Human Capital, Internal Migration and Structural Transformation in Africa

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Abstract

Economic development requires the transformation of the spatial organization of a country. However, in Sub-Saharan Africa, despite recent progress, most of the population still resides in rural areas and works in agriculture. Thus, the structural transformation required for economic development remains elusive. My paper shows that education helps achieve such a transformation by inducing geographical mobility. To estimate the causal effects of education, I exploit a fuzzy regression discontinuity design created by a school reform in Zimbabwe that affected 14 year olds vis-à-vis 15 years olds in 1980. I show that one additional year of schooling, as induced by the reform, is associated with a 7.6% increase in the probability of migration and with a 8.2% increase of migration towards the largest cities. The effects are even bigger for those born in rural areas (14.2%). Several robustness checks validate these findings, including placebo tests for populations not affected by the reforms: white Zimbabwean and natives in seven other African countries. Importantly, we observe effects for males and females, but are much smaller for the latter. Finally, I identify access to new labor market opportunities and reductions in fertility as important mechanisms.

Keywords: Structural transformation, internal migration, education, labor markets, Zimbabwe.

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1. Introduction

Economic development is often described as a process that involves the reallocation of the factors of production from a traditional sector characterized by low productivity, decreasing returns and mostly agrarian to a modern sector with high productivity, increasing returns and mostly industrial. A fundamental part of this structural transformation implies a *spatial* reallocation: the migration of a large number of individuals from rural to urban areas and to bigger cities (Bardhan and Udry, 1999). In this paper, I explore the role of human capital investments on facilitating geographical mobility in the context of Sub-Saharan Africa, a region whose structural transformation remains elusive (Barrett et al, 2017) and where the majority of the population lives in rural areas and is attached to agriculture (Dercon and Gollin, 20114).

It is precisely this feature --poorer countries having a vast share of workers are in agriculture where labor productivity is low-- that has motivated a literature arguing that removing barriers to reallocate labor towards non-agriculture sectors would lead to an increase in aggregate output (e.g., Caselli, 2005 and Restuccia et al., 2008). This is reinforced by the growing number of studies documenting geographic or spatial poverty traps where the characteristics of an area create self-reinforcing mechanisms leading to poverty persistence even within a country (e.g., Jalan and Ravallion, 2002; and Beegle, DeWeerdt, and Dercon, 2011; Kraay and McKenzie, 2014).[2]

From a theoretical point of view there are several reasons why education could

[2] These traps may have been created, for example, by Colonial institutions as in the case of the Mita system in Peru and Bolivia (Dell, 2010). They can also reflect other institutional restrictions such as the *hukou* system of China or the caste system of India. Also, recent work has shown that the possibility of spatial traps is not limited to developing countries (e.g., Chetty et al, 2016, Chetty et al, 2014 for the U.S.). See Kraay and McKenzie (2014) for a recent review.

increase internal migration and facilitate escaping a geographic poverty trap. Migration can be modeled as the outcome of an optimal search process where individuals know their wage in their current location but in order to learn about their specific wages in another area, they need to move, at some cost (Sjastaad, 1962; Kennan and Walker, 2011). In such a model, education facilitates information gathering about the wage distribution in the targeted areas, reducing the uncertainty about expected gains from moving (e.g., Rosenzweig, 1995). Education could additionally ease the payment of the migration cost by reducing liquidity constraints through its income or wealth effect and therefore affecting the type of migration (Kleemans, 2014) or reduce the cost of losing your local network (Munshi and Rosenzweig, 2016). It could also make workers more attractive for a nation-wide labor market rather than just the local market (Machin et al, 2013). Finally, education could provide an alternative to short-term migration strategies (e.g., Bryan et al, 2014) by inducing long-term mobility. Therefore, schooling could open up new opportunities in the labor market by facilitating migration –mainly to urban or higher-income areas– while promoting overall economic development (Lagakos and Waugh, 2013).[3]

In this paper, I estimate the effects of schooling on several (short and long) internal migration outcomes taking advantage of a natural experiment created by an education reform in Zimbabwe. Until 1979, black Zimbabweans willing to enroll in secondary school needed to graduate from primary school (finish Grade 7), pass a high school entrance exam and hope for an available seat. As shown in Figure 1, the transition rate to

[3] There is of course the possibility that education increases agricultural productivity making stay in agriculture or in rural areas an attractive option. While theoretically possible, the evidence found here suggests that this effect is dominated by the mechanisms favoring spatial mobility.

the first year of high school (Form 1) was only around 27% in the 1970s. In 1980, the rules changed. The reform made progression to Form 1 automatic. The only requirement that persisted was graduating from Grade 7. This change created a *discontinuous* jump in the probability of advancing to secondary school.[4] Thus, students finishing Grade 7 in 1980 were disproportionally *more likely* to advance to Form 1 compared to those finishing Grade 7 just a year earlier.[5] Furthermore, as described later in section 2 and 6, the nature of the reform avoided the urban bias observed in the public provision of schooling that plague similar efforts in the Africa as reported in Barrett et al (2018).

Using the fuzzy RD design created by the reform and applied to a survey with details information on migration, I find that an extra year of schooling is associated with an increase in the overall probability of migration of 7.6% and with a 8.2% increase in the probability of moving to the largest cities: Harare, the capital, and Bulawayo. The effects are even larger for rural-born individuals: an additional year of schooling is associated with a 14% increase in the probability of moving to an urban district. These findings are robust to several checks including placebo tests for white Zimbabweans, a group not affected by the reform. For instance, while the reform increases the years of schooling of black Zimbabweans around the threshold, I find that for whites (and Asians) there is rather a *decline* in the schooling outcomes, however, it is very small and not statistically different from zero. Furthermore, I expand this analysis by showing that the

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[4] Dorsey (1989) shows that the majority of the new secondary schools were built in rural areas, ruling out the possibility of migrating in order to go to school. See section 6 for more details.

[5] My work is also related to Miguel and Hamory (2009) who focus on the impact of human capital (cognitive ability and health) on migration. Geographical coverage (all Zimbabwe vs. one district in Kenya), attrition (they rely on longitudinal data), the measure of human capital (schooling vs. health) and the time dimension of the analysis (17 years compared to 10 in Kenya) separate my work from theirs.

timing and structure of the reform does not coincide with other region-wide changes in education. Using census data from seven other Sub-Saharan African countries I found no discontinuous jumps in schooling outcomes for those aged 14 in 1980. Smoothness in the height of males and females (a measure of long-term nutrition) around the cutoff further reinforces the empirical strategy.

As in all papers that use an education reform to identify causal effects, my estimation strategy provides a Local Average Treatment Effect (LATE) of the parameter measuring the effect of schooling on internal migration. That is, the causal effect is estimated from people whose behavior is influenced by the policy change. However, my paper differs from the literature using compulsory schooling laws in three important ways. First, Zimbabwe's rule of automatic progression to secondary school creates a different and, arguably, larger set of compliers. With compulsory schooling laws, the set of compliers is characterized by those who would drop out in the absence of the laws, but must stay in school under the new regime. The law does not change the behavior of those who already wanted to remain in school. Under Zimbabwe's reform, described in the next section, the set of compliers is formed by those who wanted to stay in school but couldn't due to the apartheid-style regime. Second, the "treatment" with compulsory laws is the addition of an extra year of secondary education (or high school). In Zimbabwe, the ``treatment'' is gaining entrance to secondary school. Third, Oreopoulos (2006) argues that most compulsory laws like the ones implemented in the United States, "typically affect fewer than 10 percent of the population exposed to the instrument" (p. 153). Zimbabwe's reform affected a much larger share of its population. When given the chance to advance to secondary school, 86 percent of the eligible students changed their behavior, more than tripling the transition rate of the previous year. This implies that our LATE is closer to an average treatment effect (ATE) as the share of non-takers in the reform is quite small. Thus, my findings would be relevant to the large set of developing countries that have removed barriers to secondary education in the last decades and to those following the Millennium and Sustainable Development Goals regarding universal access to education in general and to secondary school in particular.

The data allow me to explore a few but relevant mechanisms. First, this migration is mainly a long-term change in residence rather than reflecting short-term mobility. Second, I find that education facilitates the mobility of men and women, and in both cases, with bigger effects for those born in rural areas. However, the impacts of education are much larger for males. Third, unlike recent papers in advanced economies, I find evidence that schooling facilitates migration by lowering the cost of moving by reducing the number of children for women (Machin et al, 2012) and the effects are not driven by migration to go to school as in Malamud and Wozniak (2012). These also help explain why the impacts of schooling are larger in Zimbabwe than in higher-income economies. Finally, I show that education facilitates Zimbabwe's structural transformation by altering the type of employment: reducing work in the primary sector and increasing jobs demanding higher levels of skills.

This paper directly intersections with the IUSSP Population, Poverty and Inequality themes. It shows how lifting barriers for the poor and the education-rationed causally helps to address deep-rooted inequalities and facilitates population dynamics in the form of internal migration towards urban areas and leading to structural change.

The rest of the paper is divided into four more sections. Section two briefly describes the education reform and how it provides a clear identification strategy. The data used in this paper is described in section three followed by the methodology. Section five presents the results and robustness checks. Section six discusses the main pathways and section seven summarizes our findings and concludes.

2. Education reform in Zimbabwe

In April 1980, the newly elected government of Zimbabwe reformed the education system to break with the apartheid-like regime that prevailed in Rhodesia.[6] Prior to 1980, at least 25 percent of black school-aged children failed to enter primary school due to a lack of places (Riddell, 1980). For example, in 1976, for every 1,000 black school-aged children, 250 never started school. Of those who went to school, 377 graduated from primary school, but only 60 of them transitioned into secondary education. Thereafter, 37 reached Form IV and less than 3 reached lower Form VI (Nhundu, 1992, p. 79).[7]

The 1980 education reform has been widely documented in the literature (e.g., Dorsey 1989; Edwards and Tisdell 1990; Edwards 1995). As described by Nhundu (1992), there were four key initiatives undertaken by the new government. First, the government introduced free and compulsory primary education. Second, there was a removal of age restrictions to allow overage children to enter school. This is very

[6] For a history of Rhodesia's education system and the policies dictating the quantity and quality of schooling Africans received, see Atkinson (1972) and O'Callaghan and Austin (1977).

