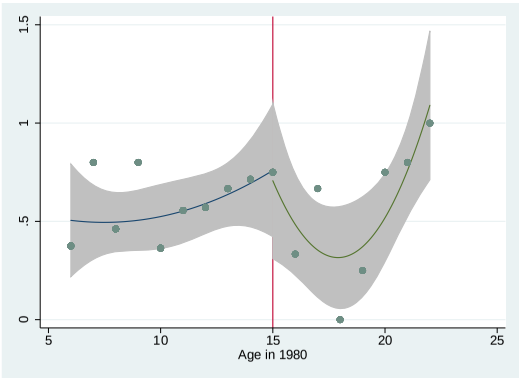
(b) Would never attend a demonstration



(c) Voted in last elections



(d) Close to a political party



(e) Close to ZANU-PF

Figure 10: Values and political affiliations by age in 1980

Source: 1999 Zimbabwean Afrobarometer. Note: In each figure the circles show the average values for men by their age in 1980 along with a quadratic regression from each side of the cutoff and the 95% confidence intervals. The cutoff point is represented by the vertical line. All variables are binary and figure (a) refers to who strongly agree with the statement "Proud to be Zimbabwean."

Table 1: **Summary Statistics of Children, Mothers and Fathers in the Sample**

Variable	Units	Mean	SD	Min	Max	Observations
			Children's Sample			
Girl	Binary	0.493	0.500	0.000	1.000	189263
Age	Years	10.383	2.853	6.000	15.000	189263
Ever attended school	Binary	0.947	0.224	0.000	1.000	189263
In school†	Binary	0.959	0.199	0.000	1.000	179229
Delayed Enrollment	Binary	0.676	0.468	0.000	1.000	165550
			Mother's Sample			
Age	Years	35.417	4.668	28.000	44.000	103995
Schooling	Years	7.945	3.195	0.000	16.000	103995
Age at first birth	Years	19.511	3.166	12.000	39.000	103025
Fertility‡	Number of children	4.751	2.167	0.000	15.000	103995
Child's Schooling	Z-score	0.111	0.920	-4.775	5.959	99523
			Father's Sample			
Age	Years	37.128	4.426	28.000	44.000	60316
Schooling	Years	9.468	3.333	0.000	16.000	60316
Child's Schooling	Z-score	0.083	0.939	-4.775	5.959	56759

Notes: The sample in the topmost panel is composed of children from 6 to 15 years of age, with at least one parent born before the reform and alive in Census 2002. The mothers and fathers in the samples are aged between 6 and 22 years in 1980.
† Conditional on attending school in the past.
‡ Fertility stands for the total number of children, both surviving and dead, born to a mother as of Census 2002.

Table 2: **Years of Schooling by Age and Sex of Children**

	Boys			*Girls*				
Age	Mean	SD	Observations	Mean	SD	Observations	Min.	Max.
6	0.103	0.304	6700	0.129	0.335	6861	0.0	1.0
7	0.508	0.594	9117	0.577	0.613	9079	0.0	2.0
8	1.178	0.781	9572	1.295	0.798	9386	0.0	3.0
9	2.039	0.965	9033	2.179	0.965	8859	0.0	4.0
10	2.908	1.058	9696	3.079	1.051	9782	0.0	5.0
11	3.849	1.104	8926	4.027	1.082	8800	0.0	6.0
12	4.659	1.198	10233	4.884	1.164	9901	0.0	7.0
13	5.583	1.226	9177	5.803	1.208	8834	0.0	8.0
14	6.455	1.320	9005	6.643	1.354	8646	0.0	9.0
15	7.197	1.523	8825	7.499	1.503	8064	0.0	10.0
Total	3.523	2.560	90284	3.635	2.606	88212	0.0	10.0

