ESSAYS ON IMPACT EVALUATIONS OF EDUCATION AND HEALTH POLICIES IN SOUTHERN AFRICA

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ABSTRACT

This dissertation investigates the extent to which schooling changes attitudes of HIV stigma and how much abortion legalization policy improved educational and labor market outcomes, as well as the sexual and reproductive health behaviors of people in Southern Africa. Stigmatizing attitudes toward people living with HIV and AIDS (PLWHA) is prevalent in Sub-Saharan Africa, which discourages people from getting tested and revealing their HIV status. However, the influence of schooling on HIV stigma cannot be accurately estimated due to unobserved factors. So, I used an exogenous method called regression discontinuity (RD) that utilized the 1980 Zimbabwean education reform to examine if there was variation in education among birth cohorts as a result of increased access to education. I find that schooling has a significant negative effect on the propensity to stigmatize PLWHA and a positive effect on knowledge of HIV but has a zero impact on HIV serostatus and testing. These findings suggest that general schooling alone does not necessarily reduce HIV stigma (and, thus, prevalence) but changes peoples' (knowledge and, thus) willingness to express discriminatory attitudes toward PLWHA. Moreover, education changes knowledge and stigma, but it alone may not necessarily change sexual behavior (and, thus, prevalence).

Furthermore, many African countries only allow abortion in situations where the pregnancy causes risks to the mother. These restrictive laws have resulted in high cases of unsafe abortions, maternal mortality, teen mothers, and very short birth intervals in Africa. However, over the past two decades, few African countries have legalized abortion. As a result, in the second part of this dissertation, I estimate the impact of abortion legalization on sexual and reproductive health behaviors and women empowerment in South Africa. I adopt a difference-in-differences (DID) design that leverages variation across birth cohorts induced by the timing of the law and variation in access to abortion facilities across provinces. The findings show that exposure to the abortion law reduced early motherhood. The result also suggests that abortion legalization effectively boosted educational attainment and labor market opportunities, but there is no evidence that the policy impacted teen fertility, marriage, and early sexual debut.

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DEDICATION

To my son, Jarrett Ramsey Chibonore who allowed me to pursue my studies in Japan while he remained in my home country.

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CHAPTER 1

INTRODUCTION

1.1 Overview

Considering that human capital accumulation is vital for economic growth and poverty eradication, improving access to education remains a significant policy issue in developing countries. Several macroeconomic studies proved that education improves economic growth. Furthermore, microeconomic studies have also shown that education improves labor market outcomes and non-labor market outcomes such as health, attitudes, and perceptions. Given the high levels of HIV/AIDS, HIV stigma, unsafe abortions, teen motherhood, maternal mortality rates, and very short birth intervals in Africa, particularly southern Africa, human capital investment becomes paramount in the region. For instance, more than half of the people living with HIV/AIDS dwell in Africa (UNAIDS 2019), where HIV stigma is also relatively high compared to other continents. HIV stigma creates a conducive environment for spreading the virus as people will not be willing to disclose their HIV status (Kilewo et al. 2001; Deribe et al. 2008; Sambisa et al. 2010), which puts the continent at a standstill when it comes to curbing the disease.

To top it up, Africa is one of the continents with the highest rates of unsafe abortions (Singh et al., 2018). This restricts girls from reaching their full economic potential as they either become sick and stigmatized or become mothers before finishing school. Many social observers have proposed schooling as a major instrument that can be used to alter HIV/AIDS prevalence rates, HIV stigma, teen pregnancy, and high maternal mortality rates. This is because schooling provides the knowledge, understanding, positive attitudes, and perceptions of health-related issues (Strauss and Thomas 1998) and the power and the strength to make the right decisions regarding one's well-being (Cannonier and Mocan, 2018).

As a result, governments in Africa have responded to improving their country's human capital by introducing direct and indirect policies targeted at increasing the educational attainment of both men and women, a strategy also seen in other developed and developing countries. The direct policies involve introducing free primary education, automatic grade progression, provision of free school uniforms, and removal of age restrictions. These policies are intended to increase access to education, especially for women. The indirect policies include abortion laws to significantly reduce teen fertility and teen marriage and trigger an increase in educational attainment for women. However, whether these policies are effective in Africa remains unclear. For instance, in their study, Tsai and Venkataramani (2015) found no link between schooling and HIV stigma in Uganda.

Additionally, evidence is scarce as to whether abortion legalization can effectively reduce teen motherhood and improve female schooling. Motivated by this inconclusive and scarce empirical evidence in Africa, this dissertation examines the causal effect of education and abortion laws on HIV status, attitudes toward PLWHA, sexual and reproductive health behaviors, and women empowerment. Specifically, the first study examines whether schooling can reduce HIV stigma, status, and testing using data from Zimbabwe (Chapter 2), and the second study focuses on the impact of abortion legalization on sexual and reproductive health behaviors and women empowerment in South Africa (Chapter 3).

1.2 Main findings

The main findings, reported in chapter 2, show that the 1980 educational reform led to an increase of 1.43 years in educational attainment for individuals who benefitted from the policy. The IV regression analysis result shows that the increase in schooling years significantly reduces HIV stigma. Specifically, a one-year increase in education for the treatment group reduced negative attitudes toward PLWHA index by 0.16 standard deviation units. However, l did not find any evidence that education affects HIV status and testing. Concerning the possible mechanisms through which education might affect HIV stigma, I find that a one-year increase in education increases the HIV knowledge index by 0.13 standard deviation units.

The results in chapter 3 show that the abortion legalization policy significantly decreased teen motherhood and teen fertility and improved women's schooling and employment status in South Africa.

1.3 Organization of the dissertation

The remaining part of this dissertation comprises two chapters that present a detailed analysis of two topics. Chapter 2 examines the causal effect of schooling on HIV status and stigma using data from Zimbabwe. First, I provide motivation for this study. Followed that, I describe the institutional background to the education policy, organization of data, and a detailed description of the empirical strategy and then discuss the results and the mechanisms through which schooling reduces HIV stigma.

Chapter 3 analyzes abortion legalization policy on women empowerment and sexual and reproductive health behaviors using data from South Africa. First, I provide institutional background to the abortion law and review the related literature studies on this topic. Next, I discuss the organization of data and then provide a detailed description of the empirical strategy. Lastly, I discuss the results.

In the final chapter, I conclude with a discussion on the policy implications of these two chapters and possible areas of extensions.

CHAPTER 2

CAN SCHOOLING REDUCE HIV STIGMA? EVIDENCE FROM ZIMBABWE

2.1 Introduction

2.1.1 Motivation

Despite the tremendous decline in the number of deaths from Acquired Immune Deficiency Syndrome (AIDS) and new Human Immunodeficiency Virus (HIV) infections globally, the number of people infected with the virus has remained relatively high in Sub-Saharan Africa (SSA) (UNAIDS 2019; Mbonu et al.2009). As of 2018, almost 37.9 million people were HIV positive worldwide, with 54.4% living in SSA. Given the magnitude of the epidemic, there has been extensive focus on reducing infection rates in the region (UNAIDS 2019). However, the stigmatization of people living with the disease has made it difficult to reduce the number of new HIV infections in the region. HIV-related stigma can deter people from getting tested, seeking treatment, participating in HIV educational programs (such as mother-to-child transmission programs), practicing safer sex (i.e., use of condoms), and disclosing HIV status lest they are suspected of being HIV positive and become outcasts in their communities (Mahajan et al. 2008; Kilewo et al. 2001; Deribe et al. 2008; Sambisa et al. 2010). Unless stigmatizing HIV stops, it will remain difficult to reduce HIV prevalence in SSA. Stigmatizing attitudes toward people living with HIV and AIDS (PLWHA) are strongly associated with inadequate knowledge and misconceptions about how the virus is transmitted (Alemi and Stempel 2019). Hence, many HIV education and prevention programs focus on increasing HIV knowledge to reduce misconceptions about the disease.

Schooling has proven to positively influence various health outcomes (Miech and Shanahan 2000; Aizer et al. 2005; Grossman 2006; Montez and Friedman 2015) because schooling ensures that people have better knowledge, understanding, attitudes, and perceptions of health-related issues and the world (Strauss and Thomas 1998). Particularly, formal education enhances the way individuals process information, making them more health-conscious (i.e., seeking and adhering to treatment). Economic theory provides several explanations for why education influences HIV status and attitude towards people with HIV. Firstly, schooling may influence sexual behavior and perceptions through improving their HIV knowledge, attitudes, and perceived behavioral control (Jukes et al. 2008, Agüero and Bharadwaj 2014, Altindag et al., 2011). Therefore, an increase in education may lead to a rise in HIV knowledge that will affect sexual behavior, HIV status, and attitude towards people with HIV. Secondly, schooling may affect HIV status through increasing female bargaining power during sex and age at first sex and marriage (Behrman 2015; Cannonier and Mocan 2018; Psaki et al. 2019). Other studies on the cognitive formation of schemas attempt to explain attitudes toward people infected with

HIV. They argue that people often do not want to come into contact with infected persons and have negative attitudes toward prostitutes, homosexuals, bisexuals, and drug users due to a lack of understanding of how the disease is acquired and transmitted (Herek and Capitanio 1995).

Given the magnitude of the HIV and AIDS epidemic and persistently high levels of stigmatization around the disease in SSA, there is a need to better understand the role that schooling might play in reducing the spread of the virus in the region (UNAIDS 2019).[1] However, few studies examine the effects of education on HIV status and testing, using the education policy change as a natural experiment. These studies estimated the effect by either two-stage least squares (Behrman 2015; de Neve et al. 2015; Cannonier and Mocan 2018) or regression discontinuity (RD) design (Agüero and Bharadwaj 2014). Furthermore, most of these studies focus on HIV status and testing while neglecting HIV stigma and discrimination, which is one of the main obstacles to effective responses to HIV. To date, the causal relationship between schooling, negative attitudes toward PLWHA, and the mechanisms through which education may affect HIV stigma is yet to

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[1] There is another strand of literature supporting the notion that education reduces stigmatization of people with mental illness (Boysen and Vogel 2008; Barke et al. 2011; Low et al. 2019), people may show less empathy to people with behaviorally related diseases like HIV (Boysen and Vogel 2008). Therefore, it is likely that highly educated individuals may not disclose their HIV status, since the cost of doing so may be higher compared to less educated individuals. For example, they may lose high paying jobs and business deals, which may not be the case for the less educated individuals.

be fully established. Several existing cross-section studies have focused mainly on the association of schooling and attitudes toward people with HIV, but have failed to provide a causal link between education and HIV stigma. One exception is Tsai and Venkataramani (2015), which finds no link between female education and HIV stigma in Uganda. However, socially embedded gender differences in responsibilities, roles, and power, combined with biological differences between men and women, can contribute to differences in HIV stigma, and health-seeking behavior (Psaki et al., 2019). For example, women generally take HIV tests when they get pregnant, but it is voluntary for men. Such differences may cause differences in HIV stigma and test refusal (See Sambisa et al., 2010). However, little is known about gender differences in HIV-related outcomes, especially stigma and status disclosure.

Understanding gender differences in HIV stigma and status disclosure is important for designing gender-sensitive programs that promote HIV testing and status disclosure among PLWHA. Thus, the present study complements Tsai and Venkataramani (2015) study by analyzing the causal relationship between education and HIV stigma in a different country (Zimbabwe) and providing heterogeneous treatment effects by gender and area of residence. Thus, this study contributes to the ongoing discussion of the role of education in reducing HIV stigma and providing heterogenous treatment effects by gender and area of residence. Furthermore, this study investigates the impact of education on biomarker-based HIV serostatus, which improves the objectivity of the results.

2.1.2 Objectives

This chapter's main objective is to investigate the causal effect of schooling on negative attitudes toward PLWHA and HIV status and testing in a country where HIV rates and HIV stigma are quite high and provide channels through which schooling can influence HIV stigma. The major challenge in analyzing the causal impacts of schooling on HIV-related outcomes is unobserved factors that may affect schooling and HIV stigma, such as family background, preferences, and community-level characteristics.[2] I take advantage of the educational reform implemented in 1980, which increased access to secondary schools in Zimbabwe. Although the reform benefitted both girls and boys, I expect the reform to have a larger effect on girls than boys because of the historical tendency to favor sending boys rather than girls to school.[3]

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[2] For example, an individual's education is likely to be correlated with their parent's educational attainment, mental ability, and social background and this information may not be captured in the data. Also, HIV stigma is correlated with beliefs; specifically, some people believe that all HIV-infected persons were promiscuous. Several studies used educational reforms to study the effects of education on HIV-related outcomes (Behrman 2015; De Neve et al. 2015; Tsai and Venkataramani. 2015; Cannonier and Mocan 2018).

[3] To be more precise, children's education was perceived as a family investment, and parents were biased toward male education. Girls were to get married, and their education would benefit the family in which they were getting married.

2.1.3 Main findings

In this chapter, I find that the 1980 educational reform led to an increase of 1.43 years in educational attainment for individuals who benefitted from the policy. Furthermore, I find that schooling decreases HIV stigma. Specifically, a one-year increase in education for the treatment group reduced negative attitudes toward PLWHA index by 0.16 standard deviation units, but there is no evidence that the policy affect HIV status and testing. Regarding the mechanisms through which education might affect HIV stigma, I find that a one-year increase in education increases the HIV knowledge index by 0.13 standard deviation units. These findings may have three possible interpretations. First, general education alone does not necessarily reduce HIV stigma (and, thus, prevalence) but changes people's (knowledge and, thus) willingness to express discriminatory attitudes toward PLWHA. Second, education changes knowledge and stigma, but it alone may not necessarily change sexual behavior (and, thus, prevalence). Third, the education policy increased years of education by 1.43 from 6.5 years (control mean). This suggests that only primary education may not be enough to properly understand HIV outcomes in developing countries.

2.1.4 Organization of this chapter

The rest of this chapter is organized as follows. The next section provides a brief background of Zimbabwe's HIV situation and education system. Next, I review the relevant literature and clarifies the literature gaps that this study seeks to fill. After the literature review, I describe the dataset and identification strategy. Then, I present and discuss the estimation results.

2.2 Literature review

2.2.1 HIV in Zimbabwe

Zimbabwe discovered the first incident of HIV in the early 1980s, and the epidemic increased rapidly to a peak in 1998, with almost 1.8 million people living with HIV (Figure 2.1). The number of new HIV infections increased faster from 1980 to 1996 and started declining after that until 2009. However, both new HIV infections and HIV prevalence have declined slowly since 2009 (MOHCC 2018). Whereas HIV prevalence and new HIV infections were first noticed in 1980, the number of AIDS deaths only started rising after 1984 and reached a peak in 2002. This was followed by a sharp decline until 2014, and a steady decline continued until 2018. The decline in the number of HIV prevalence and new HIV infections started earlier than that of AIDS deaths due to massive educational campaigns on HIV-related issues being offered by the Ministry of Health and Child Care in conjunction with the donor community and schools.

Additionally, the use of condoms curbed the spread of the virus and, the discovery of antiretroviral drugs in the late 1990s significantly contributed to the reduction of HIV deaths, new HIV infections, and HIV prevalence. Nevertheless, as of 2018, 1.3 million (9% of the total population of 14.4 million) people lived with HIV/AIDS in Zimbabwe, and almost 60% were women. In the same year, the proportion of people living with HIV among adults (15–49 years) was 12.7%, 38,000 people were newly infected with HIV, and 22,000 people died from an AIDS-related illness (UNAIDS 2019). Hence, the country remained among the top eight most HIV-infected countries in the world.

Many people in Zimbabwe and Africa in general still lack comprehensive knowledge of HIV/AIDS. Hence the levels of stigma toward people with HIV remain high, with less than 41% of the interviewed persons between 2004-2014 in Zimbabwe, Malawi, Uganda, Mozambique, Lesotho, and Zambia expressing acceptance attitudes toward PLWHA (see Appendix Table 2.A.1).[4] Appendix Table 2.A.1 shows that the stigma, HIV, and education levels vary with each country. For example, the HIV prevalence in Mozambique and Malawi was quite similar in 2010-2011, but the level of accepting attitudes in Mozambique is relatively low compared to that of Malawi. The observed differences in HIV stigma could be attributed to the differences in education. The HIV educational programs may not have a great impact in a country with very low

[4] I only reported the DHS surveys with all the four main measures of stigma (stigma toward vendors, teachers, relatives, and HIV status disclosure concerns) used by DHS. Accepting attitudes refers to accepting attitudes in all the four main measures of stigma.

levels of education like Mozambique. This argument can also be supported in the case of Zimbabwe, where the level of education is relatively high, I observed a huge improvement in accepting attitudes toward PLWHA between 2006 and 2011. I specifically observe improvement in both the average years of schooling and accepting people with HIV.

Although HIV stigma has reduced compared to the 1990s, it remains a serious threat to public health, as most people are not yet willing to disclose their HIV status or to get tested due to the fear of being victimized by society.[5] Out of the 18,351 men and women who took part in the Zimbabwe Demographic Health Survey (ZDHS) in 2015, 21% displayed negative attitudes toward PLWHA, and almost 30% had never been tested for HIV.

2.2.2 The education system in Zimbabwe

2.2.2.1 Pre-independence education system

Zimbabwe was under colonial rule from 1890 to 1980.[6] During this period, the education system favored European settlers, as government schools were meant mainly for white children. At the same time, education was compulsory and free for white children but not for black children. Although the system was racially discriminatory, it

[5] In some cases, individuals opt for traditional herbs or medicine that are sold by uncertified persons, though they are aware that these may not be effective or safe to use.

[6] For example, Zimbabwe was "under British colonial rule as 'Southern Rhodesia' from 1890 to 1965 and then under the rule of local white settlers until 1980 as 'Rhodesia'" (SAHO 2022).

was relatively gender-neutral, meaning both girls and boys had almost equal opportunities to attend school. However, parents were more willing to invest in boys than girls; thus, fewer girls were privileged to go to school, especially to the secondary level.

2.2.2.2 Post-independence educational reform

Following its independence in 1980, the Zimbabwean government embarked on educational reforms to increase access to education. These included introducing free primary education, removing age restrictions on school entry, encouraging community support for education, and automatic grade progression, particularly from primary to secondary level (Dorsey 1989; Nhundu 1992).[7] The policy also made it possible for school dropouts to return to school.

As part of the reform, the new government embarked on massive expansion and construction of schools soon after independence, resulting in a 78.7% increase in the number of primary schools between 1979 and 1986 and a 620.9% increase in the number of primary schools secondary schools (Figure 2.2). Furthermore, primary school

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[7] The free primary education policy meant that parents were no longer paying tuition fees, but they would pay general-purpose fees ranging from ZWD 1.50 to ZWD 27 per annum, depending on the school location (Colclough et al. 1990). Community support was in the form of building materials, money, and labor for the construction of school facilities (Colclough et al. 1990). Automatic grade progression implies that students were allowed to proceed to secondary school after completing grade seven, regardless of the grade seven examination results (Nhundu 1992). However, the grade seven result determined whether a student could go to the best secondary schools, as the schools screened students according to these result.

enrollment increased from 0.82 million at independence to 2.26 million within the same period. This means that about 97% of primary-school-age children were in school by the end of the 1980s. Also, secondary school enrollment increased from 0.066 million in 1979 to 0.54 million in 1986. A greater percentage (78%) of students transitioned from primary school (grade 7) to secondary school (form 1) in 1986, up from 20% in 1979 (Dorsey, 1989). The sudden rise in school enrollment created a mismatch between the number of students and the number of trained teachers soon after independence. As a temporary measure, the government employed temporary/assistant teachers and introduced multi-shift teaching, while the training of qualified teachers continued (Nhundu 1992).

Soon after independence, the dramatic increase in school enrollment has been extensively documented in the literature (Dorsey 1989; Edwards and Tisdell 1990). Although it is difficult to separate the effect of each of the four main educational policies that the government of Zimbabwe undertook in 1980, scholars like Nhundu (1992) believe that the removal of age restrictions and the introduction of free primary education allowed more students to enroll in primary schools soon after independence. At the same time, the automatic grade progression (automatic entry to secondary after completing primary school (grade 7)) and the massive construction of secondary schools increased the number of pupils enrolled in secondary schools soon after independence. In as much as the reforms impacted both primary and secondary education in Zimbabwe, statistics show that the reforms had a large impact on secondary education compared to primary schooling (Dorsey 1989).[8] Like other studies (Agüero and Bharadwaj 2014, Grépin and Bharadwaj 2014), I will concentrate on the change created by removing barriers to entering secondary school.

Zimbabwe follows a 7-4-2-3 system of education (7 years of primary, 4 years of secondary, 2 years of advanced high school, and 3-4 years of college or university), with an official school entry age of six. This implies that children aged 13 and below in 1980 had a higher chance of attending secondary school than their older siblings. However, due to the removal of age restriction, I expect kids who were aged 14 and 15 years to have partially benefitted from the policy. It is unlikely that students who were aged 16 and above might have benefitted from the new policy. It is important to note that the school curriculum for both primary and secondary schools did not include HIV-related issues up until 1992 (O'Donoghue 2002).[9] Generally, the 1980 educational reforms generated a

[8] This is because the majority (close to 75%) of black school-aged children were able to attend primary school, but only 12% of them could progress to secondary school before 1980 (Dorsey 1989). In other words, the colonial masters were not so restrictive when it came to primary education, but instead encouraged it for easy communication and to create the necessary less skilled labor, which was key for industry. During the apartheid era, blacks were seriously regulated in their access to education in terms of the quantity and quality of education. See Dorsey (1989) and Nhundu (1992).

[9] The AIDS Action Programme for Schools was introduced in 1992 and was made compulsory in all schools (both

natural experiment, where girls aged 15 years or younger had more years of education and higher chances of attending secondary school due to the automatic grade progression policy, removal of age restrictions, easy access, and greater availability of schools. To assess the effect of education on HIV stigma-related outcomes, I use the timing of the post-independence educational reforms in Zimbabwe.

2.2.3 Empirical evidence

The HIV and AIDS stigma concept is heavily aligned to Goffman's (1963, p. 256) work, which defined stigma as "an attribute that is significantly discrediting" that makes society demean the person with those attributes. Accordingly, stigma is characterized by rejection, denial, discrediting, disregarding, underrating, and social distancing of individuals. Goffman's theory was developed to explain social issues about social change and social construction (i.e., tolerance of outcasts). The concept has been applied to health-related issues like mental illness (Corrigan 2007), cancer (Fife and Wright 2000), and HIV and AIDS (Herek 1990, Tsai and Venkataramani 2015). Health-related stigma refers to rejection, exclusion, blame, or devaluation that individuals anticipate or experience from society due to actual or perceived medical condition (Genberg et al. 2009). For example, stigma faced by intravenous drug users, along the lines of "all junkies

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primary and secondary) starting from grade four. The program creates awareness and understanding of HIV related issues.

have AIDS." Furthermore, the attribution theory in psychology predicts that individuals will stigmatize certain conditions or problems based on whether the problem is a result of controllable behaviors.

The link between HIV testing and stigma can be best understood using a model developed by Bursztyn et al. (2019) on how peer pressure can affect educational investment. Borrowing from their model, I assume two types of agents (A and B) living in a community where people with HIV are discriminated/stigmatized. Considering their past sexual behavior, type-A agents believe that they are HIV negative, and type-B agents believe that they are HIV positive. We assume that the anticipated gain (benefit) of being tested for HIV is symmetric across both agents, HIV testing is voluntary, and their beliefs are correct. In this case, HIV testing can help the agents to update their sexual conduct after knowing their status. Given that, the test results are likely to be known by peers due to strong social ties in Zimbabwe.[10] Type-B agents have a higher chance of rejecting the test than the type-A agents since the test outcome can bring them psychological stress and discrimination from community members. In support of these notions, Arimoto et al.

[10] In Zimbabwe, family chain is quite long and it includes extended families and neighbors which makes it easy for people to notice your behavior change after being tested (e.g. deterioration in health, having fewer partners, being more likely to use condoms). Also, there is no privacy since the number of family members living in the same compound is generally large and it makes it easy for other family members to notice that their relative is taking ARVs.

(2013) found a negative association between HIV testing and social ties at workplaces in South Africa. Furthermore, since infecting someone knowingly can be criminal in Zimbabwe this can be a bigger disincentive to people who think they are HIV positive than to those who do not.

In this study, we focus on external HIV-related stigma, that is, attitudes or actions toward PLWHA. These attitudes or actions may include rejection, judgmental attitudes, discrimination, avoidance, intolerance, and stereotyping, for instance (Florom-Smith and De Santis 2012). HIV/AIDS stigma induces shame and fear as it is associated with sexual immorality, and HIV-positive people are often blamed for their condition, unlike people suffering from other diseases (Bos and Onya 2008; Valdiserri 2002). Because of this, it is likely that even highly educated individuals may not disclose their HIV status or that of their family members, since the cost of doing so may be higher compared to the case of less-educated individuals—for example, they may lose their jobs, risk not getting a job, or promotion, which may not be the case for less-educated individuals. This type of behavior creates a conducive environment for HIV to spread and partially explains why many people do not get tested and do not disclose their HIV status.