[7] Zimbabwe's education system consists of primary education, secondary education and tertiary education. The primary level is a seven-year cycle and the official entry-age is six years. It runs from Grade 1 through Grade 7. Primary education leads to a Grade 7 certificate. Secondary education is divided into three two-year levels: junior, middle and high/advanced. Entering high/advanced secondary school requires the student to pass the O-level examinations.

important to the validity of identification strategy of this paper. Limits to overage enrollment before 1980 means that most students were 14 years old by the time they started Form 1, the first year of their secondary education. Third, the reform provided strong community support for education. Fourth, an automatic grade progression was implemented, in particular from primary to secondary school. Prior to the reform, a black Zimbabwean student in the last years of primary school (Grade 7), had to successfully graduate, take an entrance test for secondary school, hope for a space. After the reform, it was enough to finish Grade 7 to enter Form 1. This fourth aspect of the reform, allows me to use a RD design to evaluate the impact of education on geographical mobility.

An immediate impact of these steps was an enormous increase in school enrollment. Between 1979 and 1985, total enrollment (primary and secondary) rose from 885,801 to 2,698,878: an unprecedented 205% increase Nhundu (1992, 82p). As shown in Figure 2, the greatest expansion took place in secondary education where enrollment grew by 628% during the same period (66,215 in 1979 to 482,000 in 1985).

To accommodate the increased demand, the government built new schools and undertook extensive reconstruction and expansion of existing facilities. This increase is shown in Figure 3. Between 1979 and 1983, the overall number of schools grew by 90 percent. Again, the largest increased is found in secondary schools: they grew by 575 percent since 1979 compared to 65 percent for primary schools. These figures are consistent with an increase in the budget allocated to education. In the fiscal year of 1979-80, the share of education was 11.6 percent in the national budget. It almost doubled in 1980-81 (22.1 percent), and remained at about 17 percent until 1986-87 (Dorsey, 1989). The early years of the reform focused on the 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. This emphasis on creating rural schools reduces the possibility that pupils will migrate to go to school. As discussed in the next section, the evidence presented in Dorsey (1989) goes against the possibility that children had to travel to urban areas to gain more education. Therefore, it is less likely that our results are driven but a mechanical effect induced by education (i.e., migrating to go to school).

Mirroring the massive response in enrollments are the transition rates from primary to secondary in Zimbabwe's schools. As Figure 1 shows, the transition rate from Grade 7 (last grade of primary education) to Form I (first grade of secondary education) remained below 30 percent throughout the 1970s. As discussed before, Zimbabwean children start primary school at the age of six, thus on-time completion of all primary grades would enable them to start secondary school at the age of 14. As shown in Figure 1, there is a clear discontinuity in the probability that a child (boys and girls included) would go to secondary school in 1980. A child graduating from primary school in 1979 had a 27 percent chance of enrolling in secondary school. The same child, but who graduated one year later in 1980, was more than three times as likely to enroll in secondary education (86 percent). Therefore, the educational reform of 1980 provides a natural experiment, where for reasons exogenous to their choice, 14 year olds black Zimbabweans could acquire more schooling relative to their slightly older counterparts.

3. Data sources

The main data source for this study is the 1997 Zimbabwe Inter-Censal Demographic Survey. The ICDS is a large national representative household survey with the specific mandate to collect information about migration, fertility and mortality (CSO, 1998). I construct the migration outcomes taking advantage of survey responses regarding place of birth, current place of residence, location in the 1992 census, and others.

Thus, I am able to identify three migration-related variables. First, a binary variables takes the value of one if the a person interviewed in 1997 lives in a different district from her district of birth. The second variable is applicable only to people born in rural areas and measured whether, in 1997, they reside in an urban area (zero otherwise). The third variable focuses on migrating to the largest cities (Harare, the capital city, or Bulawayo) for the sample that was not born in those cities.

This dataset is complemented with the 1992 Population Census (to measure migration by 1982), the 2010 and 2015 Demographic and Health Survey (to measure height as adults) and with population censuses from seven other countries in the region to conduct placebo tests for the reform.

4. Econometric model

The econometric model to evaluate the impact of education on migration takes advantage of the (fuzzy) discontinuity in schooling outcomes created by the education reform in 1980. In this sense I follow the identification strategy used in Agüero and Bharadwaj (2014) and Agüero and Ramachandran (forthcoming). However, unlike those papers my analysis covers all Zimbabweans and it not limited to women or adults with children.

Formally, I use the following equations to estimate two stage least squares (2SLS) parameters:

$$S_i=\pi_0+\pi_1 1(AGE1980_i\leq 14)+f(AGE1980_i-14)+\theta X_i+\upsilon_i \quad (1)$$

$$M_i=\beta_0+\beta_1 S_i+f(AGE1980_i-14)+\lambda X_i+\nu_i \quad (2)$$

In the first stage (Equation 1), S_i represents the variables capturing the schooling levels of the i-th person. We consider to possible indicators for S_i: completed years of schooling and the probability of attending Form 1 (or more). The term $1(AGE1980_i\leq 14)$ is an indicator function for whether person i's age in 1980, $AGE1980_i$, is equal or smaller than the cutoff age of 14. The term $AGE1980_i-14$ accounts for the influence of age in 1980 on S_i in a flexible nonlinear function $f(\cdot)$. For instance, in the linear case $f(AGE1980_i-14)$ estimates a linear function: $f(AGE1980_i-14) =\theta_0(AGE1980_i-14)+ \theta_1(AGE1980_i-14) 1(AGE1980_i\leq\alpha)$. For a higher order polynomial specifications, $f(\cdot)$ estimates a different polynomial for each side. Vector X includes a dummy variable for gender and υ_i and ν_i are mean zero errors.

The second stage of the 2SLS (Equation 2), uses the predicted values of S_i from the first stage to estimate the effect of schooling on migration. Thus, β_1 is the parameter of interest as it captures the effect on internal migration that comes from the exogenous changes in schooling created by the reform. The intuition is simple. If we assume that a person's age in 1980 (the running or assignment variable) has a random factor with a continuous density, then the probability of being ε years older or ε years younger than the cutoff of 14 is the same (for a sufficiently small ε: one year, for instance.). Even if the expected age in 1980 depends on individual characteristics such as family background (e.g., fertility preferences), eligibility for treatment in the small neighborhood around the cutoff will be as good as randomly assigned (Lee, 2008). In other words, people just below the cutoff can be used as a counterfactual for those just above the cutoff because the identifying assumption implies that the only difference between these two groups is that students below the cutoff receive the treatment (i.e., had more years of schooling due to the reform).

Ideally, one would like to compare the average outcome for individuals in a small neighborhood around the threshold, but usually there is not enough data in this small vicinity, and thus the estimation suffers from small sample bias. Therefore, I use a larger bandwidth than just a few years around the threshold. Also, in this paper, the running variable is discrete as age is a discretely available in the ICDS. Therefore, my approach is closer to Lee and Card (2008) and it does not represent any loss relative to having a continuous running variable (Lee and Lemieux, 2010).

Several assumptions are needed to validate the proposed identification strategy. First, the reform needs to alter the schooling levels of the targeted population, black Zimbabweans, in order to avoid a weak instruments problem. This is formally tested in the next section. However, in Figures 4A and 4B, I provide a visual support for this assumption. First, I show that there is a discontinuous jump in the number of completed years of schooling around the threshold. While the values have increased for every new generation, those aged 14 in 1980 have 1.5 additional years of schooling compared to their slightly older counterparts aged 15 in 1980. Similarly, the probability of having Form 1 or more (i.e., having completed at least the first year of secondary education) discontinuously jumps from around 0.48 to 0.61 when comparing 14 and 15 year olds in 1980, respectively.

Second, Figures 5A and 5B provide some initial (graphical) support for the exclusion restriction: all other variables should be smooth around the threshold. For example, since the reform was targeted to address racial disparities in Rhodesia, we should not find a discontinuous change around the cutoff for whites Zimbabweans (or for any other non-black racial group in general). Evidence of such discontinuity would invalidate our identification strategy. As shown in Figure 5A, while there is a clear discontinuity for blacks (blue hollow circles) in terms of completed years of schooling, there is no such evidence for whites or Asians (red filled circles). Figure 5B shows the same lack of a discontinuity for non-blacks when focusing of the probability of having Form 1 or more.

Note that the reform's elimination of the age restrictions permitted many overage children to remain in or return to school. For instance, while the were 112,890 children enrolled in Grade 6 in 1980 the number of children enrolled in Grade 7 the following year was 15 percent larger (over 129,000). Thus the benefits of the reform extended to children aged 15 in 1980 in addition to those aged 14 or less in 1980. This implies, not only that the discontinuity is rather fuzzy than sharp, but also and more importantly, that some of the 15 year olds could be part of the treatment group. In that case, our estimates are biased *downwards*. Therefore, as part of the set of robustness checks I estimate the effects of education on mobility for samples that drop 14 year olds, 15 years olds and both from the sample.

In the next section I provide further support for the identification strategy and present the estimated impacts of schooling on internal migration patterns.

5. Results

5.1. First stage

The estimates of the first stage equation are shown in Table 1. In this table I restrict the sample to individuals aged between 0 and 40 in 1980. Following Lee and Card (2008), the clustering of the standard errors is done at each value of the discrete assignment variable. In order to avoid the biases induced by having a small number of clusters the 0-40 age range in 1980 represents the preferred estimates. However, in the appendix (Table A.1) I consider other ranges.[8]

Table 1 shows a clear discontinuity around the threshold. In Panel A, column 1, I restrict the sample to blacks only and consider a linear spline for $f(AGE1980_i\text{-}14)$. I find that black Zimbabweans aged 14 in 1980 completed 2.1 additional years of schooling compared those aged 15 in 1980. This represents a large effect: 26.5 percent relative the mean of the entire sample. This is consistent with previous work using different datasets. For instance, combining data from the three Zimbabwean Demographic and Health Surveys (1999, 2005-06 and 2010-11) and restricting the sample to black women, Agüero and Bharadwaj (2014) find that the reform increased by 25 percent the number of completed years of schooling for women aged 14 in 1980, compared their 15 year old counterparts. To put these estimates in perspective, in her seminal study for Indonesia, Duflo (2001) finds an increase of 0.12 to 0.19 years of schooling for each primary school constructed per 1,000 children. Against her findings, the results for Zimbabwe are large. Panel B, column 1, confirms these findings for the probability of having at least Form 1

[8] Future versions of the paper will explore alternative clustering scenarios as well as corrections for small number of clusters.

and report an increase at the threshold of 54.1 percent (=.276/.510) with respect to the mean.