Table 3: **Intergenerational Transmission of Schooling**

Dependent Variables:	Child's Schooling							
	Years		Delay		In school		Ever Attended	
	OLS	TSLS	OLS	TSLS	OLS	TSLS	OLS	TSLS
Mother-All	0.09	0.04	-0.111	-0.045	0.005	-0.001	0.006	0.004
	[0.001]***	[0.015]***	[0.001]***	[0.019]**	[0.000]***	[0.003]	[0.000]***	[0.003]
Observations	99523	99523	91875	91875	99637	99637	103995	103995
F-test		313.39		282.95		313.89		311.84
Father-All	0.089	0.121	-0.11	-0.13	0.004	0.006	0.008	0.03
	[0.001]***	[0.025]***	[0.001]***	[0.030]***	[0.000]***	[0.004]	[0.000]***	[0.006]***
Observations	56759	56759	50404	50404	56838	56838	60316	60316
F-test		117.17		110.58		115.61		128.86

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. The full sample is composed of children aged 6 to 15 years in 2002 with either one or both parents aged 6 to 22 years in 1980 and alive in 2002. All regressions control for the child's age and use a linear spline in the parent's age in 1980. The instrument in the TSLS regressions is the point of discontinuity in treatment-probability, which occurs at age fourteen for mothers and fifteen for fathers. The reported F-statistics refer to these excluded instruments.

Table 4: **Transmission of Parental Schooling by Child's Sex**

	Child's Schooling							
Dependent	Full Sample				Shorter Age-span			
Variables:	Years	Delay	In school	Ever Attended	Years	Delay	In school	Ever Attended
Mothers-Sons	0.037	-0.03	0.003	0.004	0.079	-0.086	0.002	0.005
	[0.022]*	[0.028]	[0.004]	[0.005]	[0.037]**	[0.044]*	[0.007]	[0.008]
N	49699	45966	49754	52000	33898	31727	33937	35272
F-test	153.52	141.62	152.91	150.91	49.56	50.99	49.14	47.02
Mothers-Daughters	0.045	-0.063	-0.005	0.005	0.028	-0.056	-0.001	0
	[0.021]**	[0.027]**	[0.004]	[0.004]	[0.036]	[0.045]	[0.007]	[0.007]
N	49824	45909	49883	51995	33855	31602	33895	35156
F-test	160.05	141.52	161.16	161.10	56.42	48.72	56.76	55.09
Fathers-Sons	0.145	-0.171	0.011	0.03	0.175	-0.207	0.011	0.012
	[0.035]***	[0.044]***	[0.006]**	[0.009]***	[0.051]***	[0.062]***	[0.008]	[0.012]
N	28692	25489	28730	30591	21623	19407	21655	22912
F-test	60.79	52.83	60.08	64.23	30.93	27.45	30.74	29.14
Fathers-Daughters	0.09	-0.086	0.00	0.03	0.083	-0.082	0.003	0.011
	[0.036]**	[0.041]**	[0.006]	[0.008]***	[0.050]*	[0.059]	[0.009]	[0.011]
N	28067	24915	28108	29725	21286	19052	21323	22428
F-test	56.55	57.6	55.69	64.75	28.27	27.4	27.63	30.74

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. Children in all regressions are between 6 and 15 years of age. The full sample contains parents aged 6 to 22 years in 1980 while the columns headed "shorter age-span" include parents aged from 10 to 20 in 1980. All regressions use a linear spline in the parent's age and control for the child's age. The reported F-statistics refer to the point of discontinuity in treatment probability with respect to parent's age.