The causal relationship between education and attitudes toward PLWHA is linked to political science and sociology literature, where formal schooling is identified as a key determinant of tolerance, attitudes, and identity (Prothro and Grigg, 1960; Herek and Capitanio 1995). This is because schooling affects students' cognitive and non-cognitive skills: analytical reasoning, ability to comprehend complex issues, social skills, and community responsibility (Garcia 2016). Individuals with more schooling are more likely to learn about health and health risks and understand and comprehend health information. Also, individuals with more education are more open to health education campaigns and programs. Thus, schooling can improve health knowledge, beliefs, and attitudes and lead to greater self-advocacy and a better lifestyle. The skills obtained during schooling can make the highly educated individuals more able to understand health care issues and always keep up to date with the topical health news. Empirical studies have also supported this argument that more educated persons are quick to adapt and adopt new information that may alter health behavior and attitudes.[11] Agüero and Bharadwaj (2014) analyzed the causal impact of education on schooling and found a positive and significant impact of schooling on HIV knowledge. Altindag et al. (2011) analyzed the impact of education on health knowledge and found weak evidence that education improves health knowledge.

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11 Price and Simon (2009) discovered that vaginal birth after having a previous C-section birth significantly declined following the publication of an article on the risk of a vaginal birth after having a previous C-section birth in the New England Journal of Medicine. Likewise, it was found that there was a significant cut in the number of cigarettes taken by more educated mothers per day soon after the announcement of the 1964 Surgeon General Report on smoking and this did not happen for the less-educated mothers (Aizer and Stroud 2010).

Furthermore, education can shape someone's character and can be viewed as a basis for attitudinal change. That is, higher education can help individuals to be more tolerant (Bobo and Licari 1989). Bobo and Licari (1989) examined the impact of schooling and cognitive sophistication on political tolerance, and they found that education had a strong positive effect on political tolerance.[12] The effects were strong regardless of the individuals' feelings toward the target group, and this could explain why the educated persons have so much patience toward political leaders. Roth and Sumarto (2015) took advantage of the government policy which was implemented in Indonesia in 1965, which resulted in massive construction of schools to analyze the causal link between education and attitudes toward people who belonged to other religions and ethnic groups. They found that the exogenous increase in education that benefitted people born after 1965 resulted in these people being more tolerant of other ethnic and religious groups, particularly a year increase in education increases tolerance level by 0.4 standard deviations. In another study by Hodson and Busseri (2012), they find that lower cognitive ability during childhood results in higher prejudice in adulthood (i.e., less contact with

[12] Cognitive sophistication is defined as a person's ability to handle new information and reorganize their ideas in more sophisticated ways and according to different situations. It can be measured by "intellectual interests, openness to new ideas, and willingness to risk uncertainty and ambiguity" (Bobo and Licari, 1989)

out-groups and more conservative). Cavaille and Marshal (2019) find that one more year of schooling significantly lowers the probability of opposing immigration, believing that immigration erodes a country's quality of life, and feel close to far-right anti-immigration parties in Western Europe.

Another strand of literature supports the notion that education reduces stigmatization of people with mental illness (Boysen and Vogel 2008; Barke et al. 2011). Several other cross-sectional studies showed that educational attainment significantly contributed to lowering negative attitudes toward stigmatized "outgroups" such as religious (Rosenfield 1982) and sexual minorities (Loftus 2001) in the US. For example, education accounted for almost one-third of the change in attitudes of American people toward accepting homosexuality in the country (Loftus 2001). Herek and Capitanio (1995) also found similar results where the more educated possessed more liberal attitudes toward homosexuality compared to those who were less educated.

There is, however, very little evidence in the literature that links education with HIV stigma, and most of the studies use cross-sectional data and less rigorous estimation techniques (Chiao et al. 2009; Girma et al. 2014; Stephenson 2009). As mentioned earlier, only one good study by Tsai and Venkataramani (2015) used the Free Primary Education policy implemented in Uganda to instrument years of schooling to establish the causal effect of schooling on HIV stigma and finds no link between schooling and HIV stigma. This study adds to this small but growing literature on education and HIV stigma by analyzing the impact of schooling on a wider range of HIV-related outcomes and unpacking the gender differences associated with HIV status and stigma.

Regarding the link between education and HIV serostatus and testing, quasi-experimental studies in developing countries have mostly demonstrated a negative causal link between education and HIV status and testing. Behrman (2015), for example, used the Universal Primary Education programs implemented in Uganda and Malawi to estimate the causal effect of education on HIV status, finding that one further year of education reduced the risk of HIV infection by 40% and 33% in Malawi and Uganda, respectively. Another closely related study by De Neve et al. (2015), using the education policy implemented in secondary schools in Botswana in 1996 and the instrumental variable estimation, revealed that an additional year of education reduces the chances of being HIV positive by 31.8%. Cannonier and Mocan (2018) discovered that a year increase in schooling increases the chances of getting tested for HIV by 8.5% among women in Sierra Leone.

2.3 Data, sample frame and major variables, descriptive statistics, and empirical framework

2.3.1 Data, sample frame, and major variables

The data used in this study comes from the Demographic and Health Surveys (DHS) of Zimbabwe. To understand the recent HIV situation in Zimbabwe, we pooled the data from the last four waves of the DHS dataset (1999, 2006, 2011, and 2015). However, I only used 2006, 2011, and 2015 datasets for the HIV status analysis since the actual HIV testing only commenced in 2006. These surveys are nationally representative surveys of reproductive-age women (15-49 years). DHS also collects information of men (15-54 years) of the surveyed households who would have agreed to be part of the survey. The ZDHS sample was selected using a stratified two-stage cluster sampling.

In all four waves, 56,991 individuals were interviewed. Since the identification strategy relies on the timing of the 1980 educational reform and age cohorts that were young enough to have not entered secondary (in primary) school in 1980 (an individual was born in 1965 or after, or age 15 or younger in 1980), I restrict the sample to include individuals born between 1959 and 1972 (age 8-21 in 1980) to ensure comparability between the treated cohorts and control cohorts (Keats 2018).[13] Furthermore, I restrict the sample to individuals who answered questions on HIV stigma since it is the main

[13] I considered individuals born between 1959-1972 for 1999, 2006, and 2011 surveys, and between 1961-1972 for the 2015 survey.

variable of interest. Thus, the main sample consists of 11809 individuals, of whom 3,657 benefitted from the education policy.

Information on HIV status is based on a blood test conducted by the DHS for individuals who agreed to be tested. The HIV biomarker testing during the DHS survey is private and confidential. The respondents are assured that their results will not be known by family members, friends, and other community members. [14] Also, the respondents are told that the test results will not be given to them after the test. This helped respondents to freely take the test without fearing any form of stigma that may come with HIV testing. This helps since some people may even suspect them of being HIV positive just by seeing them getting tested. The survey indicates that 7,638 men and women had valid HIV test results, of which 5,404 women were treated. [15]Appendix Table 2.A.2 gives detailed information on how I constructed the two samples for this study.

The HIV testing rejection rate per birth cohort (1959-1972) ranges from 13-22% (Appendix Table 2.A.3). Since HIV status data is only available from individuals who consented to be tested during the survey, sample selection bias can occur when evaluating the influence of schooling on HIV status. Overall, the HIV testing rejection rate for the

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[14] Interviews and biomarker testing is conducted in private as much as possible so that no one will know that respondent took an HIV test.

[15] HIV sample is restricted to individuals who took the HIV test.

main group (age 8–21 in 1980) is 17.3%, which is lower than the 28.9% rejection rate experienced in Botswana (De Nev 2015) but higher than that of Uganda (6% according to the Uganda AIDS Indicator Survey). To rule out the possibility of a bias coming from differential non-consent by birth cohort, I performed an intention-to-treat regression of HIV status missing data on the treatment indicator (De Nev 2015). Appendix Table 2.A.4 displays no significant differences in the HIV rejection rate between the treatment and control groups. Thus, selection bias may not be a serious issue.

This study's main measure of educational attainment is education in single years (years of education). I also define educational attainment as secondary attendance, a dummy variable equal to 1 if the person had more than 7 years of education, and 0 otherwise. The DHS survey asked participants to read a phrase written in the native language as an assessment of their literacy skills. I classify individuals as literate if they were able to read the whole sentence. I used the age of the person and the years lived in their current place of residence to check whether they went to secondary school in their current province of residence. The current area of residence is defined as a dummy variable and equals 1 if urban, and 0 otherwise. Religion is a dummy variable and equals 1 if Christian and 0 otherwise. Age is a continuous variable. Ethnicity is a dummy variable constructed using native language and equals 1 if the person is a Shona native speaker and 0 for Ndebele and others. Gender is a dummy variable that takes on a value of 1 if the person is a male and 0 otherwise. Other community-level covariates include distance from the nearest boarder, temperature, slope, and rainfall (see Appendix 2.C.1 for the details). The geospatial covariates data was obtained from the 1999, 2006, 2011, and 2015 DHS geospatial data for Zimbabwe (available at https://spatialdata.dhsprogram.com). With the help of survey clusters, we linked the demographic data to the survey data.

The selection of the HIV stigma-related variables is guided by past studies on HIV testing uptake (Tsai and Venkataramani 2015; Kalichman and Simbayi 2003; Sambisa 2008) and the theories discussed in section 2. The main outcome of interest comprises seven HIV stigma-related questions. To be more specific, the questions capture peoples' stigmatizing attitudes toward PLWHA. Since Tuberculosis (TB) is closely related to HIV, one of the questions is on people's attitude toward TB patients.[16] The stigmatizing attitudes toward PLWHA questions can be divided into three main groups, namely, (1) *social rejection* (four questions); (2) *prejudiced attitudes* (two questions); and (3) *disclosure concerns* (two questions). Social rejection is when individuals are unwilling to accommodate PLWHA in their groups or circles. Disclosure concerns refer to whether

[16] TB is highly correlated with being HIV positive in Zimbabwe, and almost 80% of people with TB tend to be HIV infected (Ministry of Health and Child Welfare (MOHCW) 2012).

individuals are willing to open up on their HIV status or their family members' status. Prejudiced attitudes denote judgmental attitudes that individuals can display toward HIV persons. Appendix 2.C gives detailed information on the exact questions that form each of the three categories. I constructed a score variable that captures the number of questions an individual displayed some level of stigma. I then used the score variable to construct an overall measure of HIV stigma, a binary variable that takes a value of 1 if the person displayed some level of stigma toward people with HIV (HIV stigma score ≥ 1) and 0 if an individual showed no signs of HIV stigma (score = 0).

Similarly, HIV knowledge is defined as a dummy variable based on all the five HIV-related questions presented in Appendix 2.C.1.[17] The choice of HIV knowledge outcomes is guided by previous studies (Altindag et al. 2011 and Agüero and Bharadwaj, 2014). In addition, I constructed index measures of HIV stigma and HIV knowledge using the weighted z-scores of all the HIV stigma-related questions and HIV knowledge-related questions. To be more precise, I transformed all the outcomes that form each index (i.e., negative attitudes toward PLWHA index and comprehensive knowledge of HIV) into *z*-scores (in relation to the control mean) and then average all the z-scores of all the

[17] The DHS report defines comprehensive knowledge and negative attitudes toward people with HIV as dummy variables.

outcomes that form that index. Lastly, l then standardize the index to the control group. The standardized index and each component of the index have a mean 0 and standard deviation of 1 for the control group (see Kling et al., 2007; Banerjee, 2015). HIV test refusal is a dummy variable based on whether an individual agreed to be tested or not during the DHS survey. It takes a value of 1 if a person rejected the test and 0 otherwise.

Given that HIV stigma outcomes are based on self-reported responses, it can be argued that the relationship between education and attitudes toward PLWHA may be affected by social desirability bias. That is the more educated persons may tend to give socially acceptable answers and not reveal their true attitudes. Appendix Figure 2.B.1 illustrates that the more educated respondents consistently have less HIV stigma toward people with HIV than the less educated respondents. To test whether the observed differences in HIV stigma by education level is a result of social desirability reporting or not, I checked whether the responses of the highly educated persons in the same birth cohort varied systematically or randomly over the DHS survey rounds. Appendix Figure 2.B.2 shows that the attitudes toward PLWHA of the highly educated persons in the same birth cohort changed randomly over DHS survey rounds. Hence, I rule out the possibility of social desirability bias in our analysis.

2.3.2 Descriptive statistics

Table 2.1 presents the summary statistics of the main characteristics of the control (born before 1965) and treated cohorts (born in 1965 or later). Educational outcomes (years of education and the proportion of individuals who attended secondary school) indicate that educational attainments are higher for treated cohorts than for control cohorts. On average, the difference in years of is 2.5 years and that of secondary attendance is 0.3. Almost 29% of men and women in the sample were HIV positive, and 23% refused to be tested for HIV during the DHS survey. In addition, I observed a significant change in HIV stigma and HIV knowledge. In particular, the proportion of individuals who displayed some level of stigma toward HIV patients is significantly lower and the level of HIV knowledge is relatively large and significant for the treatment group. Women constitute 62% of the sample, and close to 36% of the main sample live in urban areas. Close to 64% of the population went to secondary school in their current province of residence. Most individual characteristics are significantly different between the treatment and control groups, with the exception of religion, region of residence, gender, ethnicity, distance from the nearest border, temperature, slope, and precipitation (controls). The descriptive statistics for the rest of the other outcome variables are described in Table 2.1.

2.3.3 Empirical framework

To investigate the effect of education on HIV-related outcomes, I apply fuzzy regression discontinuity (FRD) design, since ordinary least squares might yield biased estimates due to unobservable characteristics of the individual found in error terms that might be correlated with the level of schooling. I take advantage of the 1980 educational reform implemented throughout Zimbabwe, which created an exogenous increase in years of education for pupils who were 15 years and below in 1980 or who were about to enroll in secondary school. I argue that an individual's age at the time when the reform was implemented heavily impacted their years of schooling and chances of attending secondary school. Thus, I use the age-specific nature of the policy. Moreover, the cost of education was lower for individuals who were aged 15 or younger in 1980 compared to individuals who were just above age 15 in 1980 due to the massive construction of schools especially in rural areas that greatly lowered potential transportation costs for most rural kids and the removal of other restrictions that were targeted at African children in Zimbabwe before independence. As expected, Figure 2.3 shows that there were delays in primary completion for some students, and to fully capture the effect of the policy, I chose age 15 as the cutoff to benefit from the educational reform. Thus, the new education policy generated a fuzzy discontinuity in educational attainment in Zimbabwe for girls and boys just below or above age 15 at the time of policy implementation. Since FRD is equivalent to estimating two-stage least squares (2SLS), the first stage estimates are obtained using the following equation:

$$E_i = \gamma_0 + \gamma_1 Z_i + \gamma_2 f_i + \gamma_3 Z_i \times f_i + X_i \gamma_4 + e_i \tag{2.1}$$

where f is the forcing variable, representing the difference between the birth year of individual i and 1965 (the birth year divides individuals into the treatment or control groups), Z_i is an instrumental variable that equals 1 if the birth year is greater than 1965, indicating whether an individual benefited from the reform. To calculate the predicted values of years of schooling, equation (2.1) is estimated using ordinary least squares. The second stage of the model is estimated as follows:

$$Y_i = \beta_0 + \beta_1 \hat{E}_i + \beta_2 f_i + \beta_3 Z_i \times f_i + X_i \beta_4 + \varepsilon_i \tag{2.2}$$

where Y_i is the outcome variable of interest (HIV-related outcome) for an individual i; E_i is years of schooling; X is a vector of individual characteristics such as religion, the current area of residence, Shona (ethnicity), gender, distance from the nearest border, population density, rainfall, slope, temperature, provincial and survey year fixed effects; and ε_i is an error term. β_2 and β_3 are the linear approximation coefficients above and below the cutoff (1965), respectively.[18] I use linear approximations in Equations (2.1) and (2.2). Hence, β_1 from Equation (2.2) is the local average treatment effect and can be interpreted as the causal impact of education on outcomes. Since treatment status varies by year of birth and school construction is likely to have varied across provinces, standard errors are

[18] I include controls that I expect to be correlated with health outcomes. For example distance from the nearest border, population density, and hunger/poverty can affect the probability of having HIV. Generally, prostitution is very high around border posts, highly populated areas, and drought prone regions.

clustered at the year of birth and provincial level. However, there are only ten provinces in Zimbabwe, which raises concerns about the spatial correlation of standard errors within a province since a lot of kids in the sample belong to the same province. I then performed the wild bootstrap tests recommended by Cameron et al. (2008) in all the estimations. It is important to note that I exclude individuals who were 14-15 years old in 1980 in the main analysis since they were partially treated (see Figure 2.3).

The main identification assumptions in this setup are: (i) individuals are unable to manipulate treatment status, (ii) covariates affecting both years of schooling and health outcomes vary smoothly across the cutoff, (iii) the outcome variables change solely as a result of the individual's years of schooling, and (iv) the instrumental variable is relevant. I discuss the validity checks of assumptions in the next section.

2.3.3.1 Identification and internal validity checks

The main assumption governing the empirical strategy is that children who were just younger than the cutoff age are similar in unobservable ways to those who were just above the cutoff. Concerns that may arise in this setup are manipulation of treatment status, smoothness of covariates, and other confounders. I will start by addressing the issue of manipulation of treatment status where parents could delay giving birth to children to benefit from the policy if they had prior knowledge about the upcoming education reform, especially the free primary education and the automatic grade progression components. If this happens, then the results may be biased. However, in the case of Zimbabwe, everyone was unaware of when the country would gain independence and no one knew that education reform would come the same year as independence. Nevertheless, I formally check for any signs of manipulation of the running variable (year of birth) using the methods suggested by Imbens and Lemieux (2008). A histogram showing the distribution of birth cohorts in Appendix Figure 2.B.3 indicates no proportional decrease in births just before the cutoff. Therefore, there is no evidence of systematic manipulation of the running variable. To further support the result, I performed the McCrary (2008) tests shown in Appendix Figure 2.B.4. The null hypothesis, that the year of birth remains continuous at the cutoff is not rejected even at 10% level. This implies that no one could manipulate treatment status.

Another concern is the issue of deaths or if the educational reform reduced HIV-related deaths. Individuals in the control cohorts are older than those in the treatment cohorts. Some individuals between 30 and 40 years in the control cohort were infected by HIV/AIDS and are likely to have died before the surveys took place. The remaining population in the older birth cohorts may have different characteristics than that in the younger birth cohorts, making treatment and control birth cohorts incomparable. This is not an unusual problem when studying issues for the elderly.

Nonetheless, if the survival rate is smooth across the cutoff year, the issue of HIV-related deaths should not affect our estimates. Based on the McCrary density test (Appendix Figure 2.B.4.), we can partly rule out the HIV-related deaths concern. Also, I tried to check whether there is any discontinuity in HIV-related deaths using the adult mortality rate recorded in DHS data. Although I should check the mortality rate due to AIDS by cohorts around the cutoff, I use adult mortality in general due to data limitation to check if the mortality rate significantly varied around the cutoff. Given that AIDS is the highest cause of adult death in Zimbabwe, I would expect the result not to change much, even when considering the survival rate due to AIDS-related deaths.[19] This provides a general picture of any discontinuity on the mortality rate around the cutoff.[20] According to the graph in Appendix Figure 2.B.5, there is no discontinuity on the adult mortality rate at the cutoff.[21]

The smoothness of covariates at the threshold is a concern, as it may fail to hold if there are other policies related to education implemented around 1980. If this is the

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[19] Since 2000, more than 70% of adult mortality has been due to HIV-related disease in two major cities of Zimbabwe (Harare and Bulawayo) (Dlodlo et al. 2011).

[20] Information on mortality is only available in the DHS females dataset and that is what l used to construct the graphs

[21] The same trend is obtained even when I consider adult mortality rate due to non-maternal related deaths.

case, the estimated results will be biased as they will capture the causal effect of the 1980 reform and of other policies. To rule out this concern, I performed a test for the smoothness of covariates, and the results are presented in Appendix Figures 2.B.6 and 2.B.7. The graphs in Appendix Figures 2.B.6 and 2.B.7 show no jump/discontinuity around the cutoff in religion, area of residence, gender, ethnicity, distance from the nearest border, temperature, slope, and rainfall, providing evidence that no other policy implemented around 1980 affected the outcome variables. Therefore, I assume that the smoothness of covariates assumption holds.

I use a local linear regression to estimate the discontinuity and allow for different slopes on both sides of the discontinuity (Imbens and Lemieux 2008; Lee and Lemiuex 2010). For my main analysis, I use an ad-hoc bandwidth of 6 after excluding individuals who were 14-15 (partially treated cohorts) years old in 1980. Thus, in the main analysis, I compare individuals who were 8-13 years against those who were 16-21 years in 1980. All estimates were weighted to be nationally representative using the survey weights provided in the ZDHS and adjusted to reflect pooling across multiple survey years.

2.4 Estimation results

2.4.1 Impact of the 1980 reform on education

Figure 2.4 graphically shows a discontinuity in the years of education and the chances of attending secondary school. The birth cohorts are normalized at the pivotal cohort so that the value of a given birth cohort is positive for post-reform cohorts and negative for pre-reform cohorts. The graph on the left represents education being measured by completed years of schooling, and the graph on the right represents education being measured as a dummy indicating secondary attendance. Figure 2.4 depicts a clear discontinuity in the probability that a child who was age 15 or younger in 1980 would have more years of schooling and increased chances of attending secondary school compared to those who were just above age 15. Accordingly, Figure 2.4 shows that the education reform increased the mean years of schooling and the probability of enrolling in secondary school for the cohorts after the cutoff.

Table 2.2 displays the results obtained from the estimation of Equation (2), where years of schooling and the probability of attending secondary school are regressed on the instrumental variable *Z*, which is the dummy variable that measures an individual's exposure to the 1980 reforms. The result indicates that being exposed to the 1980 education reforms increases individual's schooling by 1.43 (Panel B, column 1) years compared to older cohorts who were not exposed to the program.

Furthermore, being a member of the birth cohorts exposed to the reforms increases the probability of attending secondary school by almost 18.7 percentage points (55.3 percent) (Panel B, column 2) compared to older cohorts not exposed to the reforms. Table

2.2, Panel A, shows that these results are robust when women and men aged 14-15 are included. Interestingly, the effects of the policy get smaller when I include individuals who were aged 14 and 15, which supports the fact that these individuals were partially treated. Hence, this justifies excluding individuals aged 14-15 in 1980 in the main analysis. The reform induced a massive increase in school enrolment that might have also reduced school quality. Therefore, increases in educational attainment may not imply improved learning. Table 2.2, panel A, column 3 outlines results on the impact of the policy on literacy. The results suggest that the treated cohorts were 9.3 percentage points (11.7 percent) more likely to be literate. Hence, I can rule out the possibility of reduced school quality due to the policy, at least for reading ability.

Although the policy benefitted both boys and girls who went to secondary school after 1980, the heterogeneous effects of the policy in Table 2.3 suggest that the education policy had a large impact on females compared to males. The differences are also observed graphically in Figures 2.5 and 2.6. This is not surprising since parents were biased toward sending the boy child to school. Hence, the policy had a larger impact on girls than boys.

Furthermore, the education law might have had a differential impact on urban and rural residence due to school accessibility and availability of school resources such as textbooks and infrastructure. To understand these differences, I estimated the effect of the education policy on educational attainment by area of residence in Table 2.4. The results suggest that the law increased the years of education by 1.77 for rural and by 0.82 for urban. Apart from the analysis for men, the F-statistics of the excluded instrument in all estimations is above 10, which implies that the instrument is relevant.

2.4.2 Impact of education on HIV status, testing, and attitudes toward PLWHA.

Table 2.5 presents the estimated effect of schooling on the main outcomes. Overall, an additional year of education is associated with an 8 percent (a decrease of 5.7 percentage points from the base of 71 percent) decrease in negative attitudes toward people living with HIV (using an indicator of not showing any signs of negative attitudes toward PLWHA in any of the HIV stigma related questions). This result is consistent when I consider negative attitudes toward PLWHA as an index variable; specifically, I find that a year increase in education reduces negative attitudes toward people living with HIV index by 0.16 standard deviation units. However, there is no evidence that education affects HIV serostatus and the probability of refusing an HIV test. The graphical representation of the effect of education on HIV status, testing, and negative attitudes toward PLWHA is shown in Figure 2.7. The figure displays significant differences in negative attitudes toward people with HIV between the treated and control group. There is no significant differences in HIV status and testing of the treated and non-treated group.

The HIV status and testing result is in line with Agüero and Bharadwaj (2014), but that of HIV stigma is different from the recent study by Tsai and Venkataramani (2015). The possible reason as to why I find a different result from Tsai and Venkataramani (2015) is that the Zimbabwe's education policy was aimed at secondary attendance, while that of Uganda is aimed at primary attendance and completion. This suggests that only primary education may not be enough to properly understand HIV stigma for poorer countries.

The result suggests that education is not the key for people to get tested for HIV, but the other factors, such as stigma surrounding the test results in the event of testing positive, are the key. In countries like Zimbabwe, where stigma is high and people can be criminalized for infecting their partners knowingly, the benefits of not knowing your HIV status may outweigh the benefits of getting tested. Sambisa et al. (2010) found a positive association between HIV testing and stigma in Zimbabwe. Hence, the criminalization of HIV/AIDS and high levels of HIV stigma may partly explain why education cannot improve HIV testing in Zimbabwe. The results for all the indicators of HIV stigma are displayed in Appendix 2.D.

The effect of education on stigma may be heterogeneous between males and females and between urban and rural residence. To test for heterogeneity in the impact of education, I repeat the same regression analysis by gender and area of residence. The results are presented in Tables 2.6 and 2.7, which show that education's effect on stigma varies by gender and place of residence. For example, education increased by 1.77 years of education for women, and for men, it was 1.12 years. So the impact of education on the stigma index is -0.21 (1.771*-0.120) for women and -0.21 (1.118*-0.186) for men. Similarly, the reform lowered the stigma index by 0.26 (1.771*0.147) for rural residence and 0.14 (0.823*0.173) for urban residence. Overall, the results show that the impact of the reform is relatively large for women and rural residents. This resulted in a relatively large effect of education on stigma for rural residence and an almost similar impact for men and women. Again, there is no evidence that education has a heterogenous impact on HIV serostatus and testing.