Table 1 also helps validate the exclusion restriction. In Panel A, column 2, I ran the same regression (Equation 1) but for non-black Zimbabweans (whites and Asians), the racial group that should not be affected by the policy. The estimated parameter shows no discontinuity around the cutoff and if anything, non-blacks 14 years olds in 1980 have *fewer* years of schooling than their slightly older counterparts. Columns (3) and (4) combine blacks and non-blacks and estimate the *difference-in-discontinuity* by adding a binary variable for blacks (=1) and well as the interaction $1(AGE1980_i \leq 14)*Black$. This interaction uses the non-black population as an additional control group. In column (3) I use a linear spline for the running variable and find an effect of 4.10 additional years of schooling for black Zimbabweans aged 14 in 1980 relative to 15 year olds and the non-blacks. Column (4) uses a quadratic spline and reports a similar effect: 4.11 additional years of schooling. In Panel B, I found analogous effects when the schooling outcome is the probability of having at least Form 1. While the effect of the reform for blacks was an increase in 27.6 percentage points, for non-blacks the effect is negative and the comparison between races yields an effect of 45.8 percentage points for the linear splines (column 3) and 46.0 for the quadratic specification (column 4). These findings suggest not only a very strong first stage but also provide important supportive evidence in favor of the validity of the exclusion restriction.

I further explore "covariate smoothness" assumption for the identification strategy by considering height (from the Zimbabwean Demographic and Health Survey), which is largely determined by early-life factors; as Figure 6 shows, height is smooth around the threshold cutoff age. The regression counterparts, shown in Appendix Table A.2, confirm these findings. There we consider height in centimeters as well as height-for-age z-score. In both cases we cannot reject the null hypothesis of smoothness around the cutoff.

Agüero and Bharadwaj (2014) presented additional support for the exclusion restriction using a sample of women from the DHS.[9] For instance, they showed that women's height is smooth around the cutoff point for Zimbabweans. This indicates that the reform affected schooling outcomes and not health outcomes directly. The authors also show that the observed discontinuity in education for 14 year olds in 1980 in Zimbabwe does not exist for neighboring countries. For instance, they found no discontinuities for South Africa or Zambia. I expand their analysis by examining whether there is a discontinuity in seven other sub-Saharan African counties using population censuses closest to the 1997 ICDS (available from IPUMS online after registration). For these countries (Kenya, Rwanda, Senegal, South Africa, Uganda, Tanzania and Zambia) I used all observations from natives (men and women) aged between 0 and 40 in 1980. As shown in Figure 7, there is no discontinuity for theses other countries either. The regression counterparts for these figures are shown in Appendix Table A.3 and confirm the lack of a discontinuity in the years of schooling for these seven countries at the threshold. All these evidence provides a stronger support for the identification strategy. The results of using 2SLS to estimate the effect of education on internal migration -- based on the fuzzy RD— are shown next.

[9] Non-blacks represent less than five percent of the population in Zimbabwe. Thus, the sample size for non-blacks in the DHS is nearly zero. In the ICDS I was able to identify only less than 300 observations for those aged between 0 and 40 in 1980. See Table 1.

5.2. Effect of education on migration

I now present the estimates for the effect of schooling on the three migration outcomes described above and for black Zimbabweans only. I start by showing the reduced form effects graphically for the preferred specification: 0-40 in 1980. In Figures 8A-8C I plot the average value of the migration outcome by age in 1980. All figures show a clear discontinuity at the threshold.

In Tables 2 to 4, I expand this analysis and show the 2SLS estimates for several specifications regarding the bandwidth: those aged 0-40 in 1980 (column 1); 10-20 (column 2) and 12-17 (column 3). The latter is possible thanks to the larger sample size available in the ICDS. I also show robustness checks by dropping from the analysis 14 years olds (Panel B), 15 year olds (Panel C) and both at the same time (Panel D).

I find that education increases the probability of internal migration and these associations are statistically significantly different from zero. For instance, more schooling is associated with a higher probability of living (in 1997) in a district different from a person's district of birth. Table 2, column 1, Panel A, shows that for the preferred sample and using all the observations, an additional year of education is associated with an increase of 7.6 percent (with respect to the mean) in that outcomes (=0.039/0.510). For those born in rural areas, schooling also increases the probability of migrating to urban areas by 14.2 percent (=0.032/0.225) as show in Table 3, column 1, Panel A. Schooling is associated with an increment in the probability of migrating to the largest cities (Harare and Bulawayo) by 8.2 percent.

5.3. Robustness checks

These findings remain robust when considering all the alternative specifications. In columns (2) and (3) I reduced the bandwidth to those aged 10-20 or to 12-17 in 1980, respectively. In fact, the 2SLS point estimates *increase* when the bandwidth is reduced. For example, using the sample of those aged 12-17 in 1980; an additional year of schooling increases the probability of migrating by 18.2 percent, the probability of migrating to urban areas by 18.2 percent and the probability of migrating to the largest cities by 42.6 percent.

The possibility of overage enrollment created by the reform also could affect the schooling of those aged 15 in 1980. Dropping from the analysis those aged 14, 15 or both does not alter the main findings. I still find a large and statistically significant association between education and migration.

6. Pathways

I consider several possible pathways for the transmission. I start by exploring whether the impact on migration arises from recent moves. To do so I define recent migration in two ways. First, the ICDS ask whether movers did that in the last 12 months or before. Second, the survey asked for place of living in 1992. With the caveat that the latter is a retrospective question, Table 5 displays the 2SLS estimates of the association of schooling on these measures of recent migration (see Figure 9 for the reduced form graphs). Overall, the results show that there is no effect on recent migration. This is clearly observed for last 12 months migration (Panel A). For migration since 1992, using the largest bandwidth the effects are statistically significant (at 1%) but they are not robust to changes in the bandwidth and tend to be much smaller than the effects reported earlier for migration from place of birth. Thus, we conclude that the effects on migration are driven from long-run changes in the residence location.

Second, I evaluate differential impacts by gender. These are shown in Table 6. In all regressions, the 2SLS show that more schooling promotes migration, with larger effects for rural-urban mobility (column 2). However, the effects are much larger for men, even after considering women's lower probability to migrate.

As a possible third mechanism and following Malamud and Wozniak (2012), I explore whether people migrated to go to school. Scholars reviewing the 1980 education reform in Zimbabwe suggest that was not the case. For example Dorsey (1989) and Nhundu (1992) document that the goal of the reform was to equalize education opportunities by focusing on areas that were previously disadvantaged and hence, targeted rural areas. By 1981, 40 rural secondary schools were created where before there were none. Community-based efforts also helped with the creation or improvements of schools. Again, by 1981, 400 community-based schools were opened in rural areas compare to 40 in urban zones. Budget wise, in the 1982-83 fiscal year, US$13.75 million were assigned toward rural secondary schools compared to US$0.6 million for urban schools. All this evidence implies that if rural children wanted to go to school they did not need to move to another area to accomplish that goal. To further confirm this claim, I use data from the 1992 Population Census. This census asks place of residence in 1982, two years after the reform. Again, with the caveat that this is retrospective data, Figure 10 shows the reduced form graphically while the regression counterpart if presented in column (1) of Table 7. If any, the education *decreases* the probability of migration by 1982. Thus, it does not seem the case that people migrated to gain access to education.

As a third mechanism and as explained by Machin et al (2012), education could facilitate migration by reducing the cost of mobility. For the case of women, they explore whether education reduces fertility rates since having (more) children will limit mobility. For the case of Zimbabwe and using the 1997 ICDS, Figure 11 provides evidence in favor of this mechanism. There is a discontinuity at the cutoff where younger women (aged 14 or less in 1980) have fewer children. Table 7 shows the regression counterpart for this graph. Each additional year of schooling is associated, estimated via 2SLS, with 0.2 fewer children (column 3) and with a 0.56 years delay in the age at first birth (column 2). This evidence has been confirmed by Agüero and Ramachandran (forthcoming) using the 2002 Zimbabwean Census and by Grepin and Bharadwaj (2015) using several rounds of the Zimbabwean Demographic and Health Survey. This mechanism could be explaining the larger impact observed of education on internal mobility in Zimbabwe relative to the literature from more advanced economies (e.g, McHenry, 2013 and Machin et al, 2012).

Finally, the last two columns of Table 7 indicate the type of jobs that the educated have, for the employed sample in the 1997 ICDS. In column (4) we observe a decline in the probability of being employed in a primary sector, such as agriculture.[10] Column (5) shows an increase in the probability of employment in high-skills jobs. Overall, these findings suggest that education stimulates spatial mobility away from rural areas and this spatial transformation leads to a structural transformation by relocating jobs from agriculture to non-agriculture.

[10] Other jobs include hunting, fishing, logging, mining, quarrying, brick-laying, masonry, painting, cleaning or subsistence work in general. Jobs requiring higher skills included for example programmers, academics, accountants, lawyers, doctors, engineers, artists, executives, librarians, and bankers among others.

7. Conclusions

This paper uses the exogenous variation in schooling generated by the 1980 education reform in Zimbabwe and shows that geographical mobility responds, causally, to more education. An additional year of education also increases the probability to migrate out of rural areas (by 14 percent) and the probability to move to the largest cities in the country by more than eight percent. Several robustness checks, including varying the bandwidth, and the sample confirm these findings. Also, placebo tests using populations not affected by the reform (e.g., white Zimbabweans and people living in other Sub-Saharan African countries) help confirm the validity of the identifying assumptions.

The use a fuzzy RD design implies that these findings should be interpreted as a local average treatment effect. This is important given the context. Prior to the reform Zimbabwe was characterized by an apartheid-type system where very few black Zimbabweans had access to secondary education. When compared to the findings in advanced economies my findings report larger effects. For instance, McHenry (2013) finds a negative effect on migration and Machin et al (2012) find a positive but smaller effect.

All together, this evidence provides a strong argument for the role of human capital accumulation on creating the structural transformation needed to achieve economic development in Sub-Saharan Africa.