Table 5: **First-Stage**

	Parent's Schooling			
Dependent	Full Sample		Shorter Age-span	
Variables:	Mothers	Fathers	Mothers	Fathers
All children	0.75	0.613	0.543	0.524
	[0.043]***	[0.055]***	[0.052]***	[0.066]***
Observations	99189	56559	67526	42762
F test	304.31	123.79	108.04	62.24
All, including rainfall	0.721	0.662	0.539	0.549
	[0.045]***	[0.059]***	[0.053]***	[0.069]***
Observations	95424	52721	67526	42762
F test	252.51	129.36	101.83	63.72
Sons†	0.737	0.609	0.520	0.497
	[0.061]***	[0.075]***	[0.074]***	[0.091]***
Observations	49550	30591	33805	22912
F test	146.98	65.63	49.88	29.67
Daughters†	0.763	0.627	0.567	0.515
	[0.061]***	[0.077]***	[0.074]***	[0.092]***
Observations	49639	29725	33721	22428
F test	157.41	66.94	58.41	31.36

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. All first-stage results are reported for the sample of children with non-missing values for years of schooling. The full sample contains parents aged 6 to 22 years in 1980 while the shorter age-span is a restricted sample of parents aged 10 to 20 years in 1980. Each coefficient is a different estimate of δ in equation (4). The F-statistics come from the test of the null, δ=0. Rainfall is expressed in number of standard deviations from the mean for the period, 1959-2001.
† Including rainfall as a control in these regressions left the point estimates unimpaired in significance and changed by no more than 0.05.

Table 6: **Robustness Checks: Rainfall**

Dependent Variables:	Child's Schooling Outcomes			
	Years	Delay	In school	Ever Attended
Mothers-All	0.065	-0.086	0.001	0.002
	[0.026]**	[0.032]***	[0.005]	[0.005]
Observations	67753	63329	67832	70428
F-test	99.94	95.34	99.85	96.47
Mothers-Sons	0.091	-0.100	0.002	0.005
	[0.037]**	[0.044]**	[0.007]	[0.008]
Observations	33898	31727	33937	35272
F-test	50.19	52.02	49.75	47.87
Mothers-Daughters	0.042	-0.076	0.000	-0.001
	[0.037]	[0.047]	[0.007]	[0.008]
Observations	33855	31602	33895	35156
F-test	49.91	43.68	50.25	48.73
Fathers-All	0.144	-0.162	0.009	0.012
	[0.035]***	[0.042]***	[0.006]	[0.008]
Observations	42909	38459	42978	45340
F-test	60.72	56.38	59.85	61.02
Fathers-Sons	0.177	-0.207	0.011	0.011
	[0.050]***	[0.061]***	[0.007]	[0.011]
Observations	21623	19407	21655	22912
F-test	32.31	28.70	32.06	30.38
Fathers-Daughters	0.085	-0.089	0.006	0.012
	[0.051]*	[0.059]	[0.009]	[0.011]
Observations	21286	19052	21323	22428
F-test	27.95	27.06	27.35	30.10

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. The estimate reported in each cell is the coefficient of the parent's schooling. Each estimate comes from a different regression. All regressions control for rainfall, measured in number of standard deviations from the mean over the period, 1959-2001. Samples contain parents aged 10 to 20 years in 1980 and children aged 6 through 15 years in 2002.

Table 7: **Robustness Checks: Women's Citizenship and Political Involvement**

Dependent Variables:	Proud to be Zimbabwean	Voted in 1996 Elections	Would Never join a Protest march	Close to a political Party	
				Any	ZANU-PF
	(1)	(2)	(3)	(4)	(5)
$1\{x \leq 14\}$	-0.025	0.165	0.165	-0.052	-0.081
	[0.140]	[0.147]	[0.138]	[0.139]	[0.213]
x	-0.014	0.036	0.03	0.01	-0.004
	[0.022]	[0.023]	[0.021]	[0.022]	[0.032]
$(14-x)*1\{x \leq 14\}$	-0.019	0.005	0.022	0.023	-0.01
	[0.028]	[0.029]	[0.028]	[0.028]	[0.041]
Observations	253	198	252	251	96
F test	0.03	1.27	1.43	0.14	0.15
Prob > F	0.86	0.26	0.23	0.71	0.7

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. The running variable x refers to the mother's age in 1980. In column (1), the dependent variable takes the value 1, for those who strongly agree with the statement "Proud to be Zimbabwean". The sample is composed of women aged between 6 and 22 in 1980 obtained from the 1999 Round of the Zimbabwe Afrobarometer Survey.