2.4.3 Channels linking education to HIV stigma

Guided by literature and the empirical evidence discussed in section 2.2.3, the possible mechanisms through which education might have affected HIV stigma are improving HIV knowledge and tolerance of people with HIV. Due to data limitations, I only explore how education may affect HIV knowledge as one of the possible mechanisms for HIV stigma. Although not being the best measure of the mechanism that education might have affected HIV stigma, HIV knowledge can partially explain the channel through which education can affect HIV stigma. There is a general misconception on how HIV is transmitted and DHS asks questions to try and capture the misconceptions around the disease. For example; whether HIV can be transmitted by mosquitoes or through sharing food. Also, some people tend to think that a condom is hundred percent safe and that a healthy-looking person is HIV-free. Many people in Zimbabwe judge someone's HIV status by their looks, and usually those who are fat are viewed as being healthy, while those who are thin are suspected of being HIV. All these questions can help to measure an individual's knowledge of HIV.

The results are presented in Table 2.8. The 2SLS estimate (Table 2.8) shows that schooling increases an individual's comprehensive knowledge of HIV by 16.59 percent (an increase of 6.8 percentage points from the base of 41percent). The result is also confirmed when I consider comprehensive knowledge of HIV as an index variable. I find that an additional year of schooling increases the knowledge of HIV index by 0.13 standard deviation units. Results of the study indicate the importance of education in helping people understand that HIV does not spread via mosquitoes or food sharing. The result can explain why more educated individuals are less likely to discriminate against people with HIV and to be HIV infected. These results are in line with the results obtained by Agüero and Bharadwaj (2014). The results for the main mechanisms discussed above are shown graphically in Figures 2.8 and 2.9. The graphs confirm a jump in the level of HIV knowledge around the cutoff. On average, individuals who benefitted from the policy had higher knowledge of HIV compared to those who did not.

To understand the differences between men and women and rural and urban residence obtained in Tables 2.6 and 2.7, I performed heterogenous analysis for the mechanisms. The results are presented in Tables 2.9 and 2.10. As stated previously, the reform increased the years of education for men and women by 1.18 and 1.77 respectively. It induced the years of education for rural residents by 1.77 and that of urban habitants by 0.82. Thus, the impact of education on comprehensive knowledge of the HIV index is 0.16 (1.118*0.147) for men and 0.20 (1.771*0.113) for women. Also, the reform raised the comprehensive knowledge of HIV for rural people by 0.26 (1.771*0.144) and for urban residence by 0.08 (0.823*0.103). Therefore, the gender and rural-urban differences in stigma observed in Tables 2.6 and 2.7 can be explained by the differences in the impact of the education reform on HIV knowledge.

2.4.4 Robustness checks

To test the validity of the main results, I performed several robustness checks. Since I am considering a range of outcomes, my results are likely to suffer from multiple inferences. I deal with this issue by employing the Romano-Wolf correction method, which considers the family-wise error rate (FWER) that may cause type 1 error when dealing with a family of hypotheses (Akresh et al. 2018, Jones et al. 2019; Clarke et al. 2020). Hence, I performed multiple hypothesis testing on all the main outcomes (HIV serostatus, HIV testing, HIV stigma index and dummy, and HIV knowledge index and dummy). The joint test confirmed the same significance level for all the outcomes as those obtained in the main results, see Appendix Table 2.A.5. Second, I use lower bandwidths to test the stability of all results discussed in the previous sections, and the results are presented in Appendix Tables 2.A.6-2.A.8 and they are all stable. Third, I included individuals who might have delayed enrolling in secondary school, particularly, I incorporated individuals who were aged 14 and 15 in 1980, and the results remained significant and stable (Appendix Tables 2.A.9. and 2.A.10).

Considering that the relationship between education and the main outcome variables is linear, the results will be biased if the correct model specification is non-linear. Appendix Tables 2.A.11 and 2.A.12 show that the main findings are robust to higher-order polynomials of the forcing variable. The results for the first stage and the mechanisms remained significant up to a bandwidth of 4 and the main results (HIV stigma) remained significant up to a bandwidth of 5. Hence, I performed Akaike information criterion (AIC) tests as presented in Appendix Table 2.A.13 and the results show that the linear model best predicts the data. Therefore, the main results are less likely to be biased due to the linear specification. Furthermore, the results are robust to different clustering. I present the results of the main outcome variables without clustering and with clustering at the year of birth in Appendix Table 2.A.14. The standard errors remain almost similar to those of the main results when I do not include any clustering and when I cluster at birth year.

To end this section, I used the new STATA command that offers data-driven bandwidth selectors that were developed by Calonico et al. (2020) to check if the results would remain unchanged. Appendix Table 2.A.15 shows that the optimal bandwidth is 5, and hence I performed a regression for all the outcomes and some of the key mechanisms using the new Fuzzy RD design command proposed by Calonico et al. (2020). Results are presented in Appendix Table 2.A.16 and they are in line with the main results. The results show that an additional year of schooling has a negative and significant effect on HIV stigma for individuals affected by the policy compared to those not affected by the policy.

2.4.5 Discussion and conclusion

The HIV pandemic has continued to be a life-threatening disease in SSA. Meanwhile, negative attitudes toward PLWHA make people uncomfortable disclosing their HIV status and getting tested, promoting the spread of the disease. To date, most developing countries have not yet achieved universal primary and secondary enrollment, though education increases HIV knowledge and may result in changing people's negative attitudes towards PLWHA. Given the continued stigma in SSA countries, there is an urgent need to study the causal link between education and HIV-related outcomes.

This study reveals a causal effect of education on HIV stigma. The implementation of the 1980 reform led to an increase in educational attainment for the treatment group by 1.43 years. I find that additional schooling reduces HIV stigma by 0.16 standard deviation units. This positive effect of education on HIV stigma implies that education improves an individuals' knowledge of HIV. Overall, the results imply that the 1980 education reform improved the educational attainment of the treated cohorts and the attitudes of people toward HIV infected persons, and knowledge of HIV. Education policy contributed partially to the decrease in HIV stigma, but it seems that there should be better policies to mitigate HIV prevalence by increasing test uptake and change the actual sexual behavior.

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Table 2.1: Descriptive statistics

Variable		Control Cohorts	Treated Cohorts	T-statistic	Whole Sample	N
A. Educational outcomes:	Years of education	6.51(4.13)	9.03(3.46)	-2.52***	8.25(3.86)	11809
	Secondary attendance	0.34(0.47)	0.66(0.47)	-0.32***	0.56(0.50)	11809
	Literacy	0.79(0.25)	0.94(0.25)	-0.14***	0.90(0.31)	9128
B. HIV-related outcomes:	HIV status	0.27(0.44)	0.29(0.46)	-0.02**	0.29(0.45)	7638
	HIV test refusal	0.24(0.42)	0.22(0.42)	0.01	0.23(0.42)	11809
Not willing to buy from HIV$^+$ vendor		0.42(0.49)	0.26(0.44)	0.15***	0.30(0.46)	9128
HIV$^+$ teacher should not be allowed to teach		0.33(0.47)	0.21(0.41)	0.12***	0.25(0.43)	6932
HIV status should be kept a secret		0.47(0.50)	0.46(0.50)	0.01	0.46(0.50)	9584
TB status should be kept a secret		0.64(0.48)	0.70(0.46)	-0.06***	0.68(0.67)	3710
Not willing to take care of an HIV$^+$ relative		0.13(0.34)	0.09(0.30)	0.04	0.11(0.31)	9592
PLWHA should be blamed		0.27(0.45)	0.22(0.41)	0.05***	0.238(0.43)	3870
PLWHA should be ashamed		0.33(0.47)	0.17(0.39)	0.14***	0.23(0.42)	6067
HIV Stigma (dummy)		0.71(0.45)	0.57(0.50)	0.14***	0.62(0.49)	11809
HIV Stigma Index		0.00(1.00)	-0.26(0.85)	0.26***	-0.18(0.91)	11809
C: HIV knowledge:	Mosquito can transfer HIV	0.69(0.46)	0.80(0.40)	-0.11***	0.76(0.43)	11792
	Condom reduces HIV	0.71(0.45)	0.84(0.37)	-0.13***	0.80(0.40)	11792
	Can get HIV by sharing food	0.80(0.40)	0.87(0.34)	-0.07***	0.85(0.36)	9123
	A healthy-looking person can be HIV$^+$	0.87(0.34)	0.90(0.30)	-0.03***	0.85(0.36)	11782
Having one uninfected faithful partner can reduce HIV		0.80(0.40)	0.86(0.34)	-0.06**	0.80(0.40)	11790
HIV comprehensive knowledge (dummy)		0.41(0.49)	0.53(0.50)	-0.121***	0.49(0.50)	11792
HIV comprehensive knowledge index		0.00(1.00)	0.32(0.80)	-0.33***	0.26(0.88)	11792
D. Control variables:	Gender	0.45(0.50)	0.42(0.49)	0.01	0.43(0.49)	11809
	Age	43.63(5.03)	38.23(5.97)	5.40***	39.90(6.22)	11809
	Urban	0.34(0.48)	0.37(0.48)	-0.03	0.36(0.48)	11809
	Christian	0.73(0.44)	0.75(043)	-0.02	0.75(0.44)	11809
	Shona	0.75(0.45)	0.76(0.45)	-0.025	0.75(0.43)	11809
Secondary school province (=1 if same with current province of residence)		0.66(0.48)	0.63(0.48)	0.03	0.64(0.48)	11809
Population density, 2005		520.90 (127.90)	536.30(107.50)	-15.42	528.60(226.90)	11809
Average temperature (℃) in survey unit		23.667(2.10)	23.73(2.05)	-0.06	23.72(2.07)	11809
Average slope (degrees) in survey unit		1.54(1.36)	1.49(1.31)	0.05	1.507(1.33)	11809
Distance from survey unit to the nearest border (km)		113.90(67.25)	121.28(69.58)	-7.38	118.70(68.95)	11809
Average annual rainfall (mm) in survey unit		487.22(1514.44)	466.15(1460.11)	21.08	472.67(1477.11)	11809

Note: Standard deviations are shown in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. T-statistic is control cohorts minus treated cohorts

Table 2.2: First stage - Effect of the policy on educational attainment

	(1)	(2)	(3)
	Years of education	Attended secondary	Literacy
Panel A: Including ages 14 and 15			
1[Birth_yr ≥1965]	0.923***	0.121***	0.076***
	(0.175)	(0.022)	(0.018)
	{0.000}	{0.000}	{0.000}
Control mean	6.509	0.338	0.794
Observations	11809	11809	9128
R-squared	0.323	0.269	0.137
F-statistic	27.79	31.11	18.26
Panel B: Excluding ages 14 and 15			
1[Birth_yr ≥1965]	1.431***	0.187***	0.093***
	(0.192)	(0.024)	(0.020)
	{0.000}	{0.000}	{0.000}
Control mean	6.509	0.338	0.794
Observations	10373	10373	8002
R-squared	0.333	0.277	0.145
F-statistic	55.50	60.91	21.81

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include dummies for religion all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.3: First stage- Heterogenous effect of the policy on educational attainment - male vs. female

	Women			Men		
	Years of education	Attended secondary	Literacy	Years of education	Attended secondary	Literacy
Panel A: Including ages 14 and 15						
1[Birth_yr ≥1965]	1.234***	0.184***	0.120***	0.623**	0.052	0.020
	(0.190)	(0.022)	(0.029)	(0.293)	(0.033)	(0.020)
	{0.000}	{0.000}	{0.000}	{0.052}	{0.159}	{0.337}
Observations	6789	6789	4848	5020	5020	4280
R-squared	0.314	0.258	0.171	0.249	0.226	0.065
F-statistic	42.22	70.10	16.81	4.51	2.48	1.01
Panel B: Excluding ages 14 and 15						
1[Birth_yr ≥1965]	1.771***	0.263***	0.151***	1.118***	0.101***	0.022
	(0.209)	(0.024)	(0.032)	(0.311)	(0.038)	(0.021)
	{0.000}	{0.000}	{0.000}	{0.001}	{0.016}	{0.316}
Observations	5944	5944	4233	4429	4429	3769
R-squared	0.333	0.275	0.185	0.253	0.227	0.069
F-statistic	71.64	123.20	22.36	12.93	7.03	1.13

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.4: First stage- Heterogenous effect of the policy on educational attainment - rural vs. urban

	Rural			Urban		
	Years of education	Attended secondary	Literacy	Years of education	Attended secondary	Literacy
Panel A: Including ages 14 and 15						
1[Birth_yr ≥1965]	1.066***	0.128***	0.089***	0.649**	0.109***	0.054**
	(0.190)	(0.027)	(0.023)	(0.254)	(0.036)	(0.022)
	{0.000}	{0.000}	{0.002}	{0.015}	{0.015}	{0.015}
Observations	7506	7506	5752	4303	4303	3376
R-squared	0.266	0.198	0.139	0.220	0.178	0.075
F-statistic	31.22	22.83	14.45	6.75	9.24	5.69
Panel B: Excluding ages 14 and 15						
1[Birth_yr ≥1965]	1.771***	0.210***	0.099***	0.823***	0.146***	0.080***
	(0.187)	(0.030)	(0.026)	(0.293)	(0.040)	(0.022)
	{0.000}	{0.001}	{0.001}	{0.007}	{0.005}	{0.001}
Observations	6601	6601	5054	3772	3772	2948
R-squared	0.280	0.207	0.146	0.228	0.189	0.088
F-statistic	89.62	50.14	14.38	8.92	13.64	13.66

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.5: The impact of education on HIV-related outcomes

	(1)	(2)	(3)	(4)
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.022	-0.057***	-0.155***	0.014
	(0.025)	(0.015)	(0.035)	(0.014)
	{0.191}	{0.000}	{0.001}	{0.382}
Control mean	0.269	0.713	0	0.235
R-squared	-0.002	0.225	0.140	0.123
Observations	6694	10373	10373	10373

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.6: Heterogenous impact of education on HIV-related outcomes - male vs. female

	(1)	(2)	(3)	(4)
Panel A:	**Women**			
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.029	-0.049***	-0.120***	0.009
	(0.022)	(0.014)	(0.033)	(0.015)
	{0.224}	{0.000}	{0.002}	{0.564}
R-squared	0.040	0.261	0.072	0.123
Observations	3669	5944	5944	5944
Panel B:	**Men**			
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.003	-0.058*	-0.186**	0.014
	(0.083)	(0.032)	(0.082)	(0.031)
	{0.951}	{0.039}	{0.008}	{0.657}
R-squared	0.018	0.223	0.104	0.131
Observations	3025	4429	4429	4429

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 2.7: Heterogenous impact of education on HIV-related outcomes - rural vs. urban

	(1)	(2)	(3)	(4)
Panel A:		**Rural**		
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.029	-0.043***	-0.147***	0.009
	(0.027)	(0.015)	(0.039)	(0.014)
	{0.301}	{0.003}	{0.001}	{0.545}
R-squared	-0.039	0.278	0.147	0.077
Observations	4506	6601	6601	6601
Panel B:		**Urban**		
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.002	-0.091*	-0.173*	0.037
	(0.072)	(0.052)	(0.095)	(0.049)
	{0.975}	{0.040}	{0.035}	{0.487}
R-squared	0.017	0.049	0.176	0.076
Observations	2188	3772	3772	3772

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.8: The impact of education on HIV knowledge (Mechanisms)

	(1)	(2)	(3)	(4)
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	A healthy-looking person can be HIV+	Having one uninfected faithful partner can reduce HIV
Years of education	0.068***	0.134***	0.019*	0.020
	(0.017)	(0.030)	(0.010)	(0.016)
	{0.000}	{0.000}	{0.074}	{0.244}
Control mean	0.408	0	0.872	0.802
Observations	10356	10356	10346	10356
	Mosquito can transfer HIV	Can get HIV by sharing food	Condom reduces HIV	
Years of education	0.044***	0.043**	0.042***	
	(0.012)	(0.022)	(0.014)	
	{0.003}	{0.058}	{0.004}	
Control mean	0.686	0.799	0.712	
Observations	10356	7995	10356	

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.9: Heterogenous impact of education on HIV knowledge (Mechanisms) - male vs. female

	Women						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	Mosquito can transfer HIV	A healthy-looking person can be HIV+	Can get HIV by sharing food	Having one uninfected faithful partner can reduce HIV	Condom reduces HIV
Years of education	0.067***	0.147***	0.062***	0.005	0.016	0.027*	0.066***
	(0.018)	(0.033)	(0.017)	(0.011)	(0.020)	(0.016)	(0.016)
	{0.000}	{0.000}	{0.030}	{0.721}	{0.444}	{0.052}	{0.000}
Observations	5934	5934	5931	5922	4222	5932	5934
	Men						
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	Mosquito can transfer HIV	A healthy-looking person can be HIV+	Can get HIV by sharing food	Having one uninfected faithful partner can reduce HIV	Condom reduces HIV
Years of education	0.071**	0.113*	0.020	0.036*	0.112*	-0.001	0.003
	(0.036)	(0.060)	(0.024)	(0.021)	(0.062)	(0.025)	(0.026)
	{0.044}	{0.036}	{0.386}	{0.058}	{0.009}	{0.961}	{0.906}
Observations	4422	4422	10356	4424	3773	4422	4422

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.10: Heterogenous impact of education on HIV knowledge (Mechanisms) - rural vs. urban

	Rural						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	Mosquito can transfer HIV	A healthy-looking person can be HIV^{+}	Can get HIV by sharing food	Having one uninfected faithful partner can reduce HIV	Condom reduces HIV
Years of education	0.074***	0.144***	0.037***	0.024*	0.052**	0.024	0.050***
	(0.020)	(0.039)	(0.014)	(0.013)	(0.022)	(0.016)	(0.016)
	{0.001}	{0.001}	{0.010}	{0.079}	{0.020}	{0.175}	{0.003}
Observations	6590	6590	6590	6579	5049	6589	6590
	Urban						
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	Mosquito can transfer HIV	A healthy-looking person can be HIV^{+}	Can get HIV by sharing food	Having one uninfected faithful partner can reduce HIV	Condom reduces HIV
Years of education	0.051	0.103*	0.067	0.003	0.010	-0.001	0.023
	(0.045)	(0.056)	(0.042)	(0.021)	(0.054)	(0.031)	(0.034)
	{0.230}	{0.037}	{0.114}	{0.890}	{0.844}	{0.970}	{0.521}
Observations	3766	3766	3766	3767	2946	3767	3766

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

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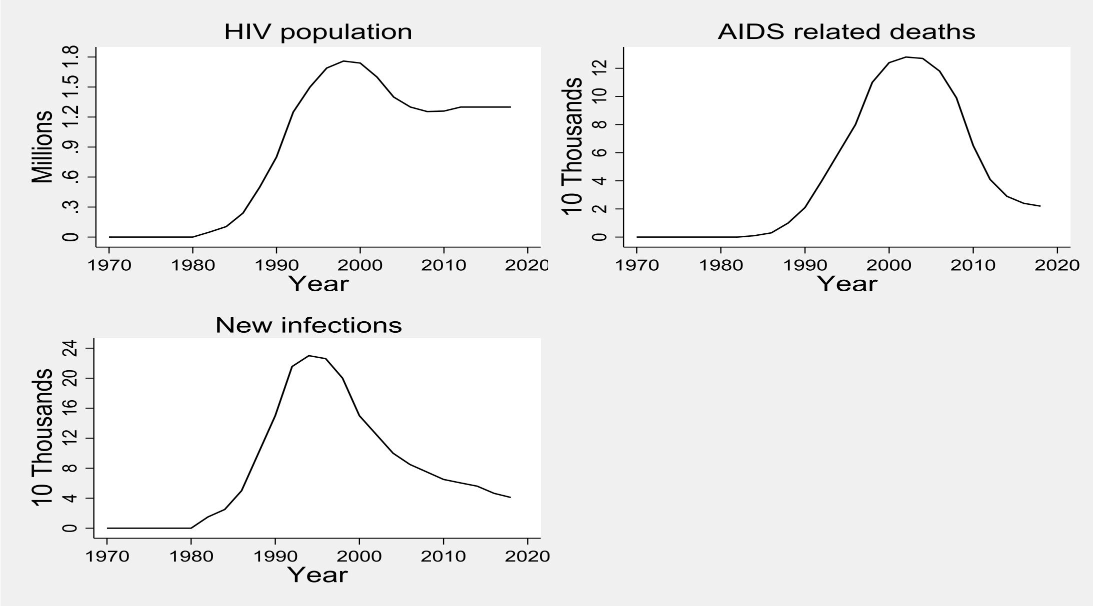
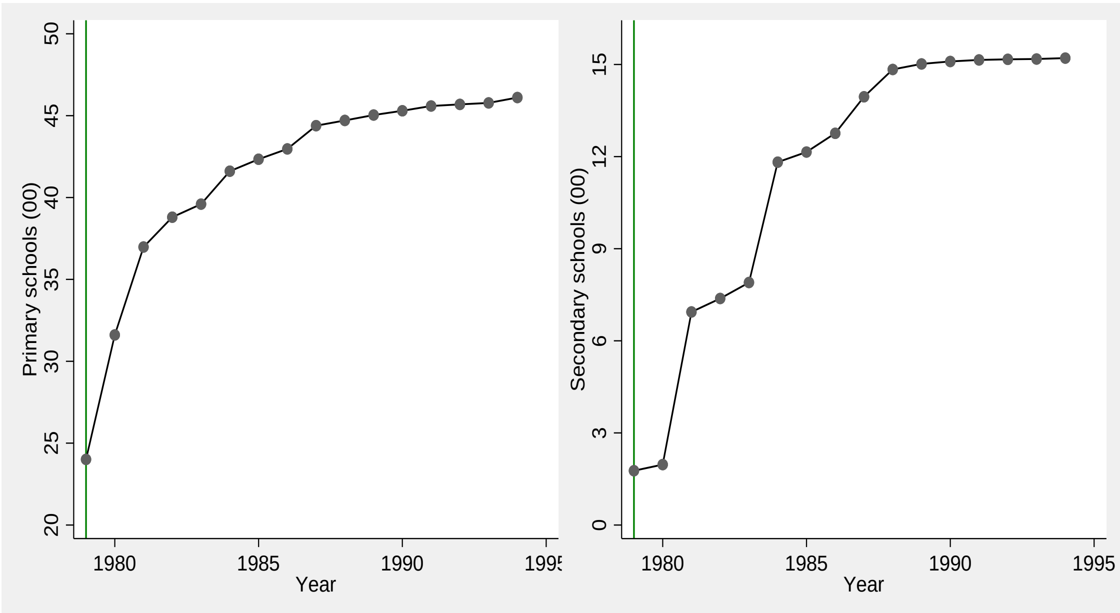
Figure 2.1: Trends in HIV new infections, prevalence, and AIDS related death



Source: Zimbabwe Ministry of Health and child Welfare. National HIV Estimates 2017.

Figure 2.2: Total number of schools



Source: Zimbabwe Ministry of Education, Sport, Arts and Culture.