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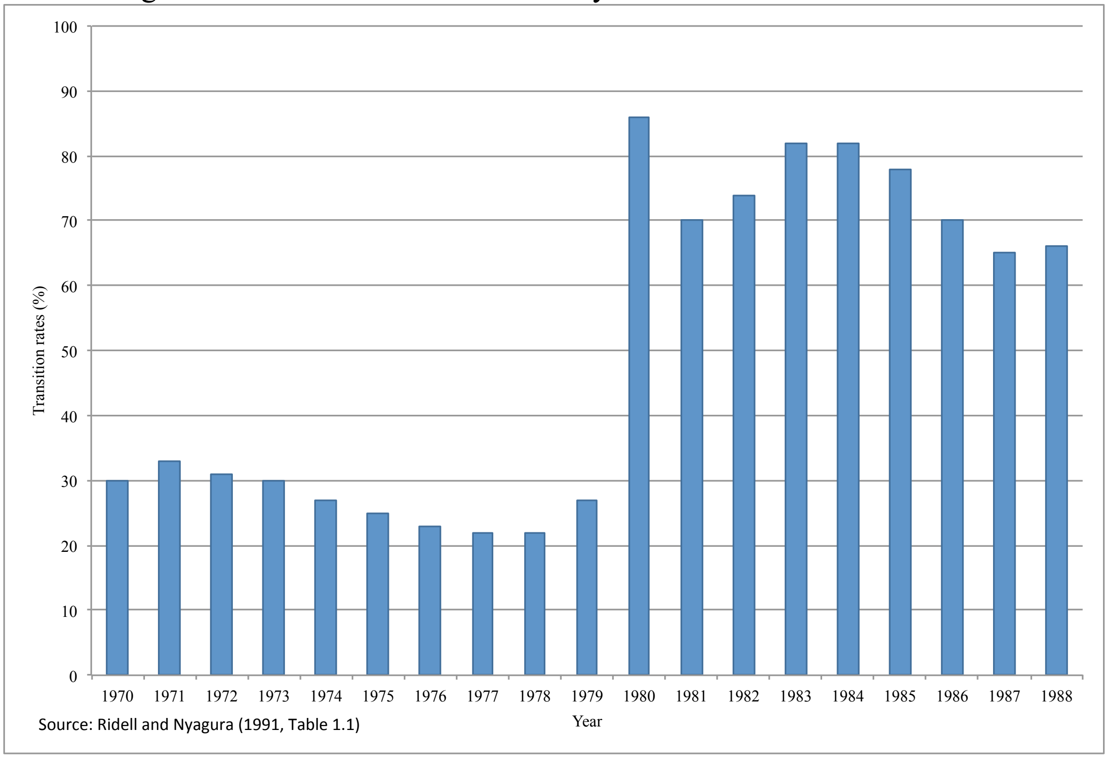
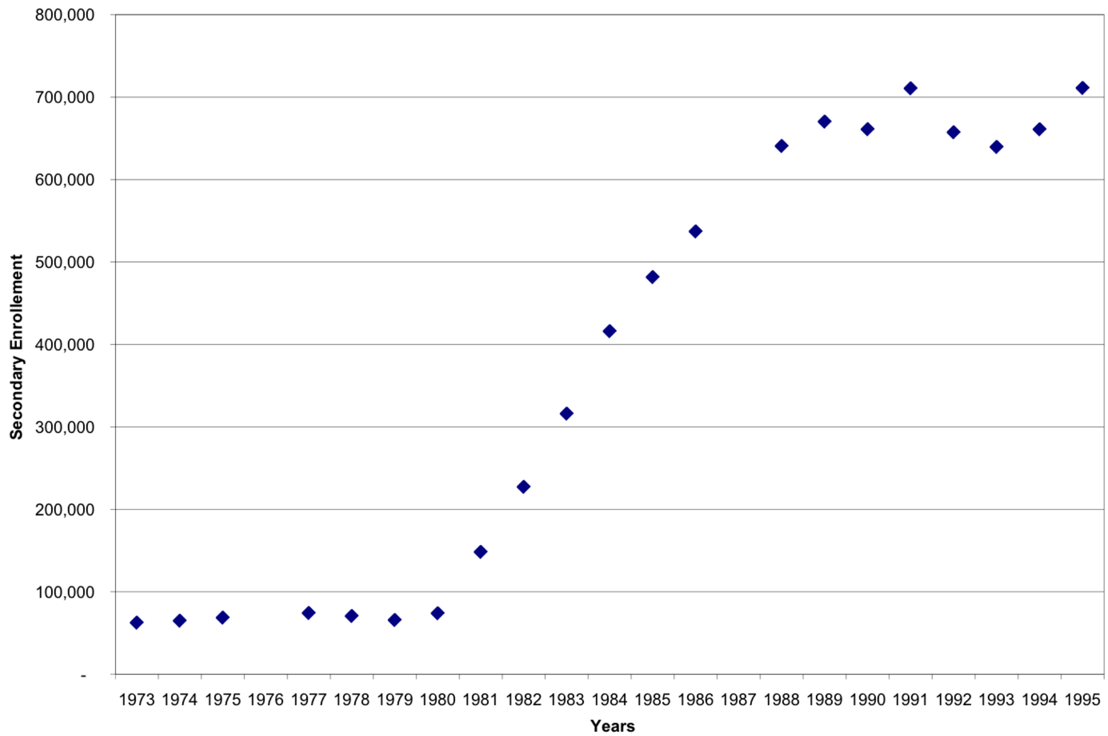
Figure 1. Transition rates to secondary education: Grade 7 to Form 1



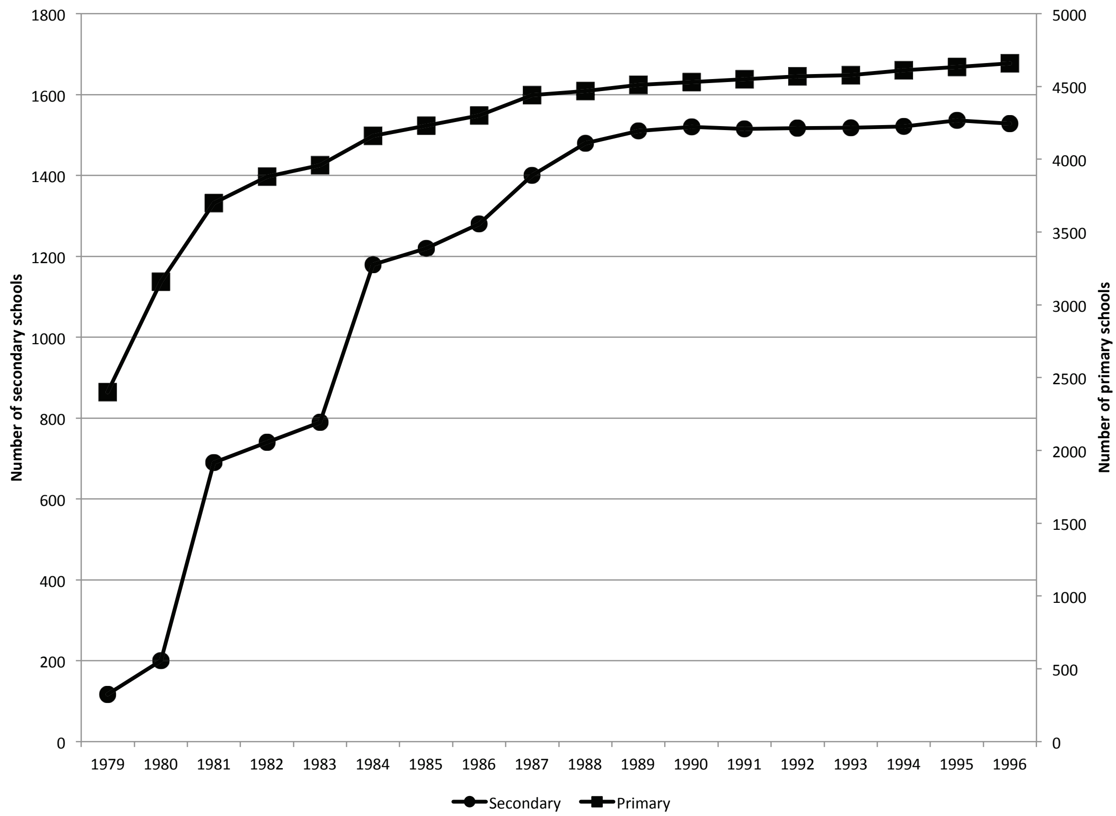
Data source: Riddell and Nyagura (1991), Table 1.1.
Note: Grade 7 is the last year of primary education and Form I is the first year of secondary education.

Figure 2. Secondary enrollment by year



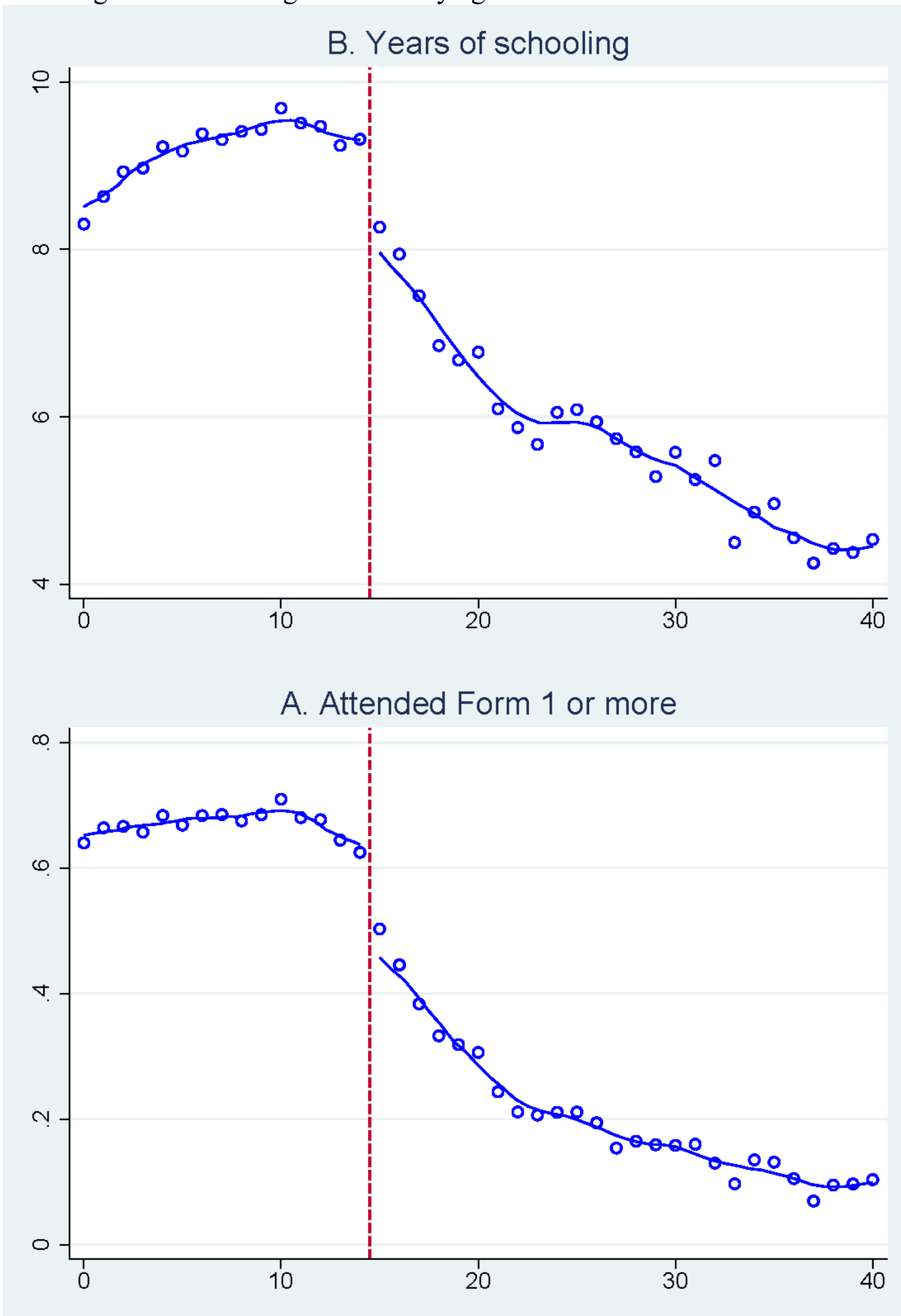
Note: Elaborated based on data from United Nations Statistical Yearbook, various years