Table 8: **Robustness Checks Again: Men's Citizenship and Political Involvement**

Dependent Variables:	Proud to be Zimbabwean	Voted in 1996 Elections	Would Never join a Protest march	Close to a political Party	
				Any	ZANU-PF†
	(1)	(2)	(3)	(4)	(5)
$1\{x \leq 15\}$	-0.077	0.014	0.033	0.1	0.182
	[0.155]	[0.164]	[0.153]	[0.158]	[0.455]
x	-0.033	-0.002	0.018	0.02	-1.373
	[0.031]	[0.033]	[0.031]	[0.032]	[1.074]
$(15-x)*1\{x \leq 15\}$	-0.025	-0.044	0.005	0.014	-0.273
	[0.034]	[0.036]	[0.033]	[0.034]	[0.247]
Observations	269	204	266	267	104
F test	0.25	0.01	0.05	0.4	0.16
Prob > F	0.62	0.93	0.83	0.53	0.69

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. The running variable x refers to the father's age in 1980. In column (1), the dependent variable takes the value 1, for those who strongly agree with the statement "Proud to be Zimbabwean". The sample is composed of men aged between 6 and 22 in 1980 obtained from the 1999 Round of the Zimbabwe Afrobarometer Survey.

† A quadratic spline in father's age was judged to be more appropriate in the regression of this covariate, based on Figure 10e.

Table 9: **Robustness Checks using Birth-District Fixed Effects**

Dependent	Child's Schooling Outcomes			
Variables:	Years	Delay	In school	Ever Attended
Mothers-All	0.03	-0.032	-0.001	0.003
	[0.016]*	[0.020]	[0.003]	[0.003]
N	98178	90611	98288	102584
Mothers-Sons	0.025	-0.014	0.002	0.003
	[0.022]	[0.028]	[0.004]	[0.005]
N	49018	45326	49071	51286
Mothers-Daughters	0.037	-0.051	-0.005	0.002
	[0.022]*	[0.028]*	[0.004]	[0.004]
N	49160	45285	49217	51298
Fathers-All	0.117	-0.126	0.005	0.031
	[0.025]***	[0.030]***	[0.004]	[0.006]***
N	55484	49252	55556	58946
Fathers-Sons	0.128	-0.148	0.01	0.031
	[0.034]***	[0.041]***	[0.005]*	[0.008]***
N	28050	24912	28085	29905
Fathers-Daughters	0.092	-0.092	-0.001	0.03
	[0.038]**	[0.043]**	[0.007]	[0.009]***
N	27434	24340	27471	29041

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%; ** at 5% and *** at 1%. The estimate reported in each cell is the coefficient of the parent's schooling from a TSLS regression with fixed effects for the parent's district of birth. Samples contain parents aged 6 to 22 years in 1980 and children aged 6 through 15 years in 2002.

Table 10: **Mechanisms for Transmission of Mother's Schooling**

Dependent	Age at First Birth		Number of Children		Husband's Schooling	
Variables:	(1)	(2)	(3)	(4)	(5)	(6)
Mother's Schooling	0.354	0.395	-0.133	-0.118	0.567	0.397
	[0.054]***	[0.093]***	[0.033]***	[0.057]**	[0.071]***	[0.174]**
Shorter Age-span	N	Y	N	Y	N	Y
Observations	103025	69797	103995	70428	42920	21044
Mean of Dependent Variable	19.51	19.51	4.75	4.75	9.65	9.65

Notes: Robust standard errors in brackets. * indicates statistical significance at 10%, ** at 5% and *** at 1%. The full sample contains mothers aged between 6 and 22 years in 1980 and the shorter age-span refers to only those mothers aged 10 to 20 years in 1980.