Figure 2.3: Proportion of boys and girls in primary school

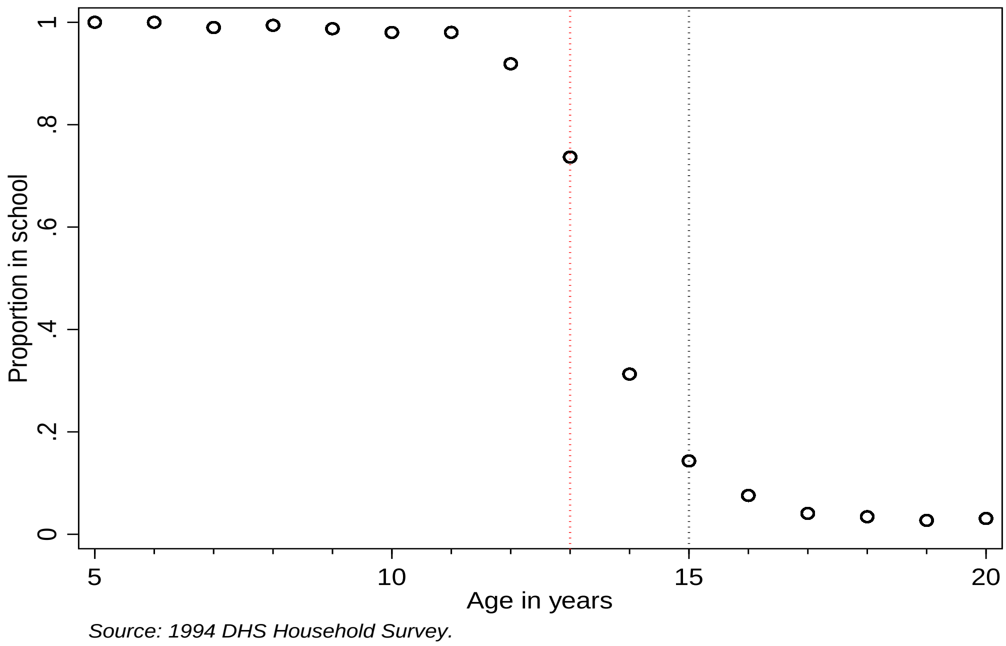
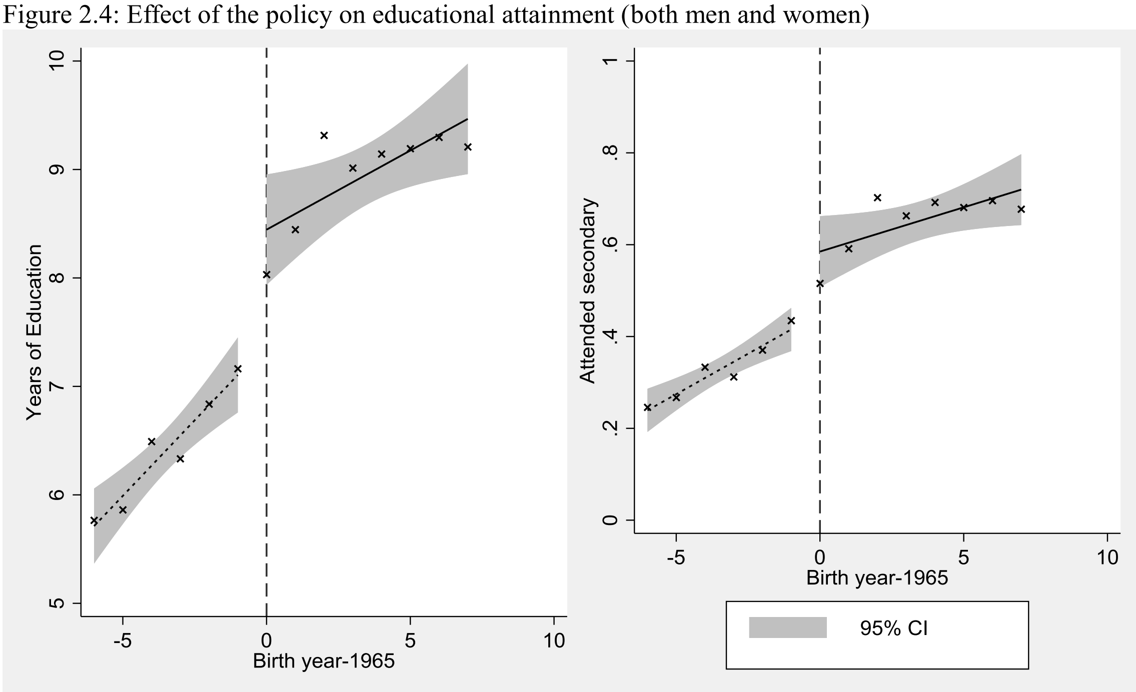
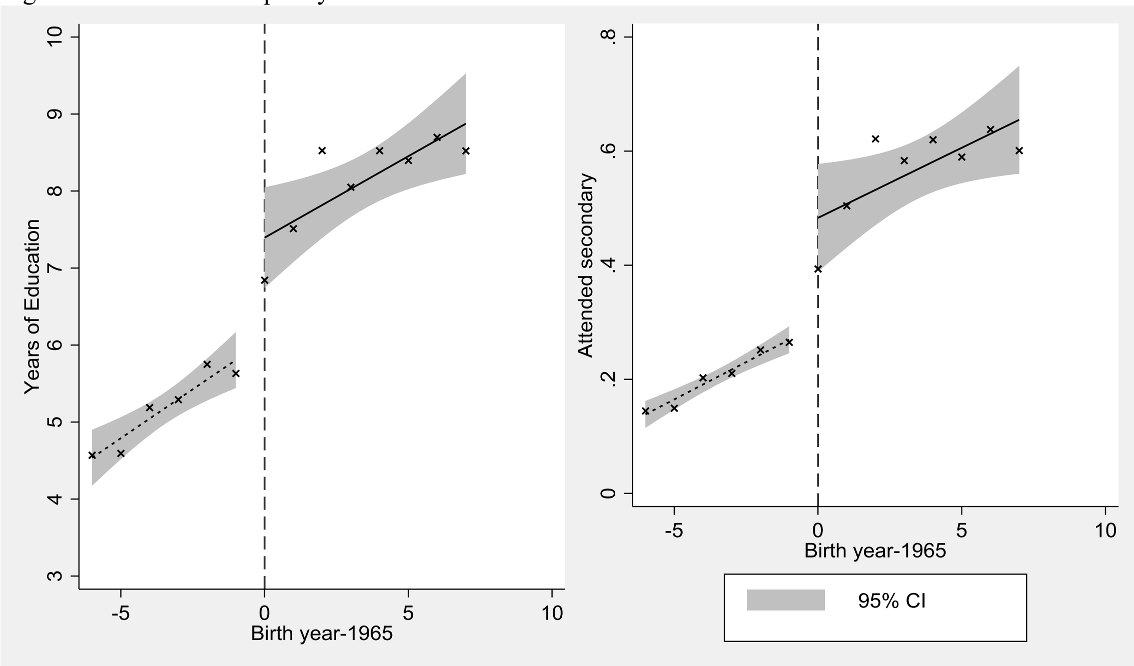


Figure 2.4: Effect of the policy on educational attainment (both men and women)



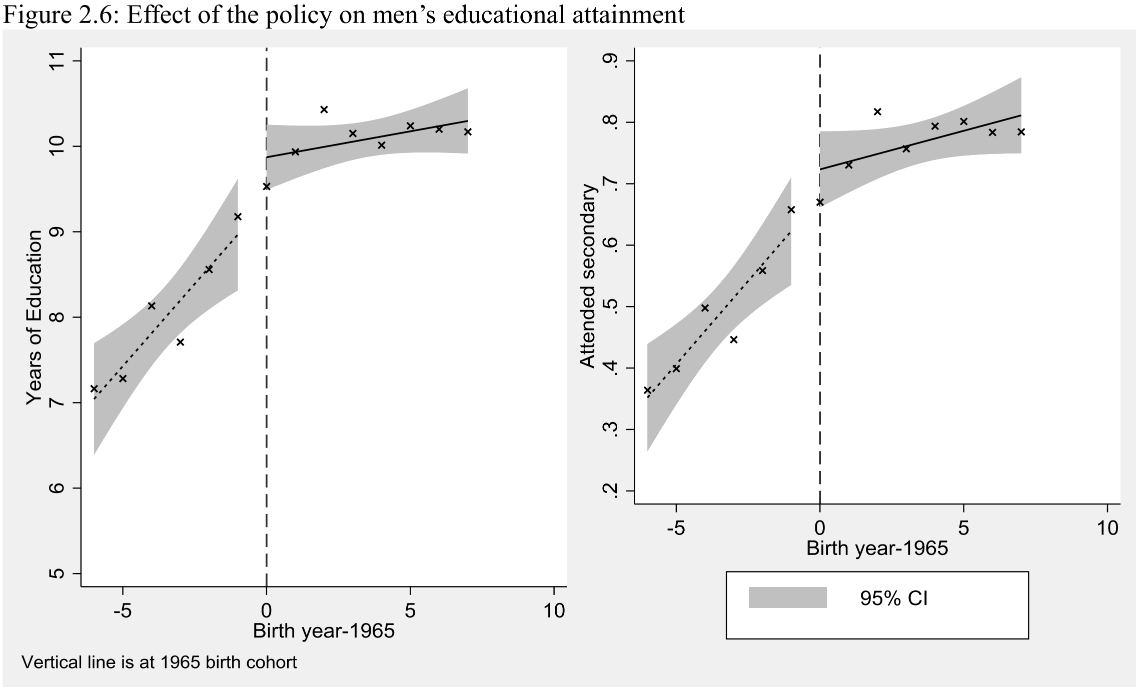
Source: Zimbabwe 1999, 2006, 2011 and 2015 DHS survey.

Figure 2.5: Effect of the policy on women's educational attainment



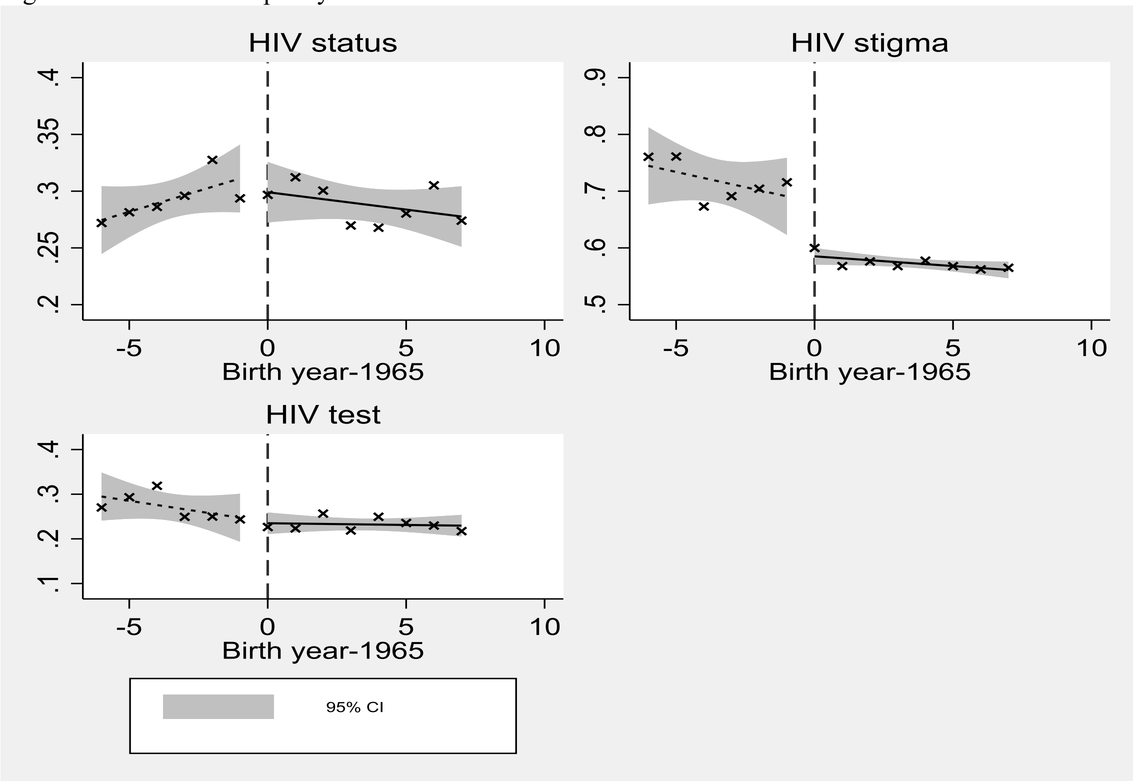
Source: Zimbabwe 1999, 2006, 2011 and 2015 DHS survey.

Figure 2.6: Effect of the policy on men's educational attainment



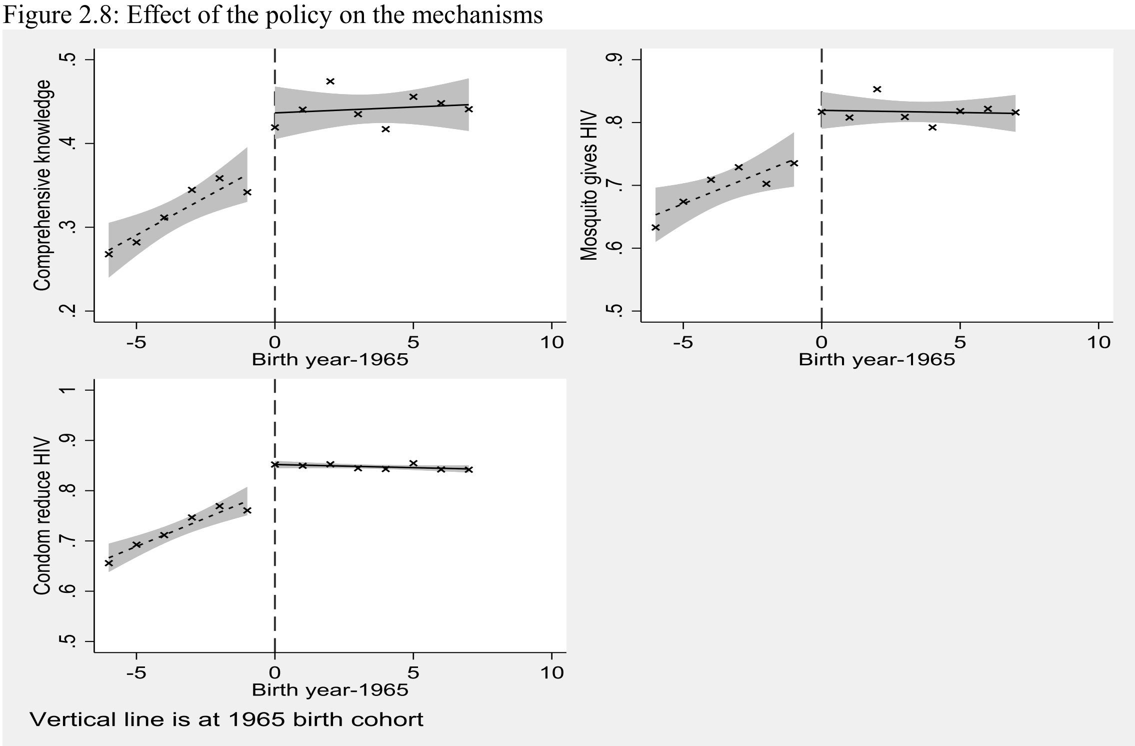
Source: Zimbabwe 1999, 2006, 2011 and 2015 DHS survey.

Figure 2.7: Effect of the policy on HIV-related outcomes



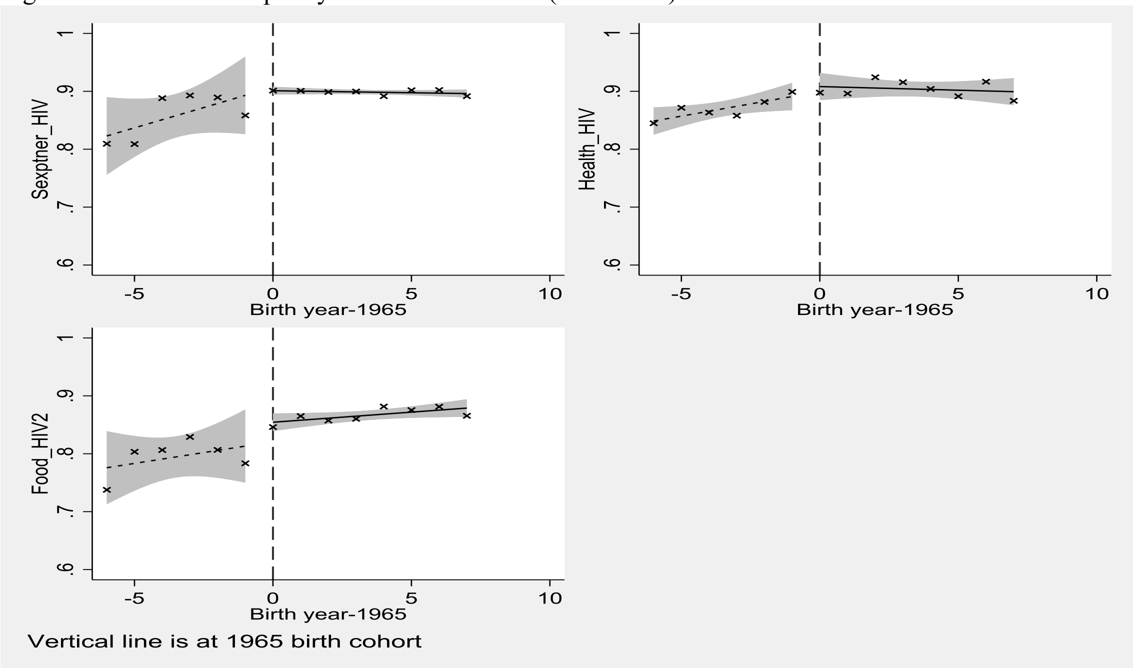
Source: Zimbabwe 1999, 2006, 2011 and 2015 DHS surveys.

Figure 2.8: Effect of the policy on the mechanisms



Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS surveys

Figure 2.9: Effect of the policy on the mechanisms (Continued)



Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS surveys

Appendix 2.A: Tables

Table 2.A.1: Percentage of men and women aged 5-49 years with accepting attitudes towards PLWHA, HIV, and their educational attainment in Africa

Country	Percentage expressing Acceptance attitudes on all four indicators	Percentage of HIV prevalence	Average years of education
Zimbabwe			
2011	39.5	15.0	9.5
2006	14.0	18.0	7.9
Uganda			
2011	25.4	7.3	5.6
2005	31.1	6.4	5.0
Zambia			
2013	23.1	13.0	7.1
2007	26.0	14.0	6.6
Malawi			
2010	27.7	11.0	5.5
2004	30.3	12.0	4.9
Mozambique			
2011	11.9	12.0	3.7
2009	18.0	11.2	-
Lesotho			
2014	40.8	25	6.5
2004	22.0	24	5.8

Source: Zimbabwe DHS reports.

Table 2.A.2: Sample construction

Individual recode (female): Number of women interviewed in each survey:	Number
1999	5,907
2006	8,907
2011	9,171
2015	9,955
Total	33,940
Number of women with valid HIV results (after merging with the HIV dataset)	24,400
Main sample:	
Number of women born after the policy (born between 1965-1972)	8,152
Number of women born before the policy (born between 1959-1964)	3,657
Number of women born between 1959 and 1972 (8-21 years in 1980)	11,809
Main sample excluding ages 14 and 15 in 1980:	
Number of individuals born after the policy (born between 1965-1972)	6,716
Number of individuals born before the policy (born between 1959-1964)	3,657
Number of individuals born between 1959 and 1972 (8-21 years in 1980)	10,373
HIV sample:	
Number of women born after the policy (born in 1965 or later) with valid HIV results	5,404
Number of women born before the policy (born before 1965) with valid HIV results	2,234
Number of women born between 1959 and 1972 (8-21 years in 1980) with valid HIV results	7,638
HIV sample excluding ages 14 and 15 in 1980:	
Number of women born after the policy (born in 1965 or later) with valid HIV results	4,460
Number of women born before the policy (born before 1965) with valid HIV results	2234
Number of women born between 1959 and 1972 (8-21 years in 1980) with valid HIV results	6,694

Notes: The actual testing of HIV commenced in 2006, therefore, the 1999 survey is not included in the HIV sample.
Data source: 1999, 2006, 2011, and 2015 DHS Surveys.

Table 2.A.3: HIV testing rejection rate per each birth cohort (1959-1972)

birth cohort	
1959	0.132
1960	0.220
1961	0.176
1962	0.178
1963	0.152
1964	0.171
1965	0.163
1966	0.175
1967	0.153
1968	0.190
1969	0.156
1970	0.176
1971	0.192
1972	0.173

Source: 2006, 2011, and 2015 DHS Surveys.

Table 2.A.4: The effect of the policy on missing HIV data

Variable	Missing HIV test result
1[Birth_yr >1965]	-0.005
	(0.018)
Control mean	0.173
R-squared	0.043
F-statistics	0.07

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The survey weights were used in all models. Estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.5: The impact of education on outcomes (multiple hypothesis testing)

		Model Coefficient	Model p-value	Resample p-value	Romano-Wolf p-value
Panel A:		**Main Analysis**			
HIV positive	Table 2.5, Column (1)	-0.022	0.433	0.441	0.651
HIV Stigma	Table 2.5, Column (2)	-0.057	0.000	0.001	0.001
HIV Stigma index	Table 2.5, Column (3)	-0.155	0.000	0.001	0.001
Refused the HIV test	Table 2.5, Column (4)	0.014	0.408	0.402	0.651
Comprehensive HIV knowledge	Table 2.8, Column (1)	0.068	0.001	0.001	0.001
Comprehensive HIV knowledge index	Table 2.8, Column (1)	0.134	0.000	0.001	0.001
Panel B:		**Women**			
HIV positive	Table 2.6, Panel A, Column (1)	-0.029	0.178	0.164	0.334
HIV Stigma	Table 2.6, Panel A, Column (2)	0.049	0.001	0.001	0.003
HIV Stigma index	Table 2.6, Panel A, Column (3)	0.120	0.004	0.002	0.002
Refused the HIV test	Table 2.6, Panel A, Column (4)	0.009	0.668	0.665	0.665
Comprehensive HIV knowledge	Table 2.9, Panel A, Column (1)	0.147	0.001	0.001	0.003
Comprehensive HIV knowledge index	Table 2.9, Panel A, Column (1)	0.067	0.000	0.001	0.001
Panel C:		**Men**			
HIV positive	Table 2.6, Panel B, Column (1)	-0.003	0.790	0.784	0.808
HIV Stigma	Table 2.6, Panel B, Column (2)	0.058	0.017	0.015	0.044
HIV Stigma index	Table 2.6, Panel B, Column (3)	-0.186	0.006	0.018	0.023
Refused the HIV test	Table 2.6, Panel B, Column (4)	0.014	0.580	0.580	0.808
Comprehensive HIV knowledge	Table 2.9, Panel B, Column (1)	0.071	0.021	0.016	0.044
Comprehensive HIV knowledge index	Table 2.9, Panel B, Column (1)	0.113	0.020	0.018	0.044

Table 2.A.6: First stage - Effect of the policy on educational attainment

	Bandwidth of 5 (1960-1971)			Bandwidth of 4 (1961-1970)		
	Years of education	Attended secondary	Literacy	Years of education	Attended secondary	Literacy
1[Birth_yr ≥1965]	1.511***	0.191***	0.098***	1.517***	0.181***	0.089***
	(0.255)	(0.029)	(0.025)	(0.312)	(0.034)	(0.029)
	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}	{0.006}
Control mean	8.192	0.556	0.889	8.199	0.557	0.884
Observations	8401	8401	6470	6920	6920	5343
R-squared	0.246	0.222	0.095	0.232	0.211	0.102
F-statistic	34.99	43.84	15.51	23.58	27.86	9.51

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.7: The impact of education on HIV-related outcomes

	(1)	(3)	(4)	(5)
Panel A:	Bandwidth of 5 (1960-1971)			
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.018	-0.065***	-0.200***	0.013
	(0.027)	(0.020)	(0.043)	(0.016)
	{0.525}	{0.001}	{0.000}	{0.448}
Observations	5404	8401	8401	8401
Panel B:	Bandwidth of 4 (1961-1970)			
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.004	-0.073***	-0.217***	0.022
	(0.033)	(0.023)	(0.049)	(0.017)
	{0.904}	{0.001}	{0.000}	{0.242}
Observations	4495	6920	6920	6920

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.8: The impact of education on HIV knowledge

	(1)	(2)	(3)	(4)
	Bandwidth of 5 (1960-1971)			
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	A healthy-looking person can be HIV+	Mosquito can transfer HIV
Years of education	0.076***	0.150***	0.014	0.056***
	(0.020)	(0.038)	(0.012)	(0.015)
	{0.000}	{0.001}	{0.310}	{0.003}
Observations	8387	8387	8379	8387
	Having one uninfected faithful partner can reduce HIV	Can get HIV by sharing food	Condom reduces HIV	
Years of education	0.029*	0.040	0.055***	
	(0.016)	(0.025)	(0.017)	
	{0.093}	{0.104}	{0.001}	
Observations	8388	6466	8387	
	Bandwidth of 4 (1961-1970)			
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	A healthy-looking person can be HIV+	Mosquito can transfer HIV
Years of education	0.081***	0.165***	0.016	0.067***
	(0.022)	(0.039)	(0.013)	(0.016)
	{0.002}	{0.002}	{0.252}	{0.002}
Observations	6908	6908	6903	6908
	Having one uninfected faithful partner can reduce HIV	Can get HIV by sharing food	Condom reduces HIV	
Years of education	0.046**	0.036	0.042***	
	(0.018)	(0.027)	(0.016)	
	{0.016}	{0.221}	{0.003}	
Observations	6912	5341	6908	

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values are reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.9: The impact of education on HIV-related outcomes (Including ages 14 and 15 in 1980)

	(1)	(2)	(3)	(4)
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.047	-0.113***	-0.242***	0.011
	(0.037)	(0.026)	(0.054)	(0.017)
	{0.200}	{0.000}	{0.000}	{0.513}
Observations	7638	11809	11809	11809

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.10: The impact of education on HIV knowledge (Including ages 14 and 15 in 1980)

	(1)	(2)	(3)	(4)
	Comprehensive HIV knowledge	Comprehensive HIV knowledge index	A healthy-looking person can be HIV$^+$	Mosquito can transfer HIV
Years of education	0.092***	0.162***	0.007	0.052***
	(0.025)	(0.047)	(0.014)	(0.017)
	{0.000}	{0.003}	{0.620}	{0.004}
Observations	11792	11792	11782	11792
	Having one uninfected faithful partner can reduce HIV	Can get HIV by sharing food	Condom reduces HIV	
Years of education	0.027	0.067**	0.054**	
	(0.021)	(0.031)	(0.023)	
	{0.224}	{0.018}	{0.024}	
Observations	11790	9123	11792	

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values are reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.11: The impact of the policy on educational attainment (Including 2nd order polynomials)

	Years of education		
	1959-1972	1960-1971	1961-1970
	(1)	(2)	(3)
1[Birth_yr ≥1965]	1.523***	1.829***	1.648*
	(0.460)	(0.627)	(0.893)
	{0.005}	{0.008}	{0.102}
Observations	10373	8401	6932
	Secondary Attendance		
1[Birth_yr ≥1965]	0.146***	0.144**	0.073
	(0.053)	(0.070)	(0.102)
	{0.022}	{0.056}	{0.529}
Observations	10373	8401	6920

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.12: The impact of education on outcomes (Including 2nd order polynomials)

	1959-1972	1960-1971	1961-1970
	(1)	(2)	(3)
HIV positive	0.021	0.053	0.056
	(0.046)	(0.060)	(0.054)
	{0.650}	{0.330}	{0.256}
HIV Stigma	-0.095**	-0.095*	-0.096
	(0.045)	(0.051)	(0.080)
	{0.011}	{0.035}	{0.162}
HIV Stigma index	-0.304***	-0.263**	-0.284
	(0.105)	(0.108)	(0.176)
	{0.003}	{0.005}	{0.035}
Refused the HIV test	0.010	0.026	-0.029
	(0.031)	(0.032)	(0.050)
	{0.760}	{0.417}	{0.573}
Comprehensive HIV knowledge	0.113***	0.129***	0.185**
	(0.041)	(0.046)	(0.093)
	{0.007}	{0.009}	{0.022}
Comprehensive HIV knowledge index	0.220***	0.245***	0.320**
	(0.067)	(0.077)	(0.148)
	{0.005}	{0.003}	{0.0260}

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.13: Akaike Information Criterion for the Reduced-Form Regression

	1959-1972	1960-1971	1961-1970
	(1)	(2)	(3)
		HIV positive	
Linear model	8501.895 †	6867.173 †	11737.53 †
Quadratic model	8791.042	8634.49	13932.79
		HIV Stigma index	
Linear model	27792.26 †	23461.12 †	5687.297 †
Quadratic model	32642.02	25237.46	6913.865
		HIV Stigma	
Linear model	11805.62 †	9935.515†	8530.757 †
Quadratic model	14009.87	11429.35	9573.384
		Refused the HIV test	
Linear model	10724.32 †	8776.54 †	7267.284 †
Quadratic model	10691.48	8989.011	7559.135
		Comprehensive HIV knowledge index	
Linear model	25436.89 †	20818.75 †	17437.36 †
Quadratic model	27632.63	23156.49	21191.2
		Comprehensive HIV knowledge	
Linear model	14181.8 †	20816.36 †	9778.857 †
Quadratic model	16102.03	23165.32	14077.33

Notes: † shows that the AIC is smaller relative to the other model specification. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Regressions exclude men and women born in 1965 and 1966. Linear slopes on either side of the cutoff are included in all specifications.