Figure 3. Trends in school construction by educational level, 1979-1996



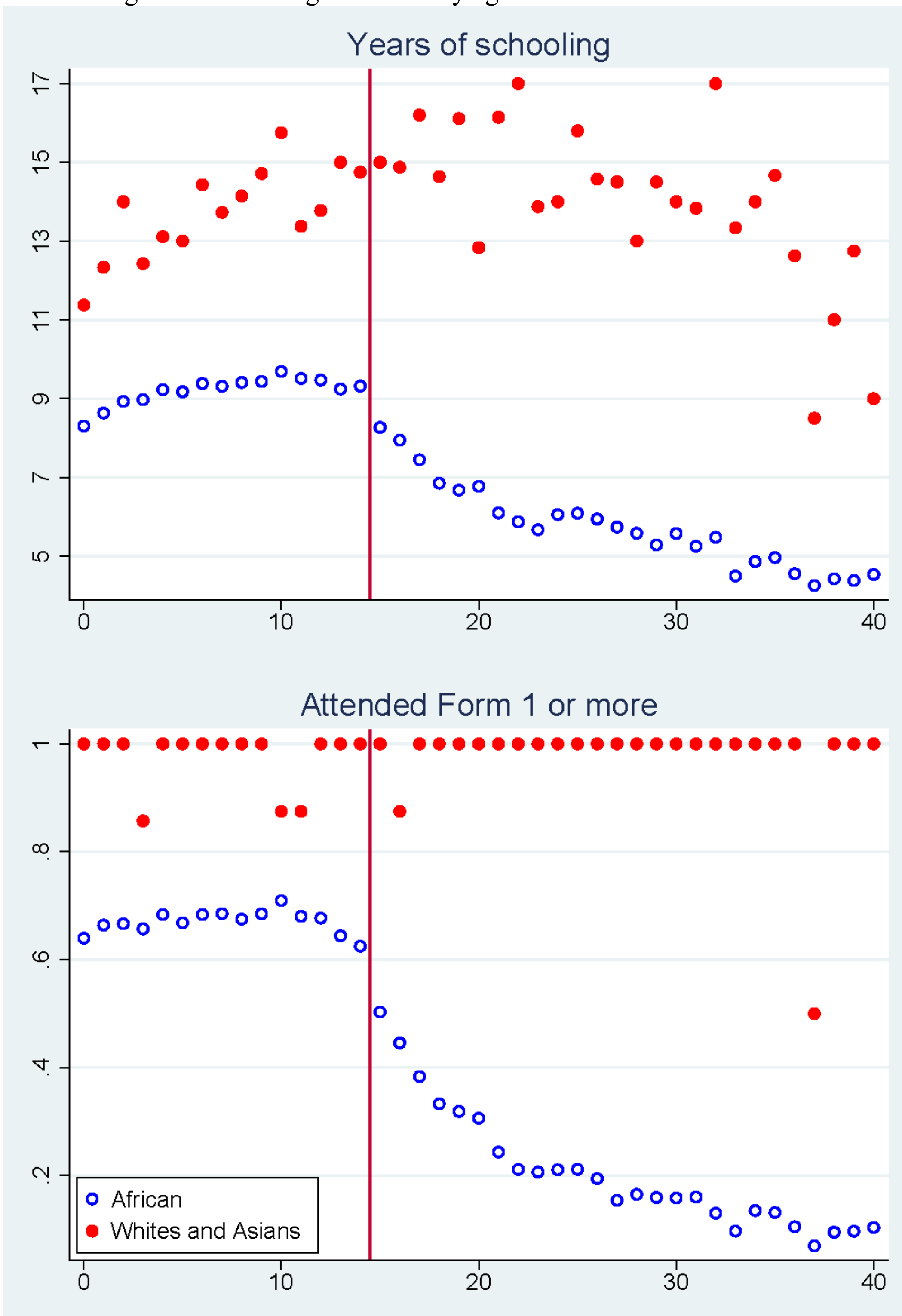
Note: Elaborated based on Zimbabwe Ministry of Education, Culture, and Sports, Annual Education Report, various years.

Figure 4. Schooling outcomes by age in 1980: Black Zimbabweans



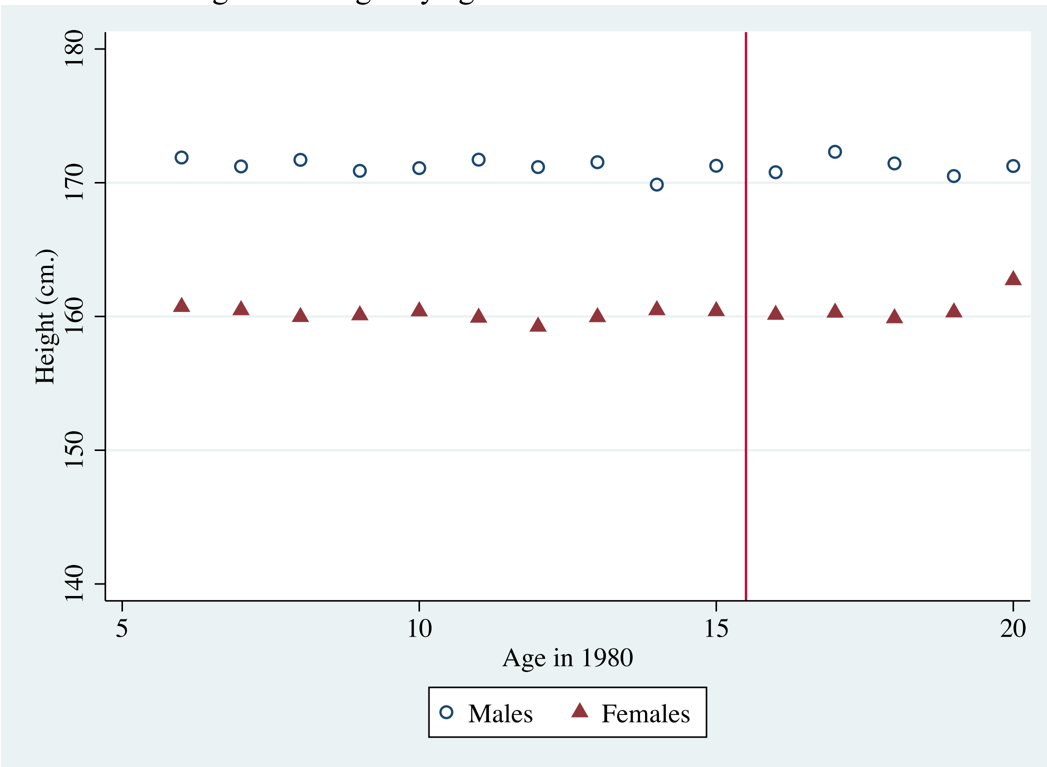
Note: Each symbol represents the average by age in 1980 for the selected variables. Sample is restricted to blacks born in Zimbabwe using the 1997 ICDS. The lines are local polynomials estimated for each side of the cutoff.

Figure 5. Schooling outcomes by age in 1980: All Zimbabweans



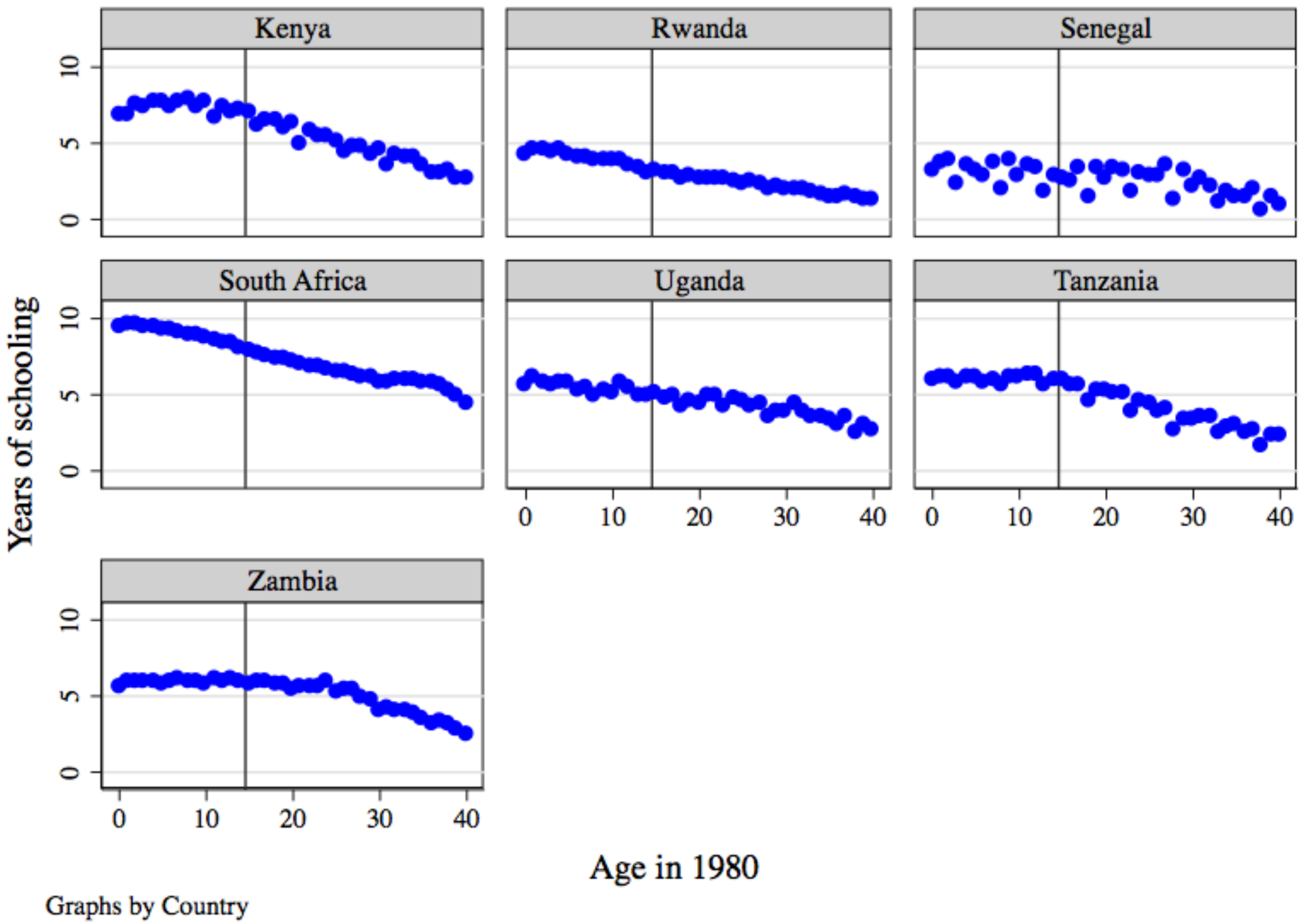
Note: Each symbol represents the average by age in 1980 for the selected variables for the corresponding race. Sample is restricted to those born in Zimbabwe using the 1997 ICDS.

Figure 6. Height by age in 1980: Black Zimbabweans



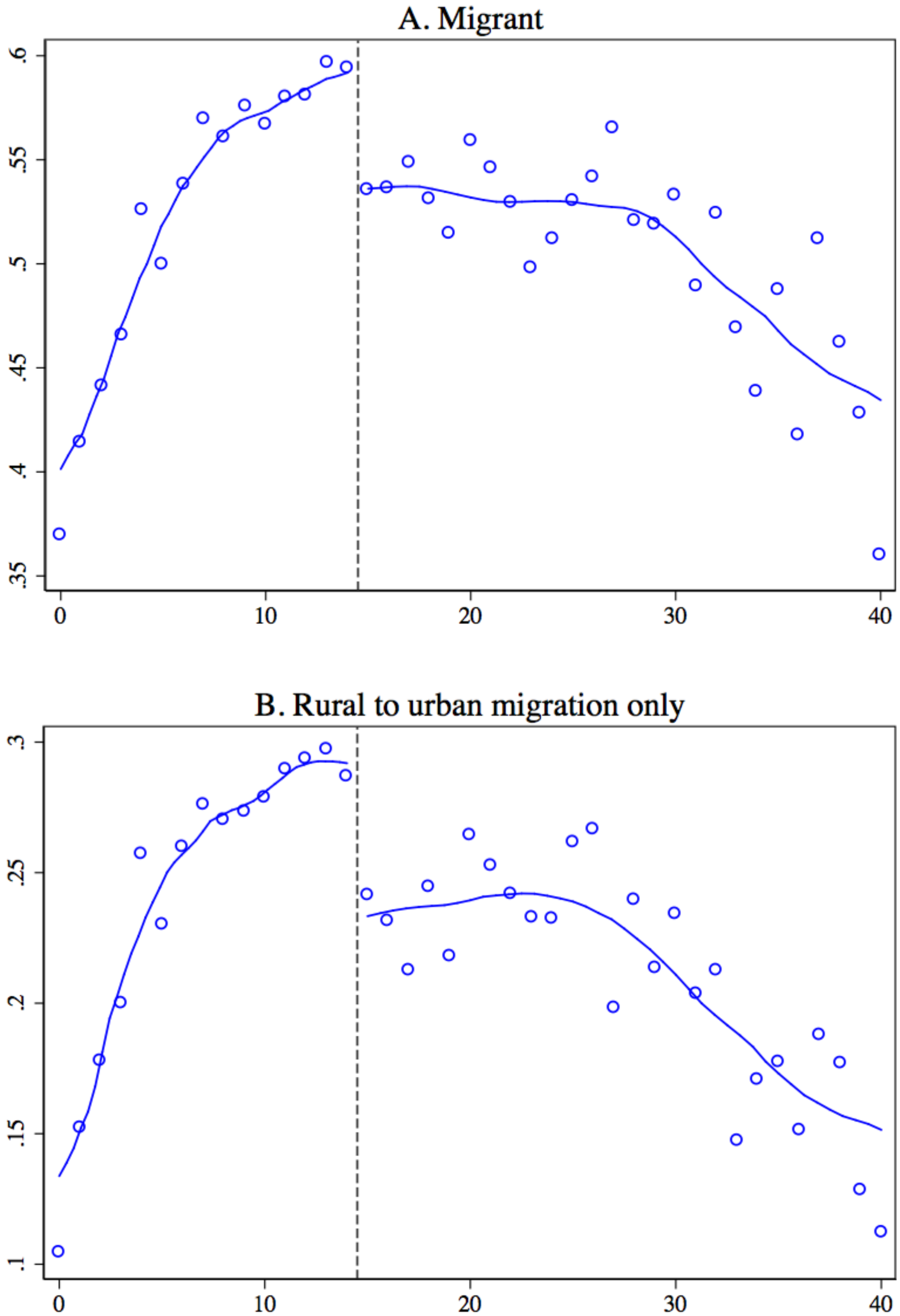
Note: Each symbol represents the average by age in 1980 for the selected variables. Sample is restricted to blacks born in Zimbabwe using the 2010 and 2015 Demographic Health Surveys.

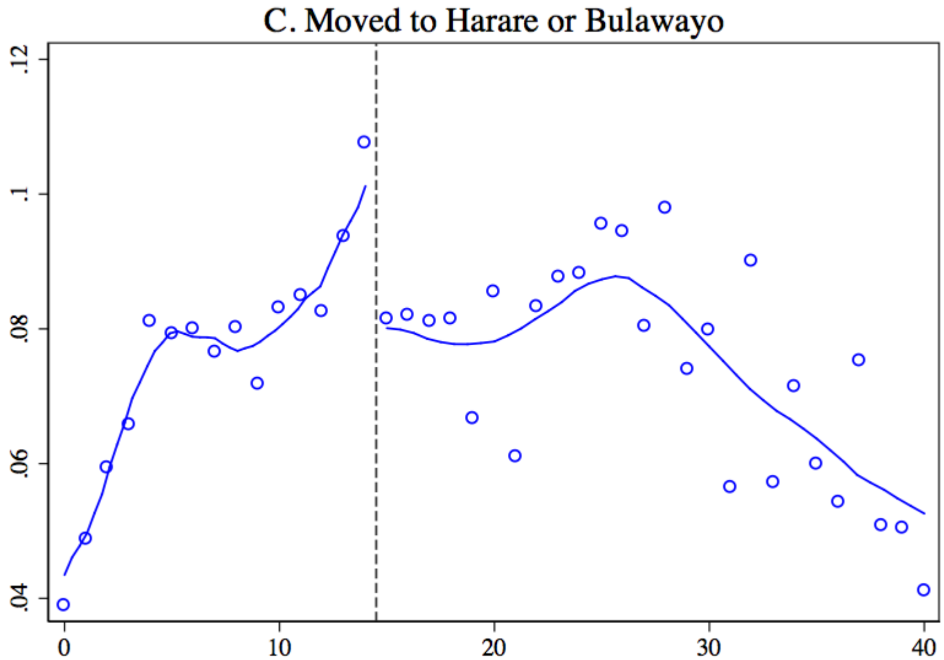
Figure 7. Age in 1980 and schooling in other African countries



Note: Each symbol represents the average number of completed years of schooling by age in 1980 using the latest census in each country. Data source: IPUMS.

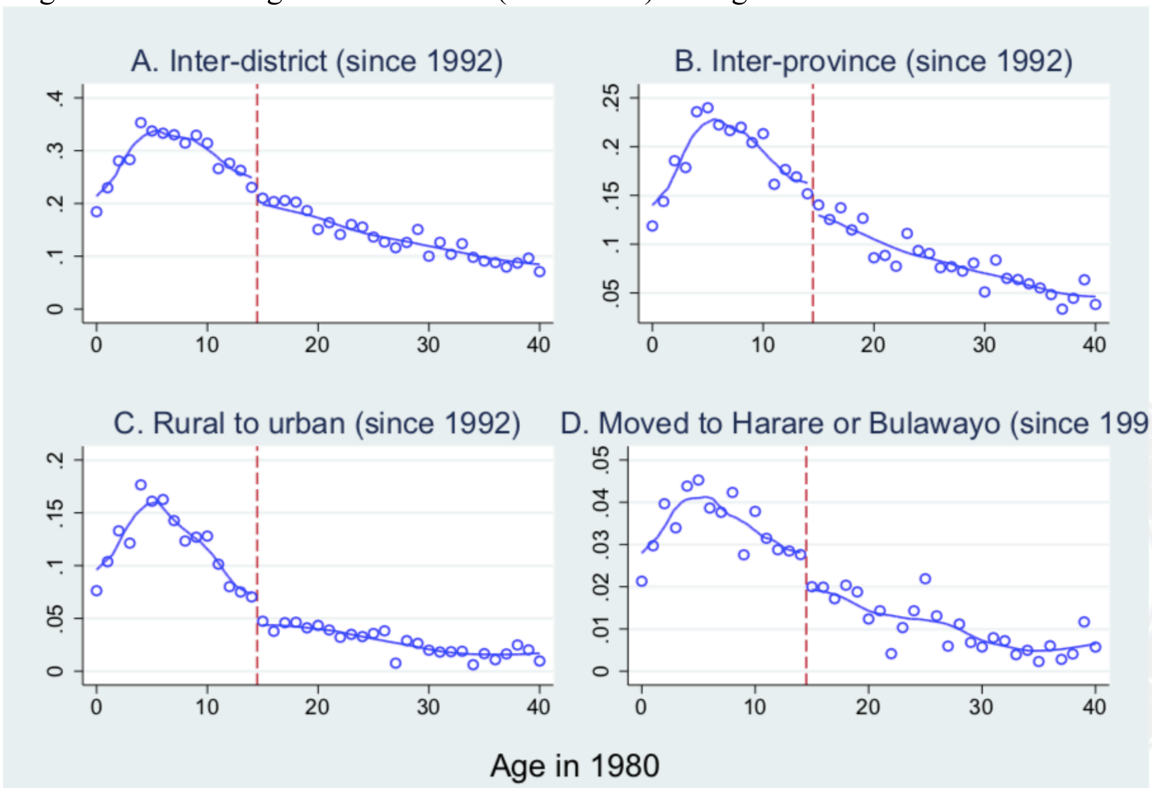
Figure 8. Migration outcomes (ever) and age in 1980: Black Zimbabweans