Table 2.A.14: The impact of education on outcomes – Robustness

	No clustering (1)	Clustering at birth year (2)
HIV positive	-0.022	-0.022
	(0.026)	(0.019)
HIV Stigma	-0.057***	-0.057***
	(0.018)	(0.015)
HIV Stigma index	-0.155***	-0.155***
	(0.037)	(0.041)
Refused the HIV test	0.014	0.014
	(0.017)	(0.013)
Comprehensive HIV knowledge index	0.127***	0.127***
	(0.033)	(0.037)
Comprehensive HIV knowledge	0.067***	0.067***
	(0.020)	(0.015)

Notes: The wild cluster bootstrap p-values reported in curly brackets. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.A.15: Bandwidth calculation using fuzzy regression discontinuity STATA packages

	BW est. (h)		BW bias (b)	
Method	Left of c	Right of c	Left of c	Right of c
mserd	5.799	5.799	9.445	9.445

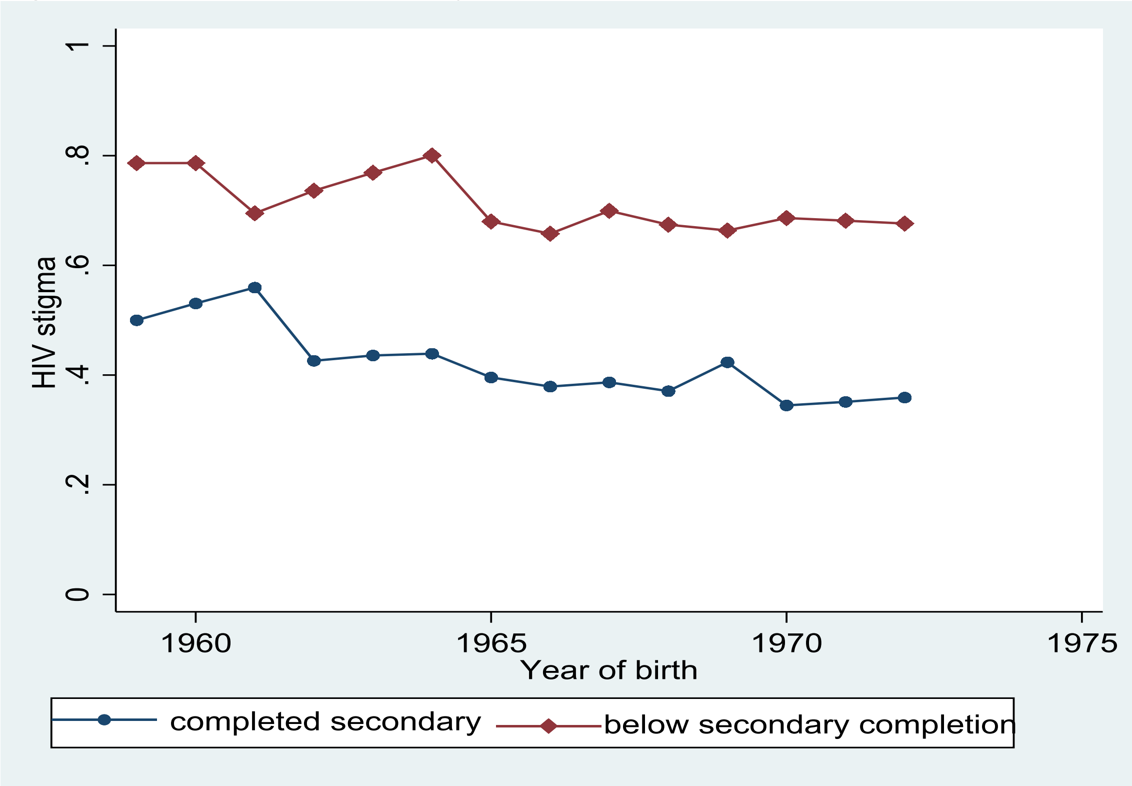
Table 2.A.16: The impact of education on outcomes using fuzzy regression discontinuity STATA packages – bandwidth of 5

Main outcomes	
HIV positive	0.004
	(0.030)
HIV Stigma	-0.087***
	(0.021)
HIV Stigma index	-0.228***
	(0.043)
Refused the HIV test	0.008
	(0.017)
Comprehensive HIV knowledge index	0.229***
	(0.054)
Comprehensive HIV knowledge	0.104***
	(0.031)

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. *p < 0.1, **p < 0.05, ***p < 0.01.

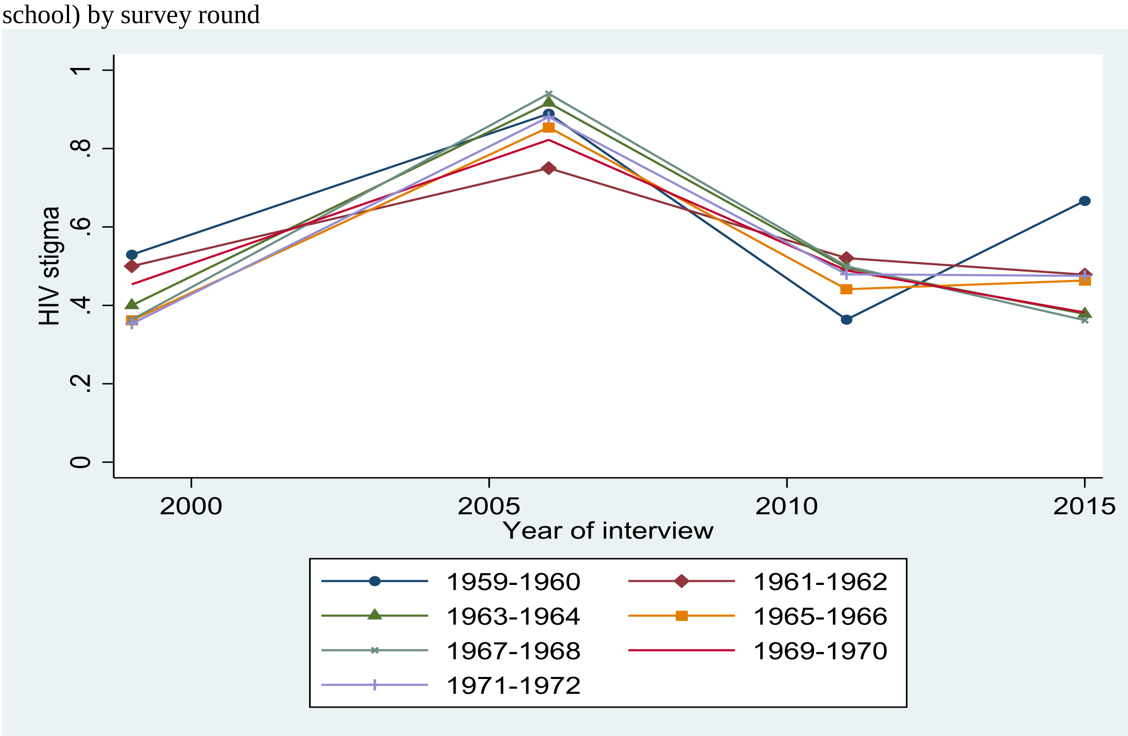
Appendix 2.B: Figures

Figure 2.B.1: Attitudes toward PLWHA by level of education



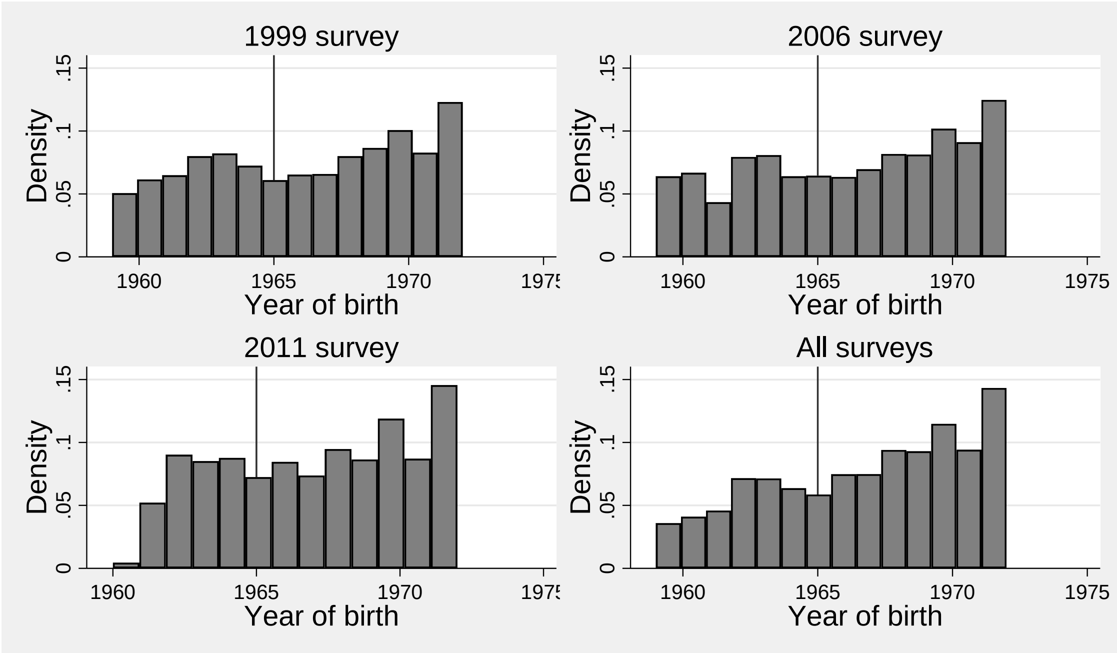
Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS Surveys.

Figure 2.B.2: Attitudes toward PLWHA of people in the same birth cohort (who completed secondary school) by survey round



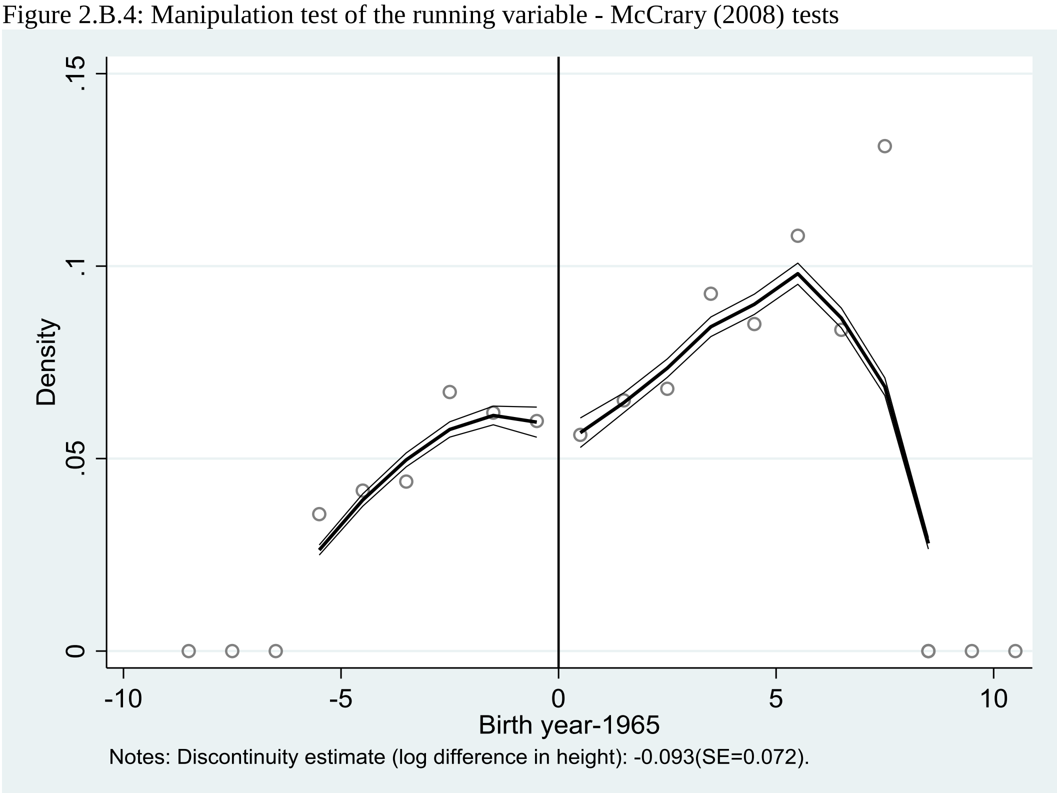
Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS Surveys.

Figure 2.B.3: Distribution of birth cohorts



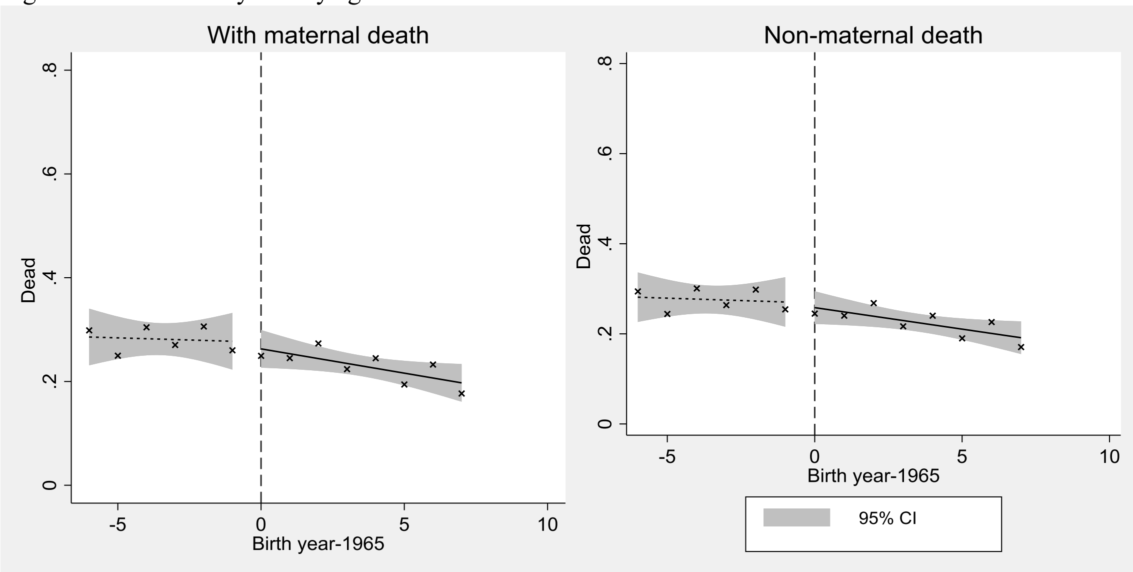
Source: Zimbabwe DHS surveys.

Figure 2.B.4: Manipulation test of the running variable - McCrary (2008) tests



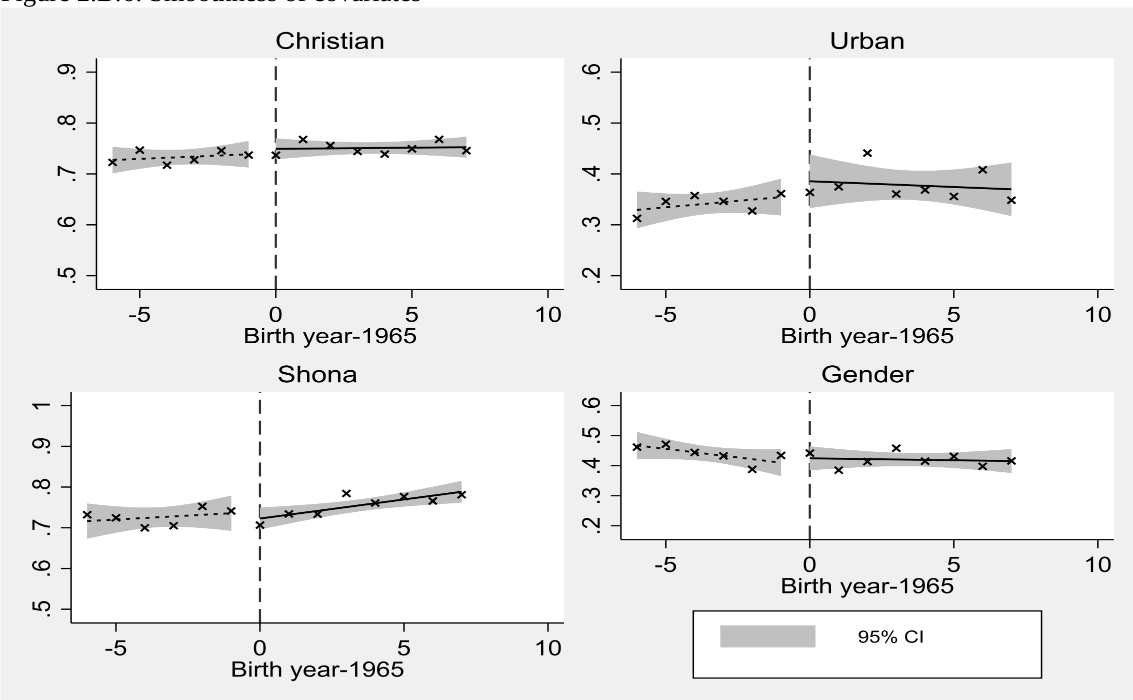
Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS Surveys.

Figure 2.B.5: Mortality rate by age in 1980



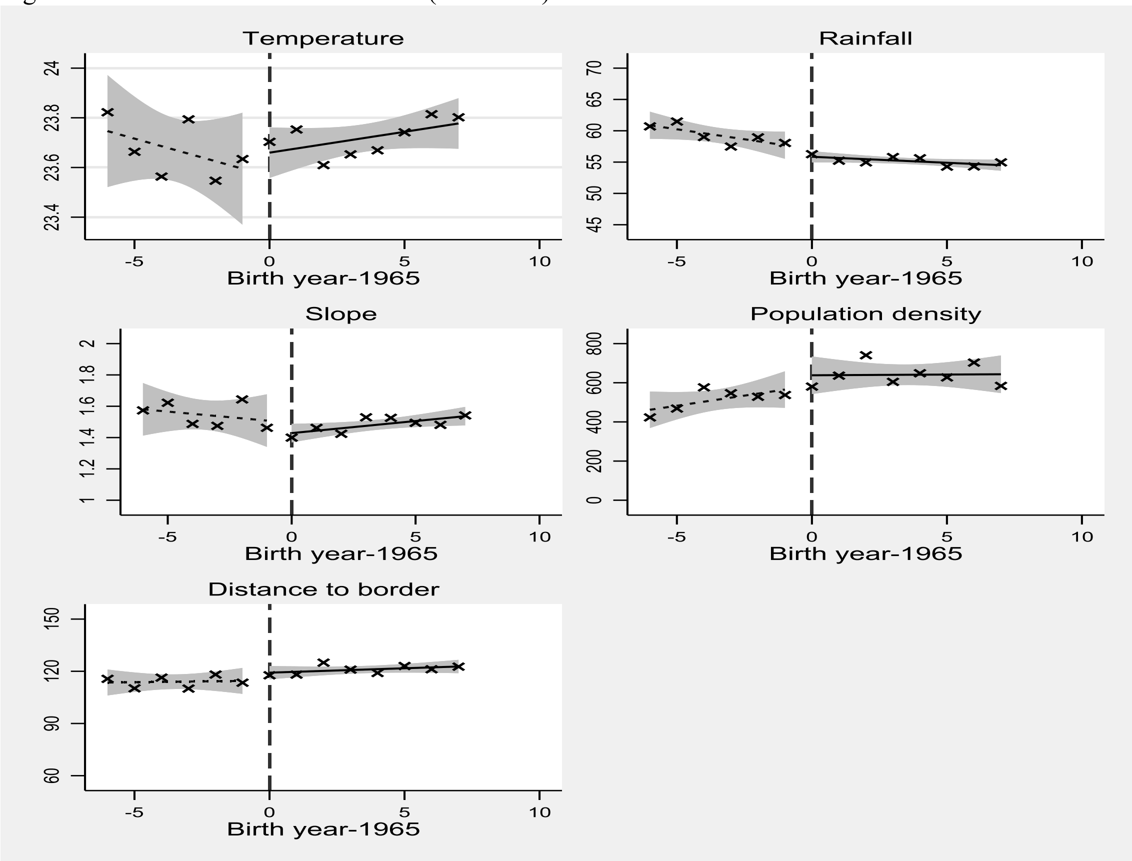
Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS Surveys.

Figure 2.B.6: Smoothness of covariates



Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS Surveys.

Figure 2.B.7: Smoothness of covariates (continued)



Source: Zimbabwe 1999, 2006, 2011, and 2015 DHS Surveys.

Appendix 2.C: Data description

2.C.1: Major variables

This section provides further information about the data, sample frame, and major variables used in this study. It is imperative to note that all variables were constructed from questions asked in the DHS survey questionnaire. Therefore, I quote the questions as they appear in the DHS final reports.

Social Rejection comprises of four questions; a) Would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV?; b) If a member of your family became sick with AIDS, would you be willing to care for her or him in your own household?; and c) In your opinion, if a teacher has HIV but is not sick, should he/she be allowed to continue teaching in the school?

Disclosure Concerns is measured by two questions; a) If a member of your family got infected with HIV, would you want it to remain a secret or not?; and b) If a member of your family got infected with Tuberculosis (TB), would you want it to remain a secret or not?

Prejudiced Attitudes is measured by these questions; a) People with aids should be ashamed of themselves? and b) People with aids should be blamed for bringing disease to community?

Overall Stigma (=1 if someone indicates some level of stigma on any of the questions under social rejection ((a)-(c)), disclosure concerns ((a)-(b)); and prejudiced attitudes ((a)-(b))).

Overall Stigma index (a standardized weighted average of z-scores of all the questions that belong to social rejection ((a)-(c)); disclosure concerns ((a)-(b)); and prejudiced attitudes ((a)-(b))).

Comprehensive knowledge of HIV is a dummy variable constructed from the following questions; a) Can get HIV by sharing food with a person who has aids?; b) Can people get HIV from mosquito bites?; c) Can people reduce their chance of getting HIV by having just one uninfected sex partner who has no other sex partners?; d) Can people reduce their chance of getting HIV by using a condom every time they have sex?; e) Is it possible for a healthy-looking person to have HIV?

Particularly, **Comprehensive knowledge of HIV (=1** if the person answered correctly in all the five questions).

HIV comprehensive knowledge index (a standardized weighted average of z-scores of all the questions on HIV knowledge ((a)-(e))).

Geospatial covariates are defined as follows (for more details, see Mayala et al. 2018):

a) **Distance to the nearest national boarder:** distance (km) from the nearest border 2000, 2005, 2010, and 2015.
b) **Temperature**: 2000, 2005, 2010, and 2015 average temperature (℃) within a 2 km distance (urban) or 10 km (rural) from the DHS buffer point in each survey unit.
c) **Rainfall**: 2000, 2005, 2010, and 2015 average annual rainfall (mm) within a 2 km distance (urban) or 10 km (rural) from the DHS buffer point in each survey unit.
d) **Slope**: roughness of the cluster terrain (degrees) in each survey year.
e) **United Nations (UN) Population density**: average population density within a 2 km (urban) or 10 km (rural) distance from the DHS buffer point in each cluster

2.C.2: Missing values

In each survey year, DHS had a set of questions related to HIV stigma, but some of the questions were dropped as they became irrelevant while new ones were introduced within the period 1999-2015. Questions on willingness to take care of an HIV-positive relative and wanting to keep HIV status a secret were only asked in 1999, 2006, and 2011 waves. The question on willingness to buy from a vendor is available in 2006, 2011, and 2015 surveys while that of people with HIV should be ashamed of themselves was asked in 2006 and 2015 surveys. TB should be kept secret, and those with HIV should be blamed is only available in the 2006 survey. Kids with HIV should not attend school is only recorded in 2015 survey. An HIV-infected teacher should teach is in 2006 and 2011 surveys. At the same time, Questions (b)-(e) on HIV knowledge were asked in all the four survey years except the question on sharing of food from 2006-2015. As earlier indicated, HIV stigma index is constructed from an equally-weighted average of z-scores of its components. The index is generated based on each individual's available responses. The overall measure of HIV stigma equals one if some level of stigma is detected in any of the answered questions and zero if all the responses show no signs of stigma. Since some of the questions are not found in all the survey years, so the observations for the index and the individual questions are different. To deal with these inconsistencies in questions being asked in each survey year, I decided to check whether the results would change by using the survey years with similar questions (2006 and 2011 DHS) and the results are quite consistent with the main result (see Appendix Table 2.C.1).