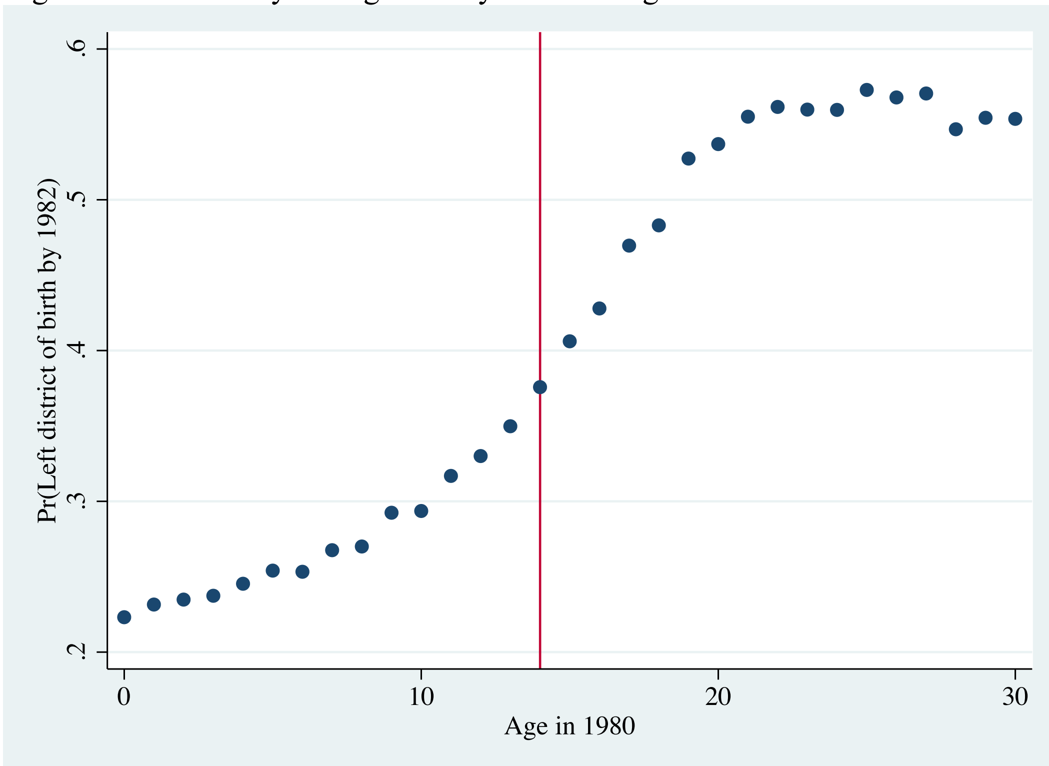
Note: Each symbol represents the average by age in 1980 for the selected variables. Sample is restricted to black born in Zimbabwe using the 1997 ICDS. Panel A includes all black Zimbabweans. Panel B is for those born in rural areas and Panel C for those born outside Harare or Bulawayo. Lines are local polynomials estimated for each side of the cutoff.

Figure 9. Recent migration outcomes (since 1992) and age in 1980: Black Zimbabweans



Note: Each symbol represents the average by age in 1980 for the selected variables. Sample is restricted to black born in Zimbabwe using the 1997 ICDS. Lines are local polynomials estimated for each side of the cutoff.

Figure 10. Probability of migration by 1982 and age in 1980: Black Zimbabweans



Note: Each symbol represents the average by age in 1980 for the selected variables. Sample is restricted to black born in Zimbabwe using the 1992 Population Census.

Figure 11. Number of children and age in 1980: Black Zimbabweans women

Note: Each symbol represents the residuals of the average values by age in 1980 for the selected variables after regressing the number of children by women on age (linear). Sample is restricted to black women born in Zimbabwe using the 1997 ICDS.

Table 1. Age in 1980 and schooling outcomes (First Stage)

	Blacks	Non-Blacks	All	
	Linear		Linear	Quadratic
	(1)	(2)	(3)	(4)
Panel A. Dependent variable: Completed years of schooling				
1(AGE1980≤14)	2.112***	-1.106	-1.985***	-2.997***
	(0.253)	(0.707)	(0.394)	(0.408)
1(AGE1980≤14)*Black			4.101***	4.111***
			(0.384)	(0.380)
Black			-8.587***	-8.592***
			(0.305)	(0.302)
Obs.	42,844	229	43,073	43,073
Panel B. Dependent variable: Probability of attending Form 1				
1(AGE1980≤14)	0.276***	-0.0530	-0.181***	-0.307***
	(0.0308)	(0.0319)	(0.0289)	(0.0295)
1(AGE1980≤14)*Black			0.458***	0.460***
			(0.0319)	(0.0312)
Black			-0.759***	-0.760***
			(0.0271)	(0.0263)
Obs.	42,844	229	43,073	43,073

Note: Robust standard errors clustered by age in 1980 (41 clusters) are shown in parenthesis. Sample is restricted to Zimbabwe-born individuals using the 1997 ICDS. The bandwidth corresponds to individuals aged between 0 and 40 in 1980. All regressions include (not shown) linear (columns 1-3) or quadratic splines (column 4). *** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.

Table 2. Schooling and the probability of migrating (2SLS)

	Dependent variable: Migrated		
Bandwidth	0-40	10-20	12-17
	(1)	(2)	(3)
	Panel A: All ages in 1980		
Years of schooling	0.039***	0.092***	0.103***
	(0.008)	(0.014)	(0.017)
Mean of dep. var.	0.510	0.560	0.566
Observations	42,844	11,791	6,152
F-stat (first stage)	676.8	15.98	6.114
	Panel B: Excludes 14 years olds in 1980		
Years of schooling	0.041***	0.110***	
	(0.008)	(0.015)	
Mean of dep. var.	0.509	0.557	
Observations	42,020	10,967	
F-stat (first stage)	696.8	9.448	
	Panel C: Excludes 15 years olds in 1980		
Years of schooling	0.034***	0.086***	
	(0.007)	(0.020)	
Mean of dep. var.	0.510	0.562	
Observations	41,782	10,729	
F-stat (first stage)	699.4	9.972	
	Panel D: Excludes 14 and 15 years olds in 1980		
Years of schooling	0.036***	0.103***	
	(0.008)	(0.024)	
Mean of dep. var.	0.508	0.560	
Observations	40,958	9,905	
F-stat (first stage)	719.8	6.719	

Note: Robust standard errors clustered by age in 1980 are shown in parenthesis. Sample is restricted to black Zimbabwean using the 1997 ICDS. Dependent variable is equal to one if the person lives in a district different from birth district and zero otherwise. Coefficients were estimated instrumenting completed years of schooling with 1(AGE1980≤14). The bandwidth changes by column: those aged between 0-40 in 1980 (column 1), between 10 and 20 (column 2) and between 12 and 17 (column 3). There are not enough observations to correctly estimate the 2SLS for columns three for the panels where additional years are removed (Panels B-D). All regressions include (not shown) linear splines and a gender indicator. *** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.

Table 3. Schooling and the migration to urban areas (2SLS)

	Dependent variable: Migrated to urban areas		
Bandwidth	0-40	10-20	12-17
	(1)	(2)	(3)
	Panel A: All ages in 1980		
Years of schooling	0.032***	0.081***	0.049***
	(0.008)	(0.017)	(0.011)
Mean of dep. var.	0.225	0.262	0.262
Observations	33,573	9,124	4,694
F-stat (first stage)	639.1	19.92	6.753
	Panel B: Excludes 14 years olds in 1980		
Years of schooling	0.035***	0.102***	
	(0.008)	(0.016)	
Mean of dep. var.	0.224	0.260	
Observations	32,970	8,521	
F-stat (first stage)	652.1	11.57	
	Panel C: Excludes 15 years olds in 1980		
Years of schooling	0.028***	0.096***	
	(0.008)	(0.022)	
Mean of dep. var.	0.225	0.264	
Observations	32,745	8,296	
F-stat (first stage)	647.9	11.61	
	Panel D: Excludes 14 and 15 years olds in 1980		
Years of schooling	0.031***	0.118***	
	(0.008)	(0.026)	
Mean of dep. var.	0.223	0.262	
Observations	32,142	7,693	
F-stat (first stage)	662.0	7.713	

Note: Robust standard errors clustered by age in 1980 are shown in parenthesis. Sample is restricted to black Zimbabwean born in rural areas using the 1997 ICDS. Dependent variable is equal to one if the person lives in an urban district and zero otherwise. Coefficients were estimated instrumenting completed years of schooling with 1(AGE1980≤14). The bandwidth changes by column: those aged between 0-40 in 1980 (column 1), between 10 and 20 (column 2) and between 12 and 17 (column 3). There are not enough observations to correctly estimate the 2SLS for columns three for the panels where additional years are removed (Panels B-D). All regressions include (not shown) linear splines and a gender indicator.
*** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.

Table 4. Schooling and the migration to largest cities (2SLS)

	Dependent variable: Migrated to Harare or Bulawayo		
Bandwidth	0-40	10-20	12-17
	(1)	(2)	(3)
	Panel A: All ages in 1980		
Years of schooling	0.006**	0.025***	0.037***
	(0.003)	(0.005)	(0.004)
Mean of dep. var.	0.073	0.084	0.087
Observations	41,248	11,377	5,919
F-stat (first stage)	678.3	16.13	6.390
	Panel B: Excludes 14 years olds in 1980		
Years of schooling	0.005**	0.017**	
	(0.002)	(0.008)	
Mean of dep. var.	0.073	0.082	
Observations	40,467	10,596	
F-stat (first stage)	699.0	9.432	
	Panel C: Excludes 15 years olds in 1980		
Years of schooling	0.005*	0.023***	
	(0.003)	(0.007)	
Mean of dep. var.	0.073	0.084	
Observations	40,229	10,358	
F-stat (first stage)	696.5	9.242	
	Panel D: Excludes 14 and 15 years olds in 1980		
Years of schooling	0.004	0.015	
	(0.003)	(0.009)	
Mean of dep. var.	0.073	0.082	
Observations	39,448	9,577	
F-stat (first stage)	717.4	6.103	

Note: Robust standard errors clustered by age in 1980 are shown in parenthesis. Sample is restricted to black Zimbabwean born outside Harare or Bulawayo using the 1997 ICDS. Dependent variable is equal to one if the person lives in Harare or Bulawayo and zero otherwise. Coefficients were estimated instrumenting completed years of schooling with 1(AGE1980≤14). The bandwidth changes by column: those aged between 0-40 in 1980 (column 1), between 10 and 20 (column 2) and between 12 and 17 (column 3). There are not enough observations to correctly estimate the 2SLS for columns three for the panels where additional years are removed (Panels B-D). All regressions include (not shown) linear splines and a gender indicator.
*** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.