Since I restricted the main sample to those with stigma-related questions, this can raise a concern about selection bias, as schooling may affect the likelihood that respondents are willing to and/or able to answer these questions. Therefore, I conducted balance checks to see if the educational attainment of those with missing values on HIV stigma-related questions is different from those who responded to the questions. The results show no major differences in the educational attainment of the two groups as displayed in Appendix Table 2.C.2.

Appendix 2.C: Tables

Table 2.C.1: Balance checks of stigma- related outcomes

Variable	Years of education			
	Missing (1)	Non-missing (2)	T statistic ((2)–(1)) (3)	N (5)
Not willing to buy from HIV+ vendor	8.143(2.755)	8.394(3.842)	0.251	9234
HIV+ teacher should not be allowed to teach	8.024(3.974)	7.964(3.684)	-0.059	7025
HIV status should be kept a secret	7.219(3.155)	7.912(3.730)	0.693**	9738
TB status should be kept a secret	5.886(3.704)	7.705(3.506)	1.819***	3924
Not willing to take care of an HIV+ relative	7.565(2.774)	7.907(3.734)	0.342	9738
PLWHA should be blamed	6.826(3.388)	7.617(3.542)	0.791	3924
PLWHA should be ashamed	7.466(3.445)	8.387(3.858)	0.922	6133
HIV Stigma ((1 if someone indicates some level of stigma on any of the questions, 0 otherwise)	8.029(2.419)	8.246(3.858)	0.216	11947

Note: Standard deviations are shown in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 2.C.2: The impact of education on HIV-related outcomes (2006 and 2011 surveys only)

	(1)	(2)	(3)	(4)
	HIV positive	HIV Stigma (overall)	HIV Stigma Index (overall)	Refused the HIV test
Years of education	-0.009 (0.023) {0.722}	-0.041*** (0.015) {0.005}	-0.136*** (0.045) {0.003}	-0.012 (0.017) {0.524}
Control mean	0.266	0.810	0	0.235
R-squared	0.014	0.200	0.081	0.058
Observations	5015	6087	6087	6087

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values are reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

Appendix 2.D: Results

2.D.1 Impact of education on HIV stigma indicators

Appendix Table 2.D.1 presents the estimated effect of schooling on the stigma-related indicators used to construct the main measures of stigma (HIV stigma dummy and the index). The results indicate that highly educated respondents had low chances of having some social rejection stigma than those who were less educated. A year increase in education decreases negative attitudes toward HIV-positive teachers by 6.3 percentage points (19.1 percent) and HIV-infected vegetable vendors/shopkeepers by 8.5 percentage points (20.2 percent). Also, education improves people's willingness to take care of HIV-infected relatives. One would expect the educated not to keep HIV status secret, but results indicate that education had no causal link to disclosing HIV status. Individuals who had higher education are not different from those who are less educated in terms of not wanting to disclose their family members' HIV and TB status. This is because the cost of disclosing family members' HIV status may be higher for the educated due to the stigma and discrimination surrounding HIV in society and at workplaces. To be more specific, the educated may miss job and business opportunities if their employers or business partners know that they are likely to be HIV positive, especially if the infected relative happens to be the husband or child. It is important to note that individuals have control over their stigma towards others, but they have no control over others stigmatizing them. Hence, no matter how educated a person is, they may still be discriminated against by others. In the case of prejudiced attitudes toward PLWHA, the 2SLS shows that the treatment group is 22.4% (0.074/0.33*100) more likely to not shame people with HIV than the comparison group.

Appendix 2.D: Tables

Table 2.D.1: The impact of education on HIV/AIDS stigma indicators

	(1)	(2)	(3)	(4)
Panel A:	Social Rejection			
	HIV^+ teacher should not be allowed to teach	Not willing to buy from HIV^+ vendor	Not willing to take care of an HIV^+ relative	
Years of education	-0.063***	-0.085***	-0.026**	
	(0.019)	(0.021)	(0.013)	
	{0.004}	{0.000}	{0.071}	
Control mean	0.332	0.417	0.130	
R-squared	0.131	0.113	0.042	
Observations	6076	8000	8428	
Panel B:	Prejudiced Attitudes		Disclosure concerns	
	PLWHA should be blamed	PLWHA should be ashamed	HIV status should be kept a secret	TB status should be kept a secret
Years of education	0.024	-0.074**	-0.027	-0.006
	(0.035)	(0.035)	(0.018)	(0.028)
	{0.553}	{0.036}	{0.139}	{0.841}
Control mean	0.272	0.333	0.465	0.644
R-squared	0.013	0.082	0.003	0.319
Observations	3408	5335	8420	3264

Notes: In parentheses, we show robust standard errors clustered by province and year of birth. The wild cluster bootstrap p-values are reported in curly brackets. The survey weights were used in all models. All estimates include all controls reported in Table 2.1, provincial, and survey year fixed effects. Linear slopes on either side of the cutoff are included in all specifications. Regressions exclude individuals born in 1965 and 1966. *p < 0.1, **p < 0.05, ***p < 0.01.

CHAPTER 3

THE EFFECT OF ABORTION LEGALIZATION ON TEEN SEXUAL AND REPRODUCTIVE HEALTH BEHAVIORS AND WOMEN EMPOWERMENT IN SOUTH AFRICA

3.1 Introduction

3.1.1 Motivation

Abortion is legalized in many developed countries but remains a very controversial issue in Africa. Many African countries only allow abortion in situations where the pregnancy poses a risk to the mother. As a result of these restrictive abortion laws, the region has the highest cases of unsafe abortions, maternal mortality, teen mothers, and very short birth intervals in the world. As of 2010-2014, nearly 8.2 million induced abortions were recorded annually in Africa, and almost 75 percent of them were classified as unsafe abortions (Singh et al. 2018). Unsafe abortion is one of the leading causes of maternal death among teenagers in Africa. Hence, the need for a public health reaction to illegal abortion in Africa is compelling. The main reason women abort is union status, age, social, economic, and health conditions.

Furthermore, adolescent motherhood remains a major socio-economic issue in many African countries. It restricts many girls from reaching their full economic potential as they become mothers before finishing school. Female schooling has been cited as one of the effective ways that can help promote female empowerment, gender equality, enhance human capital development, and economic growth. Hence, gender equality has been listed as one of the 17 Sustainable Development Goals with a particular target to reduce primary and secondary education inequalities. However, only 78 girls completed upper secondary education for every 100 boys in Sub-Saharan Africa in 2015 (UNESCO 2018). As a result, women (especially teen mothers) have fewer chances of being employed and occupy high-paying jobs.

Early childbearing negatively affects the human capital investment of the mother and affects the lifetime outcomes (i.e., education and labor market outcomes) of their children. Navarro and Walker (2012) found that children born to teenage mothers are more likely to have poorer outcomes (i.e., preterm, less healthy, low birth weight) and become adolescent mothers. One instrument that most countries use to alter fertility is through changing abortion laws. While most African nations continue to restrict women from aborting, a few recognized the importance of a more liberal policy (i.e., Tunisia, South Africa, and Cape Verde). South Africa is amongst the first few countries to liberalize abortion in Africa. Abortion was officially legalized in 1996 (Choice on Termination of Pregnancy Act, 1996) in South Africa, but the actual implementation of the Act began in 1997.

Abortion reforms have gained significant coverage in economic literature. For example, several studies were conducted in the United States around the 1970s to assess the effect of legislative reforms on fertility and family composition both in the short and long run (González et al. 2018; Angrist and Evans 1996; Ananat et al. 2009; Gruber et al. 1999). Surprisingly, studies of this nature are less common in Africa and other developing economies, where fertility and adolescent pregnancy is relatively high.

This study adds to the existing literature by providing evidence on the impact of abortion legalization on sexual and reproductive health behaviors and women empowerment in South Africa. To the best of my knowledge, this study is among the first few studies to analyze the causal impact of a major abortion legislation reform on sexual and reproductive health behaviors and women empowerment outcomes in the African setting.

3.1.2 Objectives

This chapter seeks to address the two main objectives. The first objective is to investigate the impact of the abortion law legalization on teen's sexual and reproductive health behaviors. Specifically, this study examines whether the legalization of abortion can reduce fertility (teen motherhood and number of early births), the timing of first sex, and early marriage of women. Next, I investigate whether the legalization of abortion improves the educational attainment and employment status of women. Specifically, I determine whether the policy increased women's secondary school completion and college attendance.

3.1.3 Main findings

To achieve these objectives, I employ the difference-in-differences (DID) method to assess the impacts of the abortion legalization policy on sexual and reproductive health behaviors and women empowerment outcomes. Specifically, I exploit variations in sexual and reproductive health behaviors and educational attainment generated by an exogenous abortion policy reform in South Africa, implemented in February 1997. The reform increased access and freedom to abortion, and its intensity varied between different provinces of the country. Regarding the impact of abortion legalization, I find that the policy reduces teen motherhood and teen fertility. The policy also substantially increased secondary school completion, college attendance, and the probability of being employed.

3.1.4 Organization of this chapter

This chapter continues in the following manner. This next section describes the South African economy and education system and provides a brief overview of the related literature. In addition, I provide a background to the abortion law, teen fertility, and education. In the next section, I provide a brief background of South Africa's abortion law, education system, and income distribution. Then, I describe the empirical strategy and the data. Results of the main analysis are presented in the last section.

3.2 Literature review

3.2.1 Income distribution in South Africa

Although South Africa is one of the most promising emerging economies in Africa, it is characterized by vast inequalities, and apartheid policies immensely contributed to part of them. The unemployment (narrow) rate has been increasing soon after apartheid, from 17 percent in 1994 to 33 percent in 2002. A decline up to 2008 followed this, but the unemployment rate was still above the rates that existed during the colonization era. Since then, the unemployment rate has been escalating to the latest figure of 28 percent in 2019 (World Bank 2020; Özler 2007). The South African economy can be described as a highly segmented labor market that favors high-skilled individuals and not the low-skilled individuals, who constitute the majority of South Africans. This implies that low-skilled workers tend to be unemployed and live in rural areas, where there is less economic activity. At the same time, there is excess demand for more educated and skilled individuals. As a result, the household income and expenditure inequality gap tend to be huge between the skilled and low-skilled individuals in South Africa.

According to a study by Özler (2007), more than 58 percent of the South African people were living below the poverty line of USD22 in 1995. Table 3.1, columns 7 and 8, displays significant variations in average annual household incomes and poverty levels across provinces. The lowest average yearly household income of around USD1604 was observed in Eastern Cape Province, while Gauteng had the highest annual average household income of USD4745 in 1995. As much as these two provinces differ in terms of their cost of living since Eastern Cape is largely non-urban while Gauteng is primarily urban, the variation in household income is quite huge. However, in terms of the poverty headcount, Gauteng had the lowest poverty headcount rate in South Africa, while Eastern

Cape had the highest poverty headcount rate in 1995. This implies that Eastern Cape had more than three-quarters of its population living in poverty. At the same time, only 20 percent were classified as poor in Gauteng, which shows a vast disparity in living standards between these two provinces.

The inequalities are witnessed in terms of income and expenditure and education, health, and basic infrastructure (access to housing, safe water, and sanitation). In addition, the crime rate is so rampant in South Africa, and the unemployment rate is relatively high compared to other emerging economies such as Malaysia, Thailand, Turkey, Chile, Poland, and Saudi Arabia (World Bank 2020).

3.2.2 Education system in South Africa

The education system of South African has three stages: primary, secondary, and tertiary. Primary education consists of seven years, and the official school entry age is six, or the year in which the child reaches age seven. Learners are expected to proceed to secondary after primary completion, where they are supposed to spend another five years before moving to tertiary education. Therefore, pupils are expected to complete secondary school at the age of 18.

However, South Africa has the highest school dropout rates than other countries like Brazil and Peru, where more than 67 percent of learners complete their high school (Gustafsson 2011; Spaull 2015). Almost half of learners in South Africa drop out before they reach grade 12 (mainly in grades 10 and 11) (ibid). In most cases, almost 60 percent of the students leave school without the National Senior Certificate (NSC), which is the minimum qualification in South Africa. One of the major factors contributing to female school dropout is teenage pregnancy, and it accounts for almost 33 percent of female students' dropout among South Africans (ibid). Another factor that has heavily contributed to high school dropout in South Africa is peer pressure which forces school children to engage in drug/alcohol abuse, criminal activities, and not wanting to remain in school (ibid.). Also, other factors such as lack of qualified teachers and school resources (laboratories, internet connection, chairs, school fees, and textbooks) tend to play a role in school dropout (Gustafson 2011).

In 1999, there were 27,461 public and private schools (primary and secondary schools) in South Africa. Out of these, only 5,673 were secondary schools. Ninety-seven percent (5,522) of the secondary schools were public schools, and 3 percent (151) were private schools. Again, there are noticeable variations in secondary schools per province, with the highest numbers being recorded in Limpopo (1,476) and KwaZulu-Natal (1,454). At the same time, the Northern Cape had the lowest number of secondary schools (65) (see Table 3.1, column 6).

3.2.3 The abortion reform in South Africa

The government of South Africa enacted the Choice on Termination of Pregnancy Act in 1996 to replace the 1975 Abortion and Sterilization Act that restricted women from accessing abortion services by requiring medical approvals and a magistrate's approval for abortion to take place.[22] The new law came into effect in February 1997 (Dickson et al. 2003; Dickson-Tetteh et al. 2002; Mhlanga 2003; Guttmacher et al. 1998). This law allows women to terminate the pregnancy as long as it is less than 12 weeks gestation. After 12 weeks, women are permitted to terminate the pregnancy under conditions such as rape or incest, pregnancy complication, if the pregnancy can cause physical or mental health problems, and if the pregnancy can affect her social or economic situation

[22] The 1975 Abortion and Sterilization Act only allowed women to abort when a pregnancy is likely to cause death, serious physical or mental health to the mother; disability to the child; or was the result of rape (had to be proved), incest or other unlawful intercourse (with a woman who has permanent mental health problems) Guttmacher et al. 1998.

(Dickson-Tetteh et al. 2002, Mhlanga 2003). Minors are at liberty to abort without the consent of their parents or guardian, although they are encouraged to inform them of their decision.[23] Abortion services are provided for free at all public abortion centers.

Given a long history of high teenage pregnancy rate, with over 30 percent of girls falling pregnant before age 20 (Kaufman et al. 2001), many illegal abortions have been witnessed among ages 15-19 in South Africa. Before the 1996 reform, only 1,000 legal abortions were executed per annum in South Africa compared with approximately 120,000 and above illegal abortions performed annually (Guttmacher et al. 1998). Data on illegal abortion is quite difficult to obtain because people are a bit secretive since the exercise is illegal. However, one study was able to conduct a survey in all nine South African provinces in 1994 to investigate the number of illegal abortions through counting the number of incomplete abortions witnessed at randomly selected hospitals for two weeks (see Rees et al. 1997). Although incomplete abortions may underestimate the actual illegal abortion rate as it does not include women who died at home while aborting, those who successfully abort at home, and poor women who may not afford to go to the hospital, but it provides a close measure of illegal abortion rate for South Africa before the policy. The study found that approximately 44 686 (95% Cl 35 633 -53 709) cases of incomplete abortions and an estimated 425 (95% Cl 78 - 735) incomplete related deaths per year were recorded in South Africa’s public hospitals. The cases of incomplete abortions also varied across provinces (see Rees et al. 1997). Hence, the 1996 abortion reform was enacted to try and reduce the high rates of unsafe and illegal abortions, especially among teenagers, which results in maternal mortality and morbidity. Also, the government wanted to reduce

[23] The law also stipulates that distracting the legal termination of a pregnancy or hindering anyone from utilizing abortion services is a serious offense (Stevens and Xaba 1997).

health expenditure on incomplete abortions.

As part of the 1996 abortion policy implementation, abortion services were set up in the private and public sector hospitals. The abortion services were established in all the provinces within a short time. The government mostly relied on existing infrastructure and low-cost technology (manual vacuum aspiration with misoprostol after cervical ripening). It is important to note that there were no designated abortion facilities before the announcement of the 1996 abortion policy. To perfectly execute this new mandate, the nursing staff had to undergo training. Following the implementation of the policy, more than 40,000 legal abortions were performed every year. The trend in the number of legal abortions per annum is depicted in Figure 3.1. The graph shows very low cases of legal abortions before 1997 and a sharp increase in legal abortion rates soon after implementing the new abortion law in 1997.

Given that more than 120 000 illegal abortions were performed annually prior to the implementation of the abortion policy and most of them would result in incomplete abortions that would require hospital attention, public hospitals were overwhelmed with cases of illegal abortion. Hence, most of the maternal deaths that were recorded in public hospitals were related to unsafe abortions. The 1996 abortion law was the first step towards reducing unsafe abortions in South Africa. The law resulted in notable reductions in abortion-related mortality. Evidence shows that abortion-related maternal deaths declined from 425 deaths per year in 1994 to only 40 per year in 1998 in public facilities. This represents a 91% reduction in abortion-related maternal deaths (Jewkes and Rees 2005; Grimes et al. 2006; Faúndes and Shah 2015). Mbele et al. (2006) conducted a study in the west of Pretoria to assess the effect of the Choice on Termination of Pregnancy Act on maternal morbidity and mortality. A total of 2,050 abortions were recorded in 1997 -

1998, and 80.2% were classified as incomplete. Also, 3,999 abortions were recorded in 2003 - 2005, and 42.8% were considered incomplete. Additionally, maternal mortality also declined significantly within the same period (1997-2005).

Table 3.1 shows the provincial variation in the proportion of reproductive-age women living within a distance of 0-100km (columns 2) from the nearest abortion facility and the number of abortion service facilities per 100 000 females (columns 4) in 1999. The assumption is that women who had more facilities in their province or lived near a health facility have more access to abortion services. The table shows that some provinces had almost 38 percent of their reproductive-age women not living within 100km from an abortion facility. In comparison, others had close to 100 percent of its female population living within 100km from an abortion hospital. Also, the distribution of abortion health facilities is unequal in the nine provinces; there were about 0.71-5.35 abortion facilities per 100 000 inhabitants in 1999. In addition, some provinces had no private sector abortion facilities, such as Mpumalanga, Northern Cape, and the Northern Province, and some only had one for the entire province (Dickson-Tetteh et al., 2002). In this paper, I study these provincial asymmetries in order to find the effects of interest.

3.2.4 Theoretical background

Women empowerment can be viewed as a way of promoting women's sense of self-worth, their ability to make strategic choices, and their right to influence social change for themselves, their families, and others (Kabeer 2005). At the same time, sexual and reproductive choices, including abortion, age at first sex, and birth control, can define or shape someone's future in terms of education and labor market status. Hence, teen sexual behaviors cannot be overlooked when studying issues about women empowerment.

Teen sexual behavior is greatly linked to the rational choice theory. Particularly, models of teen social behavior assume that teenagers make rational decisions about sexual activity, the timing of pregnancy, and contraceptive use. That is, teens weigh the costs and benefits of each option before taking part in any sexual activity (Levine and Staiger 2004). For example, teenagers are aware that they risk getting pregnant if they have unprotected sex, which may jeopardize their education, future earnings, and marital chances. At the same time, the availability of abortion services can influence teen sexual behavior since it provides insurance against unwanted births. Hence, abortion legalization may alter women's sexual behavior as well as their fertility.

Assuming that women are uncertain of the likely consequences of having a child when they conceive, particularly whether the father will be willing to support the child or marry them. Unlike contraceptives, abortion offers females an alternative after realizing that the pregnancy will bring drawbacks to their lives. Following Kane (1996), I assume a model where a teenager decides whether to become pregnant without knowing the consequences of becoming a mother and only gets to know the consequences of giving birth when they are already pregnant. Assuming that teenagers have an X chance of giving birth in wedlock, this probability is only revealed to the woman after becoming pregnant and differs across individuals. Therefore, women weigh the utility of becoming a teen mother against that of not being a teenage mother. Assuming that women derive utility equal to 0 for not becoming pregnant, 1 for having a child in a marriage, -U (U is positive) for aborting the pregnancy, and –S (S is positive) for having a child out of marriage. In this case, not becoming pregnant is more desirable than having an out-of-wedlock child or aborting. This simple model implies that females who anticipate a relatively high cost of abortion will avoid having unprotected sex or indulging in sexual activities and, hence, will not become pregnant. This is because the expected utility of becoming pregnant is lower than the utility of not being pregnant. Thus, the legalization of abortion decreases the cost of abortion, which reduces teenage motherhood and school dropout due to unwanted pregnancy. Also, the legalization of abortion decreased the cost of abortion, which can increase unprotected sex. However, due to the high prevalence of HIV/AIDS, the cost of unprotected sex has been increasing. Thus, the effect of legalization on sexual behavior (first sex) cannot be predetermined.

3.2.5 Empirical evidence

Abortion legalization undoubtedly improved women's educational attainment and labor market opportunities by awarding them a chance to control their fertility. Recently, several researchers have studied how access to abortion might influence social conditions and behavioral choices, and the above model seems to hold. For example, Levine and Painter (2003) analyzed how changes in abortion cost influence women's fertility decisions given the uncertain payoff of being a mother. Estimates from this paper show that teen motherhood is associated with poor educational attainment and earnings. Driscoll (2014) and Navarro and Walker (2012) also indicate that teen-out-of-wedlock motherhood is related to poor educational outcomes, low income, and ill-health for both the mother and the child. A study by Medoff (2010) reveals that the price of an abortion, Medicaid funding restrictions, and informed consent laws reduce teen pregnancy. The study implies a positive relationship between contraceptive use and abortion fee and a negative relationship between the cost of abortion and the rate of engaging in unprotected sex among adolescence.

More closely related to this study is the paper by Angrist and Evans (1996), who studied the marital, fertility, and labor market outcomes of females who were teenagers when abortion was legalized in different USA states. The abortion laws impacted teen childbearing, teen marriage, and teen out-of-wedlock motherhood for black women. At the same time, the reform had a relatively smaller effect on teen fertility and teen marriage for white women compared to that of black women. The significant decline in teen fertility and teen marriage for black women seemed to trigger an increase in education and employment rates for black women but had no impact on white women. In terms of actual abortions, Lindo et al. (2020) deduced that the longer the distance from an abortion facility the lower the number of abortions reported. Specifically, an increase from less than 50 miles to 50-100, 100-150, and 150-200 miles reduced abortion rates by 15, 25, and 40 percent, respectively. However, the law had a weak effect on birth rates. In another paper, Levine (1996) found that Medicaid funding restrictions reduce abortion rates and pregnancies but negatively affect birth rates. Levine et al. (1999) employed a quasi-experimental technique to evaluate the impact of abortion legalization in the USA. The authors relied on the variation in the timing of the abortion policy across states to come up with the treatment and control cohorts. The study shows that abortion legalization reduced fertility rates by 4 percent in repeal states than those with no law change. Levine et al. (1999) also established that the legalization of abortion reduces teen fertility rates by 12 percent and only 8 percent for women aged 35 years and above. Clarke and Mühlrad (2021) found that Mexico's abortion legislation led to a sharp decline in maternal mortality rates.

In another study, Donohue et al. (2009) evaluated the effect of abortion legalization on out-of-wedlock teen childbearing in the USA. The study was conducted after 15 to 24 years following the enactment of the abortion law in the 1970s. The study tries to explain the sudden drop in out-of-wedlock teen pregnancy that occurred in 1991 and 2002. The paper argues that exposure to the abortion law *in utero* can explain the decline in the number of teenage mothers in the 1990s. The study concludes that the legalization of abortion altered the composition of women who were prone to out-of-wedlock childbearing after 15–24 years of implementing the 1970s abortion law. This composition effect lowered unmarried teen birth rates by 6 percent. The legalization of abortion also lowered unmarried birth rates among females aged 20–24 and increased the number of marriages among married women aged 20–24. Hence, the observed total fertility reduction appeared to be very small. The effect of abortion policy on fertility has also been examined by Levine and Staiger (2004), when they utilize the timing of abortion policy in eastern European countries between the 1980s and 1990s. Comparing countries with very restrictive abortion laws and those with modest restrictions and granting permission upon request, the authors found that countries with very restrictive laws experienced large reductions in fertility rates.

However, abortion legalization is associated with some negative social degradation because it may increase sexual activity among teens, sexually transmitted diseases (STDs), and promote prostitution. This is because abortion legalization lowers the cost of sexual activity, which happens to be an unwanted pregnancy. Hence, I expect people, especially teens, to increase their sexual activity following abortion legalization. This was witnessed in the USA, where gonorrhea and syphilis cases increased soon after the legalization of abortion (Klick and Stratmann 2003). In my case, I would expect age at first sex to decline and age at first marriage to rise following the implementation of the abortion policy in South Africa. This is because youths will no longer be worried about getting pregnant or forced to get married due to unplanned pregnancy.

There seems to be a consensus among researchers on the positive link between abortion legalization and female education and employment status and a negative correlation between access to abortion and adolescent fertility. However, most of these studies were primarily concentrated on developed countries with less emphasis on developing nations. Yet, teenage motherhood is relatively high in developing countries, especially in African countries. In Africa, childbearing and schooling are considered incompatible because once a schoolgirl falls pregnant, they are dismissed from school and not allowed to rejoin after giving birth (Birungi et al. 2015). Although contraceptives are readily available in most African countries, teenagers face serious challenges openly obtaining and using them (Chandra-Mouli et al. 2014). The restrictive cultures do not permit single ladies and young girls to use contraceptives as it is believed to promote promiscuity and derail African morals. As a result, young women are vulnerable to unplanned pregnancies that can hamper their educational ambitions. Given this different setting, it makes sense to conduct studies on the link between abortion laws, teen fertility, and education in an African setting.

There is one good study by Azarnert (2009) that examined the association between abortion laws and educational attainment in SSA. The article employed a growth model with endogenous fertility to illustrate that availability of abortion services can lower gender inequality in education. The paper argues that the educational gap between males and females emanates from the return on investment parents anticipate from their children. Notably, parents tend to invest in male children when they anticipate that girls may end up being pregnant and dropping out of school. Hence, the paper concludes that economic growth alone may not eliminate gender inequality in education as long as there is a possibility that a female student is likely not to complete education due to unwanted/unplanned pregnancy. However, the results were based on aggregate (country averages) data, and hence, they failed to control for individual-level characteristics or within-country variation in education, income, and total fertility. Also, with country averages, the data is weighted at the country level and not weighted at the individual level, which may bias the result (Holderness 2016). Therefore, this study will address these weaknesses by using individual-level data with a rich set of individual-specific characteristics.

Not only does abortion legalization reduce teenage motherhood and fertility, but it comes with other short- and long-term benefits. For example, holding other factors constant (number of pregnancies), an increase in abortion rate today decreases the number of future adolescents who are likely to commit most crimes. Hence, the crime rate is likely to decline due to the reduction in the population's share of young men (cohort size effect). Furthermore, mothers are more likely to abort unwanted children when abortion services are more easily accessible or when abortion is legalized. Because women who abort are teenagers, unmarried, and destitute, there is a likelihood that children born after abortion legalization will be less likely to engage in criminal activity. If the wanted kids grow up to be good children and not commit many crimes compared to the unwanted children, there will be a further decline in crime rates (selection effect). Abortion legalization also allows women to delay childbirth if their current environment is not conducive to raise children, which may reduce future criminal cases as children are born and raised in better living conditions (Foote and Goetz 2008; Donohue and Levitt 2001).

Researchers have found inconsistent results when looking at abortion legalization and crime in the US (Donohue and Levitt 2001; Lott and Whitley 2001; Donohue and Levitt 2008). For example, time-series analysis shows that juvenile crime and unmarried teen childbearing are positively correlated. Other factors identified as key predictors of teen childbearing and criminal activity were poverty, educational aspirations and performance, single-headed households, and drug use (Miller and Moore 1990; Lott and Whitley 2001). Abortion legalization was detrimental to the crime rate according to Donohue and Levitt, and it was positively related to murder according to Lott and Whitley.

The above papers have provided evidence on the link between abortion legalization and fertility, educational attainment, employment, crime rate, and sexual behavior. However, this study focuses on South Arica, an emerging economy on the African continent, where teenage pregnancy and HIV prevalence are very high. South Africa's case is more interesting given that the legalization of abortion might have triggered a rise in unprotected sex and, in turn, triggered more cases of HIV or vice versa. Hence, this study will reveal human behavior in an economy surrounded by high HIV rates.

3.3 Data and empirical framework

3.3.1 Data

To analyze the effects of the abortion policy, I relied on the 2016 South Africa DHS data. The DHS survey collects information on education, employment status, age, geographic characteristics, birth history, and other reproductive health characteristics of males and females of productive age. The DHS asks questions on the previous province of residence, the current residence area, childhood area of residence, and how long the person has stayed in the current place of residence. Half of the population never moved. I then used this information to match the DHS data to the provincial level data on access to abortion facilities. I obtained data on the availability of abortion services from a report of survey commissioned by the South Africa Department of Health in 1999 (see Table 3.1). The survey was meant to evaluate the implementation of the 1996 abortion reform. The number of public health facilities designated to perform abortions in 1997, when the policy was implemented, never changed until 1999. Nevertheless, 28 additional private facilities were designated (Community Law Centre n.d.). Given that free abortions were only offered in public hospitals and the cost of an abortion in a private facility is very high especially for an adolescent. According to Marie Stopes (2020), an abortion cost at least USD134 in South Africa in a private facility. Hence, I assume that the 28 additional private facilities might not have much impact on the abortion rate in the country. An individual is assigned a measure of access to abortion services related to a province where they lived during their teenage age. The measures for provincial variation in the availability of abortion services are the percentage of reproductive-age females living within 100km from the nearest designated abortion center and the number of abortion facilities per 100 000 females in each province.

The main sample consists of women born between 1966 and 1989, and the main exposure variable is whether the woman was aged 8-19 (treated) when the abortion law was implemented in 1997, or they were aged 20-31 (control). After restricting the sample to females born between 1966 and 1989, the total observations for the main sample are 5155. The treated cohort consists of 3011 observations, and the control cohort had 2144 observations.

The main outcome variables, teen motherhood, secondary completion, and college attendance, are dummy variables indicating 1 if an individual became a mother before 20, completed grade 12, and their highest education level is tertiary level. Appendix Table 3.A.1 includes some of the questions used to define most of the variables. In addition to secondary completion and college attendance, I also define educational attainment in terms of years of education. Employment status is defined as whether someone is currently working. The other outcome variables are the number of children before age 20, being married before age 20, and having sexual intercourse before age 20. The number of children before age 20 is a continuous variable and is measured by the number of kids an individual had before they reached age 20. In determining whether a child was born before the mother turned 20, the year of birth of both the mother and child were used. An individual is classified as married before age 20 if their age at marriage was below 20 (=1 if age at marriage<20, 0 otherwise). Similarly, someone takes on the value of 1 if they had sexual intercourse before age 20 and zero otherwise. I will control for ethnicity and race in all the estimations, and these variables are a set of dummies for all the ethnic groups (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others) in South Africa.

Table 3.2 provides detailed summary statistics for the main sample. Column (1) of Table 3.2 provides the mean and standard deviation for the control group, column (2) provides the mean and standard deviation for the treated group, and column (3) shows the mean and standard deviation of the entire sample. Almost 58 percent of women aged 8-31 in 1997 live in urban areas, and 42 percent live in rural areas. More than 80 percent of the women are black/African people and close to 50 percent of them do not use any form of contraceptives. The t-statistics show significant differences in the years of education, the propensity to be a teen mother, secondary completion, and college attendance between the treated cohort and the control cohort.[24] For example, 51.7 percent of the control cohort were teen mothers, while only 19.1 percent of the treated cohort became mothers at teenage age (Table 3.2). Also, 37.5 percent of the control group completed their secondary

[24] * The difference between the group means of the control and the treated group is statistically significant at the 5% level.

studies, whereas 46.7 of the treated cohort were able to complete their secondary education (Table 3.2). On average, there are 3 abortion hospitals per 100 000 females, but as we saw in Table 3.1, some provinces have close to zero hospitals per 100 000 females while others have close to 3 or more hospitals per 100 000 females. Statistics show that more than 15 percent of women lived beyond 100 km from the nearest abortion hospital.

To shed more light on the variations in both educational attainment and health behaviors of women who were born before and after the introduction of the abortion policy in South Africa, I grouped the provinces into low and high-intensity provinces depending on the availability of abortion services in that province. Specifically, a province is categorized as a high-intensity province if the number of abortion hospitals per 100 000 females in that province is at least 2.75 and low-intensive province as those provinces with the number of abortion hospitals per 100 000 females less than 2.75. I hypothesize that there are differences in educational attainment and the probability of being a teen mother for treated and non-treated cohorts in high and low-intensity provinces. Also, there are no significant differences in controls, Christianity, HIV prevalence, general health facilities, and the number of schools in low and high intensity provinces for the treated and non-treated group. Panel A of Appendix Table 3.A.2 displays summary statistics for individuals who lived in low-intensity provinces, while Panel B shows that of individuals in high-intensity provinces. There are significant differences in the years of education and the probability of being a teen mother, secondary completion, and college attendance between the treated cohorts in high and low-intensity provinces. However, there are no significant differences in Christianity, HIV prevalence, general health facilities, and the number of schools in low and high intensity provinces (see Table 3.A.2). This implies is consistent with the hypothesis.

3.3.2 Empirical strategy

Using a DD approach, I estimated the causal effect of the abortion legalization policy change on sexual and reproductive health behaviors and women empowerment. DD approach is usually used to evaluate policy interventions by comparing outcomes before and after a policy reform for the intervention group to that of the control group (McKinnon et al. 2015; Baird et al. 2011). Systematic reviews reveal quasi-experimental designs (i.e., DD) yield similar results with experimental designs than traditional regression methods that control for observable factors only (Cook and Shadish 2008). The main challenge of the before and after approach is that it is very difficult to observe the change in the outcomes in the absence of a counterfactual, and it is challenging to find a credible comparison group. Even though there is no comparison group because the policy was employed in the whole country (big bang approach), I exploit the provincial variation in the intensity of exposure to the reform. I argue that the effect of abortion legalization was uneven across the country due to the differences in availability of health facilities (distance from the designated abortion facility or number of abortion facilities). This is not the first study to use distance from an abortion facility to measure abortion access. According to Linda et al. (2020), abortion-clinic closures had a negative impact on clinic access, abortions, and births in Texas.

Accordingly, an individual's exposure to the policy depends on both their age in 1997 and the reform's intensity in the province they lived in during teenage age. I expect that the policy had a higher impact on teenage girls living within 50km from the designated abortion facility than those who lived further than 50km from the abortion center. This identification strategy is similar to that of Osili and Long (2008), Dinçer Dincer et al. (2014), Güneş (2015), Cannonier and Mocan (2018), and Masuda and

Yamauchi (2020). To evaluate the impact of abortion policy change on sexual and reproductive health behaviors and educational attainment, I estimate the following equation:

$$Y_{ipt} = \beta_0 + \beta_1 Post_t + \beta_2 Post_t \times Hosp_p + \beta_3 Hosp_p + \beta_4 X_{ipt} + \varepsilon_{ipt} \qquad (3.1)$$

where Y_{ipt} is the outcome of interest (teen motherhood, years of education, secondary school completion, college attendance, employment status, number of children before age 20, being married before age 20, and having sexual intercourse before age 20) for individual i, in province p, who was born in year t. $Post_t$ is a dummy variable indicating whether the individual benefitted from the reform. In the case of teenage motherhood, $Post_t$ takes 1 if the individual was aged 8-19 (born between 1978 and 1989) when abortion was legalized in 1997 or 0 if they were aged 20-31 (born between 1966 and 1977).

As mentioned earlier in section 3.2.2, children are supposed to start primary school at the age of 6, and complete primary at the age of 13 (i.e., Grade 7), and then proceed to secondary school where they are expected to complete their studies by age 18 (Grade 8 to Grade 12). However, some children may delay enrolling in primary school, and I, therefore, expect to find overage students in both primary and secondary school. Figure 3.2 depicts the proportion of girls by age group who were in primary school in 1998. The graph seems to support the official primary school leaving age of 13 since almost 50 percent of girls were reported to be in primary school at age 13, whereas at age 14 only 30 percent of girls were reported to be in primary school. Hence, when analyzing the effect of the abortion reform on educational outcomes (secondary completion and college attendance), I allow one year of a school delay. Therefore, I treat all women below age 19 in 1997 as having been in secondary school (treated group) in 1997 and those aged

20-31 as being out of secondary school (control group) when the policy was implemented. In other words, women aged 8-19 were supposed to be in secondary school when the abortion policy was introduced and had a higher chance of completing their secondary school and attending college.

$Hosp_p$ is the measure for access to abortion services in each province. In the the main analysis, I used the number of abortion facilities per 100 000 females as the measure for access to abortion services. X_{ip} contains individual characteristics (ethnicity, race, and urban dummies), provincial fixed effects, and year fixed effects, and ε_{ip} is an error term clustered at the year of birth and provincial level. Because some individuals belong to the same province and were born in the same year, spatial correlation of standard errors within a province and year of birth is a possible concern. I have nine provinces in the sample, which raises the concern that few clusters may affect inference. To address this concern, I employ the wild bootstrap procedure suggested by Cameron, Gelbach and Miller (2008) in all regressions. The parameter β_2 measures whether women who stayed in provinces with better access to abortion services experienced different teen fertility or educational outcomes from those women in provinces with limited health services after the policy.

The empirical strategy relies on the assumption that no other policies were passed around the same time that the policy intervention was implemented that may influence the results. However, evidence shows that there are no major health reforms that occurred around the same time when the abortion policy was announced in South Africa.

3.4 Results, falsification test, and robustness checks

3.4.1 Results

I first present results based on the 1997 abortion policy. Table 3.3 reports the main results of the effect of abortion legalization on teenage motherhood, secondary school completion, college attendance, number of children before age 20, being married before age 20, having sexual intercourse before age 20, and the number of years of schooling completed using the difference-in-differences method. In the first model, I controlled for ethnicity, area of residence, and the number of abortion service facilities per 100 000 females in each province. However, other unobserved province-level differences, policies, programs, and trends might have occurred around this era. Therefore, I include provincial fixed-effects and birth-year fixed effects to account for these factors.[25] The main model is the model, which accounts for provincial-level fixed effects, and birth year fixed effects. The result shows that being exposed to the abortion policy had a negative and significant impact on teen motherhood (Table 3.3, panel A, column 2). Particularly, an additional designated abortion hospital per 100 000 females reduces the probability of teen pregnancy by 5.2 percentage points and increases years of education by 0.22 for the treatment cohorts. This implies a 10.06 percent (0.052/0.517) reduction in the probability of teen motherhood and a 0.43 standard deviation (0.222/3.915) gain in years of schooling. At the same time, one more designated abortion facility increases the probability of secondary school, college attendance, and being employed by 4.2 percentage points, 2.8 percentage points, and 7.8 percentage points, respectively. This translates to a 11.2 percent (0.042/0.375), 22.2 percent (0.028/0.126), and 19.7 percent (0.078/0.396) increase in the probability of secondary completion, college attendance, and being employed for each additional hospital built. These results are in line with those obtained by Angrist and Evans (1996) in terms of educational attainment, teen motherhood, and employment for black American women. González et al. (2018) also found similar results on high school

[25] The treatment dummy and the access to abortion hospital dummy are not included in models 2, 4, and 6 because I include birth year fixed effects and province fixed effects.

completion.

The reform might have "encouraged" girls to engage in unprotected sex (and pregnancy) because they are allowed to have an abortion more easily in a monetary sense (moral hazard). However, I do not have evidence that the policy increases the probability of indulging in sexual intercourse before age 20. This may be due to misreporting (sexual intercourse questions are sensitive), though I cannot test them rigorously due to data limitations. Also, there is no evidence that the policy decreases early marriage and number teen child births. These findings are a bit different from those obtained by González et al. (2018) and Angrist and Evans (1996) and this could be due to differences in child marriage laws applied in developed countries since in South Africa girls can marry below the age of eighteen under customary law.

Since the data has multiple time periods and there is no clear cutoff to define the treated and control cohorts because of overage students. I, therefore, test the robustness of the results to the inclusion of a treatment-specific linear time trend. The results are robust to the inclusion of treatment-specific linear time trends (column (3) of Table 3.3). Overall, results show that the abortion policy had a significant impact on reducing teen motherhood and improving the educational attainment of women who were affected by the policy compared to their older siblings who did not benefit from the policy.

3.4.2 Further robustness checks

Given that I am dealing with many outcomes, I had to perform joint multiple hypothesis testing of all outcomes to see if the main results are not affected by multiple inferences. I specifically used the Romano-Wolf correction method, to test for multiple inference and the results are displayed in Appendix Table 3.A.3 (Akresh et al. 2018; Jones et al. 2019; Clarke et al. 2020). The joint test supports my initial findings presented in

Table 3.3.

A more general concern is that other underlying factors (demand factors) or policies could have influenced the availability of abortion facilities. Thus our results (i.e., teen motherhood and educational attainment) would be biased. For instance, South Africa is a Christian country, and almost 66 percent of its population were Christians in 1991 (Kritzinger 1994). Hence, when the abortion policy was introduced, most Christians tried to contest the abortion Act since abortion goes against their beliefs. Furthermore, with the high HIV prevalence in South Africa, the government might have enacted the abortion law to try and reduce high-risk pregnancies. Also, the availability of schools can determine someone's educational attainment. To minimize these concerns, I controlled for the proportion of Christians in the province, the ratio of HIV-infected persons in that province, and the school availability (number of secondary schools in each province in relation to the number of secondary school-going kids in that province).[26] I then re-run equation 3.1, additionally controlling for the availability of secondary school (and its interaction with the post dummy), the proportion of Christians in that province (and its interaction with the post dummy), and the proportion in each province (and its interaction with the post dummy) before the policy. Tables 3.A.4-3.A.6 shows that the main results remain unchanged even after controlling for these demand-driven factors. I thus conclude that the results are driven by the supply of abortion services.

To further examine the sensitivity of the results, I performed robustness checks of the main findings using a different measure of access to abortion services, particularly;

[26] Data on the number of schools in each province is based on the Department of Education, and Department of Education South Africa 1999 report. Information on Christianity is obtained from South African Christian Handbook (Kritzinger 1994). HIV prevalence information is based on national surveys (Swanevelder et al. 1998). Availability of secondary schools is measured by the number of secondary schools per 1000 secondary school going kids in each province in 1999. I used the secondary schools data after the policy due to data limitations.

the proportion of females living within 100km from the abortion facility. The results are presented in Appendix Table 3.A.7 and are consistent with the main results in section 3.4.1.

3.4.3 Falsification tests

The main assumption is that no other policies or factors influence the outcomes apart from the abortion policy (i.e., the parallel trends assumption hold). However, the parallel trend assumption may fail to hold if the initial conditions for the treatment and control group were different across birth cohorts. To check whether the parallel trend assumption holds, I performed a regression-based event study investigating the impact of the abortion policy on teen motherhood, educational attainment, and employment status. Following Clarke and Schythe (2020) and the general convention, I omit the year before the policy implementation (base year) since the impact of the policy is likely to have started changing people's behavior a year before the policy implementation. The event study graphs provide evidence of a decline in early motherhood soon after the implementation of the abortion policy (see Figures 3.3 and 3.4). Similarly, I also witness a rise in years of schooling and the probability of being employed just after introduction of the policy. However, the coefficients of other outcomes before and after the baseline are not quite different (i.e. secondary completion and college attendance), and hence, Caution should be exercised in interpreting the results.

Since abortion directly affects women and not men, I expect the law not to affect the educational outcomes and the sexual behaviors of men. Hence, I conducted another placebo test using men. The results suggest that the law did not affect men's education, employment status, and sexual behaviors (see Table 3.4). I conclude this section by performing a placebo test using access to general health care facilities (number of general health care facilities per 100 000 females) that do not provide abortion services. These facilities should not affect the outcomes, and the results are presented in Table 3.5.[27] As expected, none of the coefficients are significant. This supports the fact that access to abortion facilities created another source of variation in the impact of the abortion policy.

3.5 Discussion and conclusion

This study analyzed the effect of abortion law on teen sexual behaviors and educational outcomes. Overall results show that legalizing abortion law reduces teen motherhood and promotes educational attainment. Estimates suggest that additional designated abortion hospital per 100 000 females reduces teen motherhood by 5.2 percentage points, which translates to a 10.06 percent over the control mean. Furthermore, my study shows that one more abortion hospital raises the years of education, secondary school completion, college attendance, and probability of being employed by 0.22 percentage points, 4.2 percentage points, 2.8 percentage points, and 7.8 percentage points, respectively. However, I did not find any evidence that the policy affects teen marriage, age at first sex, and teen fertility.

These results are pretty promising that abortion laws can alter teen motherhood and fertility. Given the high crime and HIV rates in South Africa, studying the policy's impacts on crime rates and HIV outcomes would be good.

[27] The provincial health care facilities data is obtained from McIntyre (1995). To obtain general health care facilities (do not offer abortion services) per province, I subtract the number of abortion facilities from the total number of health care facilities in each province.

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Table 3.1: Provincial Characteristics when the policy was changed (Termination of Pregnancy services, secondary schools, poverty)

Province	No. of 16-50 year old females in 1999	% within 100km	No. of abortion facilities in 1999	Abortion facilities per 100 000 females in 1999	General health facilities 1993	Population 1993 (million)	Non abortion facilities ((6)-(4))	No. of secondary schools in 1999	No. of secondary schools in 1999/1000 pupils	Average annual household income (USD) 1995	Poverty -Head count ratio 1995	HIV (%) in 1996	Christians (%) in 1991
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(13)	(14)	(15)
E. Cape	1,541,476	92.4	11	0.71	653	6.7	642	839	1.882981	1603.88	0.76	8.10	69.9
N. Cape	215,261	61.5	2	0.93	156	0.7	154	65	1.403312	2071.68	0.62	6.47	77.5
Free State	702,486	95.4	9	1.28	290	2.8	281	302	1.117120	1670.71	0.70	17.49	83.6
North West	866,619	96.8	12	1.38	351	3.5	339	360	1.500976	2004.85	0.66	25.13	70.7
K.Z.Natal	2,237,265	84	66	2.95	419	8.5	353	1454	1.704850	2472.65	0.63	19.90	61.3
Limpopo	1,182,998	82.2	36	3.04	397	5.1	361	1476	2.112469	2004.85	0.65	7.96	51.5
Mpumalanga	718,689	99.9	22	3.06	333	2.8	311	353	0.886115	2004.85	0.62	15.77	70.7
Gauteng	2,097,147	100	75	3.58	496	6.8	421	514	1.025903	4744.82	0.23	15.49	72.3
Western Cape	1,102,618	91.5	59	5.35	514	3.6	455	310	1.095143	3541.90	0.40	3.09	67.9
Total	10,664,559		292	2.74		35.4	3317	5673			0.58		

Source: Figures in columns (1)–(4) are taken from a report by Dickson-Tetteh et al. 2002 (Tables 1 and 2 of the report). Figures in column (5) are author's own calculation (i.e. column (4) divided by column (1) multiplied by 100 000). Figures in columns (6), (7), and (8) are taken from the Department of Education, and Department of Education South Africa 2001, Hirschowitz 1997, and Özler 2007. Data on the number of schools in each province is based on the Department of Education, and Department of Education South Africa 1999 report. Information on Christianity is obtained from South African Christian Handbook (Kritzinger 1994). HIV prevalence information is based on national surveys (Swanevelder et al. 1998). The provincial health care facilities data is obtained from McIntyre (1995). To obtain general health care facilities (do not offer abortion services) per province, I subtract the number of abortion facilities from the total number of health care facilities in each province.

Table 3.2: Descriptive statistics.

Variable	Control Cohorts (1)	Treated Cohorts (2)	Whole sample (4)	N (5)
1(if teen mother)	0.517(0.500)	0.191*(0.393)	0.326(0.469)	5155
1(if married before age 20)	0.239(0.427)	0.126*(0.332)	0.173 (0.378)	5155
Number of children before age 20	0.405(0.605)	0.357(0.553)	0.377(0.575)	5155
1(if had sexual intercourse before age 20)	0.765(0.424)	0.781(0.414)	0.774(0.418)	5155
Years of education	9.316(3.915)	11.086*(2.577)	10.350(3.319)	5155
Secondary completion	0.375(0.484)	0.467*(0.499)	0.429(0.495)	5155
College attendance	0.126(0.332)	0.195*(0.396)	0.166(0.372)	5155
Employed	0.396(0.489)	0.703*(0.457)	0.576(0.494)	5155
No. of Hospitals/100000 females	2.400(1.375)	3.006(1.558)	2.754(1.514)	5155
% of females within 100km from an abortion hospital	0.720(0.180)	0.938*(0.062)	0.829(0.064)	5155
Age	43.680(3.277)	31.752*(3.431)	36.713(6.776)	5155
1(if urban)	0.584(0.493)	0.571(0.495)	0.576(0.494)	5155
HIV (%)	0.139(0.063)	0.151*(0.056)	0.146(0.595)	5155
Christians	0.676(0.092)	0.690(0.070)	0.684(0.080)	5155
No. of secondary school/1000 learners	1.373(0.397)	1.409*(0.359)	1.394(0.375)	5155
No. of non-abortion hospital/100 000 females	11.244(5.578)	11.003(4.935)	11.103(5.213)	5155
Race				
Black/African			0.849	5155
White			0.032	5155
Colored			0.106	5155
Indian/Asian			0.010	5155
Ethnicity				
White			0.105	5155
Afrikaners			0.094	5155
Xhosa			0.147	5155
Zulu			0.172	5155
Sotho			0.111	5155
Tswana			0.135	5155
Pedi			0.106	5155
Swazi			0.036	5155
Venda			0.028	5155
Tsonga			0.046	5155
Ndebele			0.010	5155
Other			0.011	5155
Contraceptive use			0.502	5155
Number of observations	2144	3011	5155	

Note: Standard deviations are shown in parentheses.
* The difference between the means of control and treated group is statistically significant at the 5 percent level.