Table 5. Migration since 1992 and in the last 12 months (2SLS)

	Bandwidth:		
Bandwidth	0-40	10-20	12-17
	(1)	(2)	(3)
Panel A. Dependent variable: Migration in the last 12 month			
Years of schooling	0.005	-0.005	-0.000
	(0.003)	(0.013)	(0.018)
First stage F-stat	68.97	36.87	99.14
Obs.	42,844	11,791	6,152
Panel B. Dependent variable: Inter-district migration since 1992			
Years of schooling	0.053***	0.012	0.038***
	(0.010)	(0.018)	(0.011)
First stage F-stat	68.97	36.87	99.14
Obs.	42,844	11,791	6,152
Panel C. Dependent variable: Inter-province migration since 1992			
Years of schooling	0.037***	-0.001	0.026**
	(0.007)	(0.013)	(0.012)
First stage F-stat	68.97	36.87	99.14
Obs.	42,844	11,791	6,152
Panel D. Dependent variable: Rural to urban migration since 1992			
Years of schooling	0.017***	0.010	0.021***
	(0.004)	(0.007)	(0.005)
First stage F-stat	69.20	40.52	123.2
Obs.	42,676	11,720	6,108
Panel E. Dependent variable: Migration to largest cities since 1992			
Years of schooling	0.007***	0.005*	0.011***
	(0.001)	(0.003)	(0.001)
First stage F-stat	68.43	27.06	40.74
Obs.	39,083	10,568	5,482

Note: Robust standard errors clustered by age in 1980 are shown in parenthesis. Sample is restricted to black Zimbabwean born using the ICDS. See definitions in text and Tables 2-4. Migration since 1992 compares current district or province of residence with residence in 1992 (retrospectively). Coefficients were estimated instrumenting completed years of schooling with 1(AGE1980≤14). The bandwidth changes by column: those aged between 0-40 in 1980 (column 1), between 10 and 20 (column 2) and between 12 and 17 (column 3). All regressions include (not shown) linear splines and a gender indicator. *** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.

Table 6. Effects by gender (2SLS)

	Dependent variable:	
	Inter-district migration	Rural to urban migration
	(1)	(2)
	Panel A. Males	
Years of schooling	0.293***	0.175**
	(0.104)	(0.074)
Mean of dep. variable	0.566	0.324
Observations	5366	4134
F-stat (first stage)	7.6	13.6
	Panel B. Females	
Years of schooling	0.026*	0.033**
	(0.015)	(0.016)
Mean of dep. variable	0.555	0.211
Observations	6425	4990
F-stat (first stage)	15.1	18.6

Note: Each column represents a separate regression; robust standard errors clustered by age in 1980 appear in brackets. All regressions include linear splines in age in 1980 (coefficients not shown) and the bandwidth is restricted to ages 10 to 20 in 1980. All samples include black Zimbabweans only. The instrument for parent schooling is the discontinuity at age 14 in 1980. The reported F-statistics refer to this excluded instrument. Statistical significance is indicated by * at 10%, ** at 5% and *** at 1%.

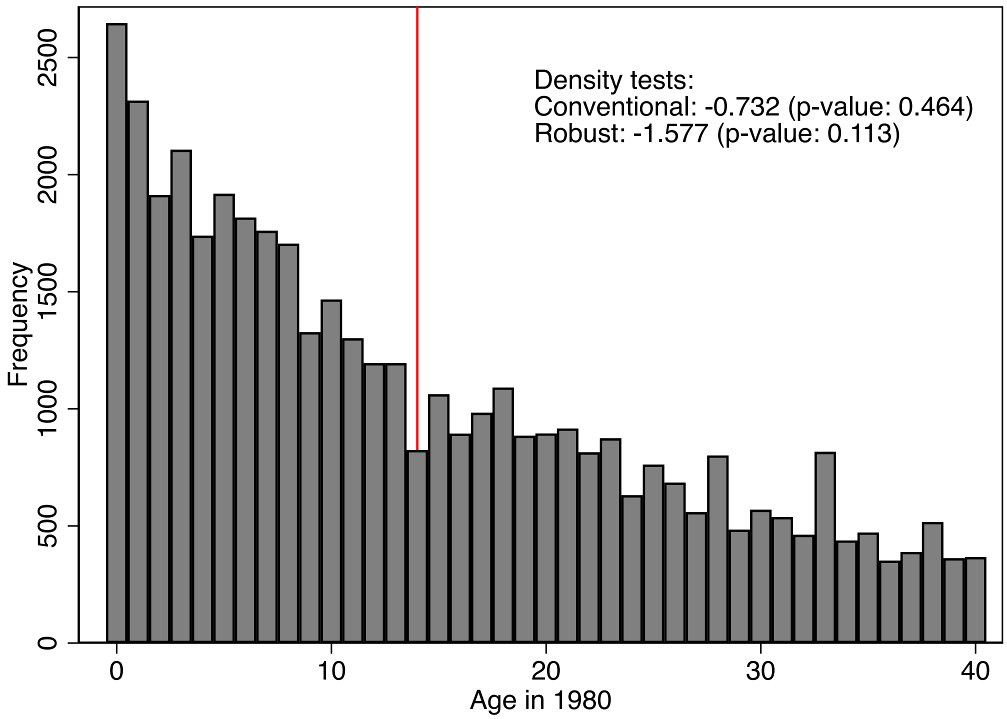
Table 7. Mechanisms (2SLS): migration by 1982, fertility and type of employment

	Moved out of district of birth by 1982	Mother's age at first birth	Number of children born to the mother	Employed in the primary sector	Employed in a high-skills Job
	(1)	(2)	(3)	(4)	(5)
Years of schooling	-0.013***	0.562***	-0.191***	-0.049***	0.030***
	[0.004]	[0.070]	[0.036]	[0.013]	[0.009]
F test	19.3	14.04	14.04	10.09	10.09
p-value	0.001	0.002	0.002	0.006	0.006
Observations	1,492,031	6,375	6,375	8,593	8,593

Note: Each column represents a separate regression; robust standard errors clustered by age in 1980 appear in brackets. All regressions include linear splines in age in 1980 (coefficients not shown) and gender and the bandwidth is restricted to ages 10 to 20 in 1980. All samples include black Zimbabweans only. Column 1 focuses on males and females interviewed in the 1992 Population Census regarding their location in 1982. Columns 2 and 3 refer to women in the ICDS while columns 4 and 5 refer to males and females. In these last two columns we drop cases where occupation was coded unknown. A person is regarded as employed in the primary sector if her/his main activity was recorded as agriculture or mining; s/he is regarded as employed in a high-skills job if their main occupation code was less than 500 in the census classification. Not all occupation codes greater than 500 fall in the primary sector. The instrument for parent schooling is the discontinuity at age 14 in 1980. The reported F-statistics refer to this excluded instrument. Statistical significance is indicated by * at 10%, ** at 5% and *** at 1%.

Appendix figures and tables

Figure A1. Histogram of the assigning variable: Age in 1980



Note: Density tests are conducted using the optimal bandwidth of -/+ five years around the threshold (14 in 1980).

Table A.1 Age in 1980 and Completed Years of Schooling (Blacks only)

	Dependent variable: Completed years of schooling		
Bandwidth:	0-40	10-20	12-17
	(1)	(2)	(3)
	Panel A: All ages in 1980		
1(AGE1980≤14)	2.112***	0.707***	0.548***
	(0.253)	(0.153)	(0.0881)
Observations	42,844	11,791	6,152
Adjusted R-squared	0.176	0.068	0.030
	Panel B: Excludes 14 years olds in 1980		
1(AGE1980≤14)	2.191***	0.615***	0.313***
	(0.262)	(0.144)	(0.0470)
Observations	42,020	10,967	5,328
Adjusted R-squared	0.178	0.070	0.030
	Panel B: Excludes 15 years olds in 1980		
1(AGE1980≤14)	2.294***	0.855**	0.313**
	(0.238)	(0.281)	(0.0766)
Observations	41,782	10,729	5,090
Adjusted R-squared	0.183	0.075	0.034
	Panel D: Excludes 14 and 15 years olds in 1980		
1(AGE1980≤14)	2.373***	0.763**	0.0779***
	(0.247)	(0.278)	(0.0245)
Observations	40,958	9,905	4,266
Adjusted R-squared	0.185	0.077	0.037

Note: Robust standard errors clustered by age in 1980 are shown in parenthesis. Sample is restricted to black Zimbabwean using the 1997 ICDS. The bandwidth changes by column: those aged between 0-40 in 1980 (column 1), between 10 and 20 (column 2) and between 12 and 17 (column 3). All regressions include (not shown) linear splines.
*** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.

Table A2. Age in 1980 and height: Black Zimbabweans

	Height (centimeters)	Height-for-age (Z–score)
	(2)	(3)
Panel A. Females		
1(AGE1980≤14)	-0.079	-0.012
	[0.335]	[0.052]
F test	0.055	0.054
p value	0.818	0.820
Observations	2031	2027
Means	160.2	-0.577
Panel B: Males		
1(AGE1980≤14)	-0.486	-0.082
	[0.676]	[0.113]
F test	0.517	0.519
p value	0.483	0.483
Observations	1648	1648
Means	171.3	1.276

Notes: Each cell represents an OLS estimate from regressing a different dependent variable on the discontinuity. The dependent variable is binary in Columns 1 and 4, and continuous in Columns 2 and 3. The height variables are taken from the 2010–2011 Zimbabwe DHS. Cluster-robust standard errors appear below the estimates in brackets. Clustering is at year of birth, i.e. age in 1980. All regressions include linear splines in parent age (coefficients not shown). Statistical significance is indicated by * at 10%, ** at 5% and *** at 1%.

Table A.3 Age in 1980 and Completed Years of Schooling in other African countries

	Dependent variable: Completed years of schooling						
Country:	Kenya	Rwanda	Senegal	South Africa	Uganda	Tanza-nia	Zambia
Census year:	1998	2002	2002	2001	2002	2002	2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1(AGE1980≤ 14)	-0.224	0.016	0.174	0.126	0.199	-0.054	0.110
	[0.345]	[0.090]	[0.664]	[0.090]	[0.242]	[0.314]	[0.130]
N	574554	249464	356777	1720606	831325	1359930	385693
Adjusted R^2	0.135	0.102	0.042	0.106	0.096	0.151	0.054

Note: Robust standard errors clustered by age in 1980 are shown in parenthesis. Sample is restricted to natives in each country using the latest census available. The bandwidth includes those aged between 0-40 in 1980. All regressions include (not shown) quadratic splines and a binary variable for gender.
*** Significant at the 1 percent level; ** Significant at the 5 percent level; * Significant at the 10 percent level.