Table 3.3: Effect of the abortion policy on sexual and reproductive health behaviors and women empowerment- Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A		Teen motherhood		Years of education				Secondary completion			College attendance	
$Post \times Hosp$	-0.036***	-0.058***	-0.052***	0.057	0.249*	0.222*	0.022*	0.052**	0.042**	0.021**	0.020**	0.028**
	(0.011)	(0.005)	(0.018)	(0.087)	(0.147)	(0.127)	(0.013)	(0.031)	(0.200)	(0.009)	(0.008)	(0.013)
Post	-0.211***			1.515***			0.011			0.010		
	(0.034)			(0.264)			(0.038)			(0.024)		
Abortion hospitals/100 000 females	-0.023**			0.197***			0.032***			0.002		
	(0.010)			(0.073)			(0.011)			(0.006)		
Provincial FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Year-of-birth FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Treatment-specific linear time trend	No	No	Yes	No	No	Yes	No	Yes	Yes	No	No	Yes
R-squared	0.178	0.184	0.208	0.142	0.146	0.180	0.090	0.097	0.125	0.058	0.073	0.077
Control mean	0.517	0.517	0.517	9.316	9.316	9.316	0.375	0.375	0.375	0.126	0.126	0.126
N	5155	5155	5155	5155	5155	5155	5155	5155	5155	5155		5155
Panel B	Number of kids before 20			Married before 20				Sex before 20		Working		
$Post \times Hosp$	-0.002	-0.009	-0.004	0.011	0.008	0.004	-0.01	-0.008	-0.001	0.050***	0.054***	0.078***
	(0.015)	(0.014)	(0.021)	(0.008)	(0.008)	(0.015)	(0.009)	(0.008)	(0.012)	(0.009)	(0.009)	(0.017)
Post	-0.034			-0.135***			0.041			0.138***		
	(0.047)			(0.025)			(0.027)			(0.030)		
Abortion hospitals/100 000 females	-0.025*			-0.023***			0.002			0.030***		
	(0.013)			(0.007)			(0.007)			(0.007)		
Provincial FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-of-birth FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Treatment-specific linear time trend	No		Yes	No	No	Yes	No	Yes	Yes	No	No	Yes
R-squared	0.045	0.052	0.059	0.049	0.062	0.069	0.033	0.043	0.051	0.165	0.192	0.198
Control mean	0.405	0.405	0.405	0.239	0.239	0.239	0.775	0.775	0.775	0.396	0.396	0.396
N	5155	5155	5155	5155	5155	5155	5155		5155	5155		5155

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications. All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban *p < 0.1, **p < 0.05, ***p < 0.01.

Table 3.4: Effect of the abortion policy on sexual and reproductive health behaviors, educational attainment, and employment status on men (Placebo test) - Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)
Panel A	Teen fatherhood	Years of education	Secondary completion	College attendance
$Post \times Hosp$	-0.030	0.025	-0.042	0.029
	(0.020)	(0.211)	(0.029)	(0.021)
Provincial FE	Yes	Yes	Yes	Yes
Year-of-birth FE	Yes	Yes	Yes	Yes
Treatment-specific linear time trend	Yes	Yes	Yes	Yes
R-squared	0.042	0.150	0.111	0103
N	1668	1668	1668	1668
Panel B	Married before 20	Sex before 20	Working	
$Post \times Hosp$	0.047**	-0.005	0.020	
	(0.021)	(0.028)	(0.031)	
Provincial FE	Yes	Yes	Yes	
Year-of-birth FE	Yes	Yes	Yes	
Treatment-specific linear time trend	Yes	Yes	Yes	
R-squared	0.071	0.077	0.062	
N	1668	1668	1668	

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications). All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 3.5: Effect of the abortion policy on sexual and reproductive health behaviors and women empowerment (Placebo test – using number of general health facilities/100000 females) - Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)
Panel A	Teen motherhood	Years of education	Secondary completion	College attendance
$Post \times Hosp$	-0.002	0.009	-0.001	-0.004
	(0.005)	(0.039)	(0.005)	(0.003)
Provincial FE	Yes	Yes	Yes	Yes
Year-of-birth FE	Yes	Yes	Yes	Yes
Treatment-specific linear time trend	Yes	Yes	Yes	Yes
R-squared	0.109	0.821	0.113	0.060
N	5155	5155	5155	5155
Panel B	Number of kids before 20	Married before 20	Sex before 20	Working
$Post \times Hosp$	-0.003	0.005	-0.001	0.006
	(0.006)	(0.004)	(0.005)	(0.005)
Provincial FE	Yes	Yes	Yes	Yes
Year-of-birth FE	Yes	Yes	Yes	Yes
Treatment-specific linear time trend	Yes	Yes	Yes	Yes
R-squared	0.059	0.069	0.051	0.195
N	5155	5155	5155	5155

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications). All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban. *p < 0.1, **p < 0.05, ***p < 0.01.

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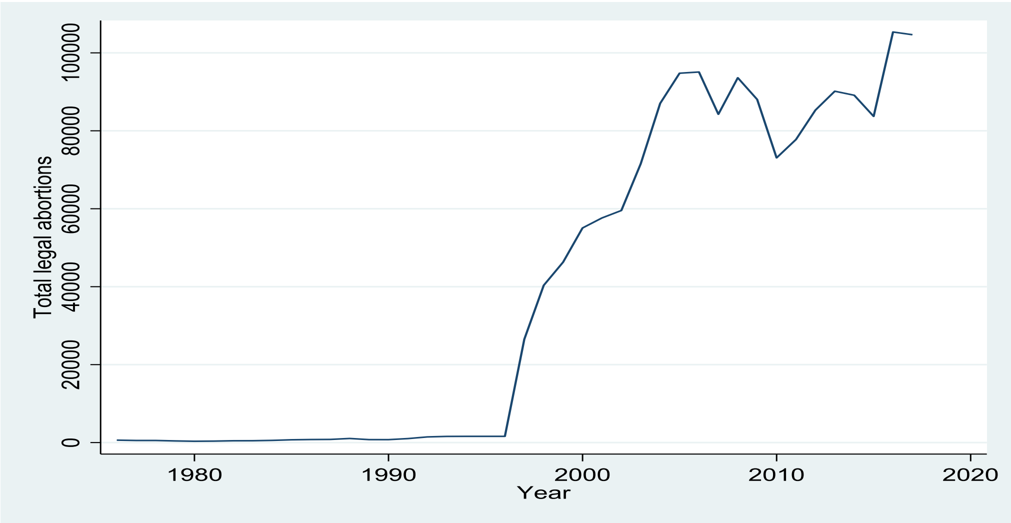
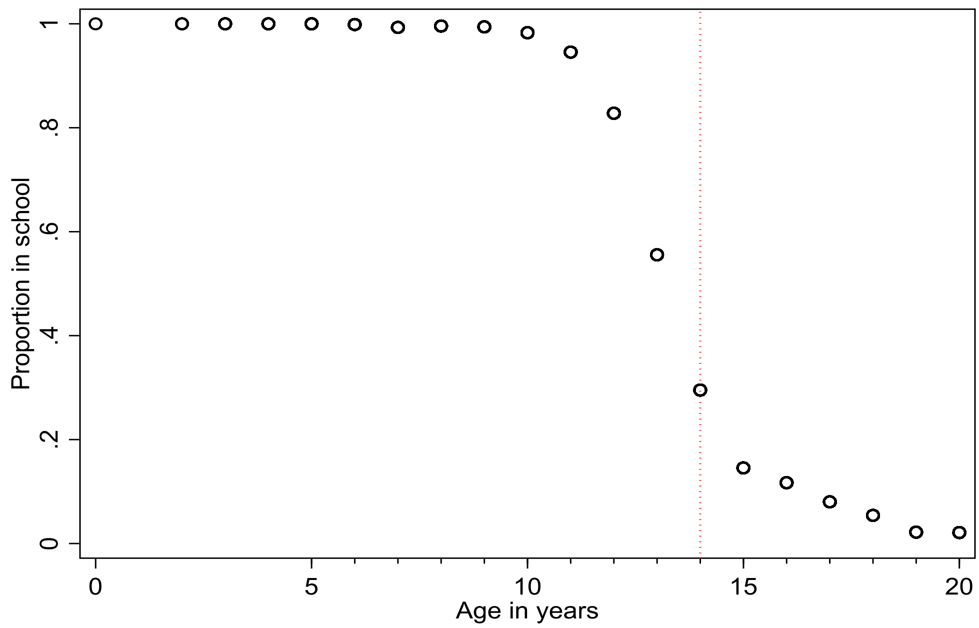
Figure 3.1: Number of legal abortions by year



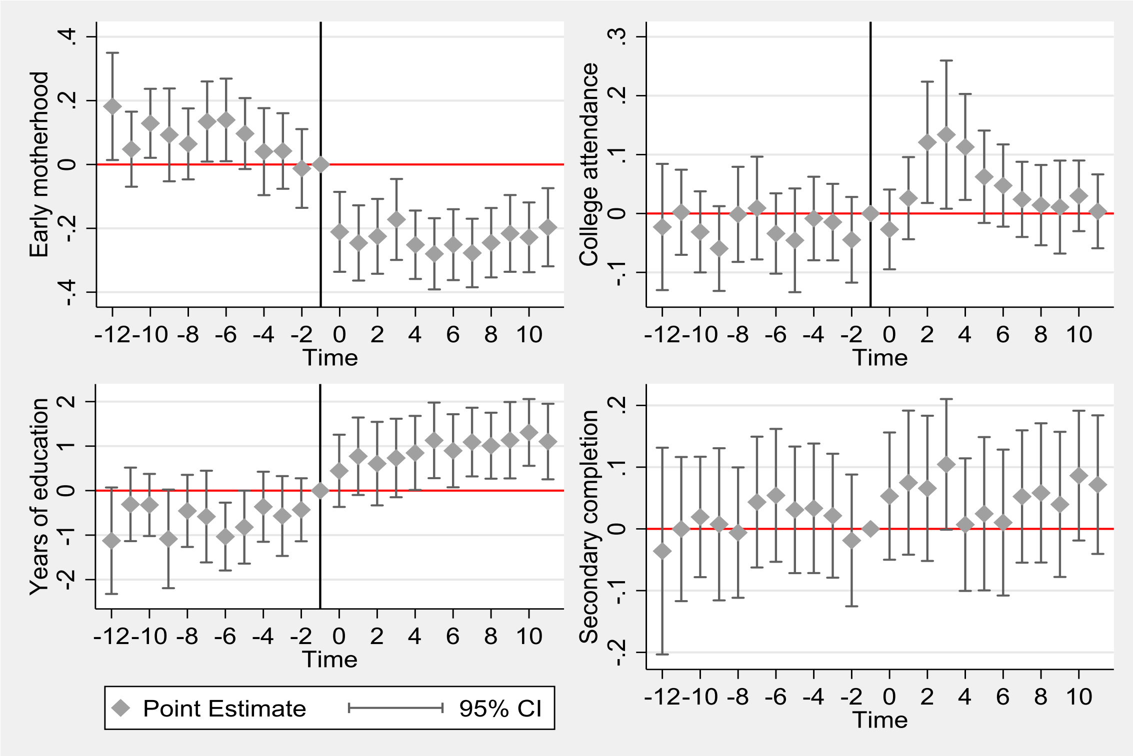
Source: Johnston (2020). "Historical abortion statistics, South Africa

Figure 3.2: Fraction of girls with incomplete primary education



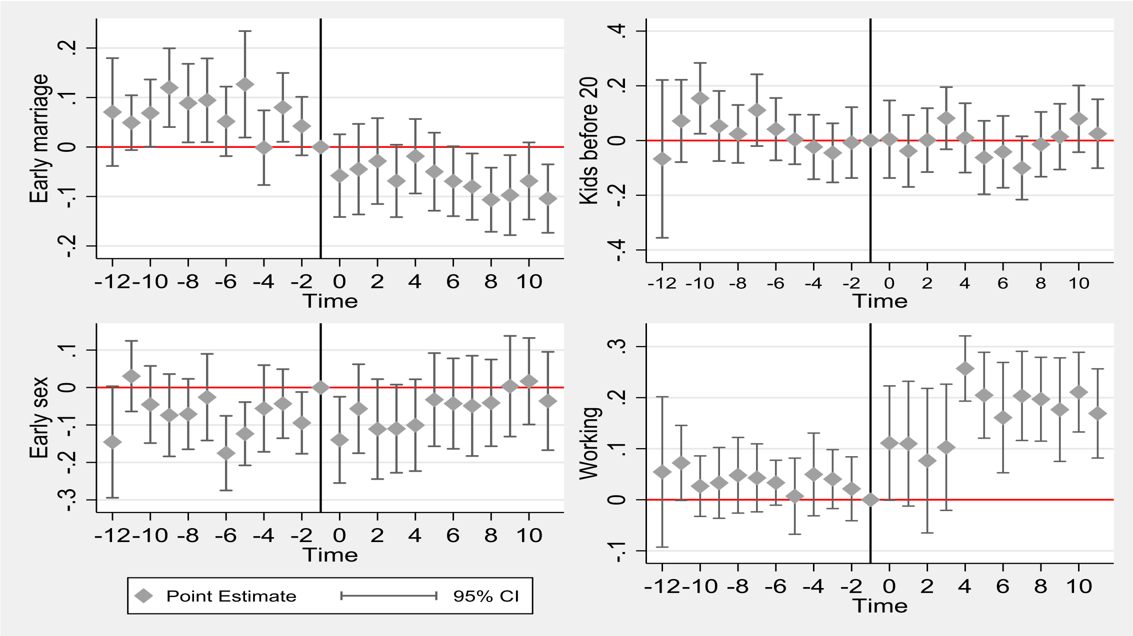
Source: 1998 South Africa DHS Household Survey.

Figure 3.3: Event study estimates of the effect of abortion policy on key outcomes



Notes: Point estimates based on the regression-based event study analysis are presented together with their 95% confidence intervals. Period -1, a year prior to the implementation of the policy is omitted and is depicted by the vertical line in the plot

Figure 3.4: Event study estimates of the effect of abortion policy on key outcomes



Notes: Point estimates based on the regression-based event study analysis are presented together with their 95% confidence intervals. Period -1, a year prior to the implementation of the policy is omitted and is depicted by the vertical line in the plot

Appendix 3.A: Tables

Table 3.A.1: Definition of key variables

Variable	Questions used to define key variables
Province of residence at teenage age	In what province do you live? How long have you been living continuously in (name of current city, town or village of residence)? Before you moved here, which province did you live in?
Teen motherhood (1 if first child was born before age 19, 0 otherwise)	How old were you when your first child was born?
1(if married before age 20)	How old were you when you first started living together?
1(if had sexual intercourse before age 20)	How old were you when you had sexual intercourse for the very first time?
Years of education	What was the highest grade or form he/she completed at that level?

Table 3.A.2: Descriptive statistics.

Variable	Control Cohorts (1)	Treated Cohorts (2)	Whole Sample (4)	N (5)
Panel A: Low-intensity province (No. of Hospitals/100000 females<2.75)				
1(if teen mother)	0.550(0.498)	0.317(0.466)	0.440(0.497)	1822
1(if married before age 20)	0.281(0.450)	0.171(0.376)	0.229(0.420)	1822
Number of children before age 20	0.462(0.653)	0.445(0.605)	0.454(0.630)	1822
Had sexual intercourse before age 20	0.774(0.418)	0.813(0.390)	0.793(0.406)	1822
Years of education	9.216(3.767)	10.627(2.696)	9.883(3.378)	1822
Secondary completion	0.333(0.472)	0.394(0.489)	0.362(0.481)	1822
College attendance	0.114(0.319)	0.157(0.364)	0.134(0.341)	1822
Employed	0.368(0.483)	0.569(0.495)	0.463(0.499)	1822
No. of Hospitals/100000 females	0.986(2.78)	1.048(0.260)	1.018(0.270)	1822
% of females not within 100km from an abortion hospital	0.752(0.036)	0.756(0.043)	0.756(0.043)	1822
HIV (%)	0.119(0.047)	0.146(0.038)	0.132(0.045)	1822
Christians	0.672(0.129)	0.699(0.114)	0.685(0.123)	1822
No. of secondary school/1000 learners	1.427(0.522)	1.479(0.511)	1.452(0.517)	1822
No. of non-abortion hospital/100 000 females	8.861(2.904)	9168(2.825)	9.059(2.857)	1822
Age	43.811(3.292)	31.578(3.383)	38.031(3.959)	1822
Panel B: High-intensity province (No. of Hospitals/100000 females >=2.75)				
1(if teen mother)	0.519(0.500)	0.140*(0.347)	0.264*(0.441)	3333
1(if married before age 20)	0.255(0.404)	0.108(0.310)	0.143(0.350)	3333
Number of children age 20	0.448(0.560)	0.321(0.526)	0.335(0.538)	3333
1(if had sexual intercourse before age 20)	0.757(0.429)	0.768*(0.422)	0.764*(0.425)	3333
Years of education	9.396(4.031)	11.270*(2.505)	10.605*(3.258)	3333
Secondary completion	0.351(0.492)	0.496*(0.500)	0.465*(0.499)	3333
College attendance	0.135(0.342)	0.210*(0.408)	0.184*(0.387)	3333
Employed	0.389(0.494)	0.757*(0.429)	0.637*(0.481)	3333
No. of Hospitals/100000 females	3.499*(0.822)	3.816*(1.038)	3.703*(0.979)	3333
% of females not within 100km from an abortion hospital	0.856*(0.030)	0.941*(0.030)	0.909*(0.030)	3333
HIV (%)	0.155(0.069)	0.133(0.062)	0.144(0.065)	3333
Christians	0.680(0.040)	0.686(0.041)	0.683*(0.041)	3333
No. of secondary school/1000 learners	1.430(0.243)	1.581(0.271)	1.462(0.262)	3333
No. of non-abortion hospital/100 000 females	14.178*(6.592)	15.587*(5.986)	13.844(6.350)	3333
Age	43.574(3.262)	31.821 (3.449)	35.993*(6.563)	3333

Note: Standard deviations are shown in parentheses. * The difference between the means of low (Panel A) and high (Panel B) facility provinces is statistically significant at the 5 percent level. The sample mean number of abortion hospital/100000 females is 2.75.

Table 3.A.3: The impact of education on outcomes (multiple hypothesis testing)

		Model Coefficient	Model p-value	Resample p-value	Romano-Wolf p-value
Panel A:		**Main Analysis**			
Early mother	Table 3.3, Column (1)	-0.052	0.001	0.020	0.009
Years of education	Table 3.3, Column (2)	0.222	0.060	0.035	0.099
High school completion	Table 3.3, Column (3)	0.042	0.020	0.018	0.049
College attendance	Table 3.3, Column (4)	0.028	0.045	0.045	0.001
Panel B:					
Number of kids before 20	Table 3.3, Column (1)	-0.004	0.849	0.835	0.183
Married before 20	Table 3.3, Column (2)	0.004	0.768	0.765	0.989
Sex before 20	Table 3.3, Column (3)	0.001	0.931	0.933	0.989
Working	Table 3.3, Column (1)	0.078	0.000	0.001	0.001

Table 3.A.4: Effect of the abortion policy on sexual and reproductive health behaviors and women empowerment (accounting for the proportion of HIV prevalence in each province) - Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)
Panel A	Teen motherhood	Years of education	Secondary completion	College attendance
$Post \times Hosp$	-0.051***	0.203	0.039**	0.027**
	(0.018)	(0.124)	(0.020)	(0.013)
$Post$	-0.301***	0.293	-0.213*	-0.089
	(0.115)	(0.821)	(0.118)	(0.071)
$Post \times HIV$	-0.226	6.166*	1.019**	0.47
	(0.438)	(3.332)	(0.424)	(0.286)
R-squared	0.208	0.181	0.126	0.077
N	5155	5155	5155	5155
Panel B	Number of kids before 20	Married before 20	Sex before 20	Working
$Post \times Hosp$	-0.004	0.006	0.000	0.081***
	(0.021)	(0.015)	(0.012)	(0.018)
$Post$	0.024	0.046	0.236**	0.147
	(0.165)	(0.083)	(0.102)	(0.108)
$Post \times HIV$	-0.134	-0.482	-0.475	-1.001**
	(0.530)	(0.296)	(0.397)	(0.435)
R-squared	0.059	0.069	0.051	0.199
N	5155	5155	5155	5155

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications). All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban, HIV rates per province, number of abortion hospitals/100 000 females, provincial, year of birth fixed effects, and treatment-specific linear time trend. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 3.A.5: Effect of the abortion policy on sexual and reproductive health behaviors and women empowerment (accounting for the number of schools in each province) - Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)
Panel A	Teen motherhood	Years of education	Secondary completion	College attendance
$Post \times Hosp$	-0.053***	0.232*	0.037*	0.025*
	(0.019)	(0.130)	(0.020)	(0.013)
$Post$	-0.291**	0.704	-0.312**	-0.181**
	(0.132)	(0.958)	(0.136)	(0.086)
$Post \times Sch$	0.014	-0.197	0.106	0.067
	(0.078)	(0.515)	(0.070)	(0.044)
R-squared	0.208	0.181	0.125	0.077
N	5155	5155	5155	5155
Panel B	Number of kids before 20	Married before 20	Sex before 20	Working
$Post \times Hosp$	0.002	0.002	-0.002	0.082***
	(0.021)	(0.016)	(0.013)	(0.017)
$Post$	0.179	-0.059	0.161	0.126
	(0.178)	(0.090)	(0.107)	(0.129)
$Post \times Sch$	-0.112	0.043	0.005	-0.07
	(0.079)	(0.057)	(0.069)	(0.069)
R-squared	0.059	0.069	0.051	0.199
N	5155	5155	5155	5155

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications). Family-wise p-values (Romano-Wolf p-value), reported in square brackets and are estimated using 1,000 bootstraps. All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban, number of schools per 1000 secondary school going children provincial, number of abortion hospitals/100 000 females, year of birth fixed effects, and treatment-specific linear time trend. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 3.A.6: Effect of the abortion policy on sexual and reproductive health behaviors and women empowerment (accounting for the proportion of Christians in each province) - Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)
Panel A	Teen motherhood	Years of education	Secondary completion	College attendance
$Post \times Hosp$	-0.051***	0.210	0.037*	0.026**
	(0.019)	(0.129)	(0.020)	(0.013)
$Post$	-0.248	0.062	-0.446**	-0.173
	(0.260)	(1.780)	(0.227)	(0.148)
$Post \times Chr$	-0.109	1.143	0.485	0.188
	(0.364)	(2.391)	(0.301)	(0.200)
R-squared	0.208	0.181	0.125	0.077
N	5155	5155	5155	5155
Panel B	Number of kids before 20	Married before 20	Sex before 20	Working
$Post \times Hosp$	0.000	0.004	-0.004	0.080***
	(0.210)	(0.016)	(0.013)	(0.017)
$Post$	0.306	-0.041	0.035	0.217
	(0.284)	(0.195)	(0.208)	(0.245)
$Post \times Chr$	-0.446	0.070	0.245	-0.235
	(0.382)	(0.267)	(0.294)	(0.320)
R-squared	0.059	0.069	0.051	0.198
N	5155	5155	5155	5155

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications). All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban, proportion of Christians in per province, number of abortion hospitals/100 000 females, provincial, year of birth fixed effects, and treatment-specific linear time trend. *p < 0.1, **p < 0.05, ***p < 0.01.

Table 3.A.7: Effect of the abortion policy on sexual and reproductive health behaviors and women empowerment (abortion access - % of women living within 100km from an abortion facility) - Age 8-19 vs 20-31

	(1)	(2)	(3)	(4)
Panel A	Teen motherhood	Years of education	Secondary completion	College attendance
$Post \times Hosp$	-0.937**	6.118**	0.952**	0.603**
	(0.447)	(3.101)	(0.435)	(0.295)
Provincial FE	Yes	Yes	Yes	Yes
Year-of-birth FE	Yes	Yes	Yes	Yes
Treatment-specific linear time trend	Yes	Yes	Yes	Yes
R-squared	0.208	0.181	0.125	0.077
N	5155	5155	5155	5155
Panel B	Number of kids before 20	Married before 20	Sex before 20	Working
$Post \times Hosp$	-0.002	-0.159	0.340	1.352***
	(0.512)	(0.352)	(0.315)	(0.450)
Provincial FE	Yes	Yes	Yes	Yes
Year-of-birth FE	Yes	Yes	Yes	Yes
Treatment-specific linear time trend	Yes	Yes	Yes	Yes
R-squared	0.059	0.069	0.051	0.197
N	5155	5155	5155	5155

Notes: Wild Cluster Bootstrap standard errors are in parentheses, clustered at the year of birth and provincial level (with 999 replications). All estimates include dummies for ethnicity (White, Afrikaners, Xhosa, Zulu, Sotho, Tswana, Pedi, Swazi, Venda, Tsonga, Ndebele, and Other) and different races (black/African, white, colored, Indian/Asian, and others), race (black/African, white, colored, Indian/Asian, and other), and urban. *p < 0.1, **p < 0.05, ***p < 0.01.

CHAPTER 4

Conclusion

4.1 Summary

This dissertation empirically examines education and abortion laws on HIV stigma, women empowerment, and sexual and reproductive health behaviors. To conclude, I summarize each chapter and the implication of the result to the literature.

Chapter 2 focuses on the causal effect of education on HIV stigma, HIV status, and testing. I used the education reform implemented in 1980 as an exogenous source of variation in years of schooling. The result indicates that the reform led to an increase in educational attainment for the treatment group by 1.43 years. Also, I find that additional schooling reduces HIV stigma by 0.16 standard deviation units. This negative effect of education on HIV stigma implies that education improves an individuals' knowledge of HIV. However, there is no evidence that education affects HIV status and testing.

Chapter 3 analyses the effect of abortion law on teen sexual behaviors and women empowerment. Overall results show that legalizing abortion law reduces teen motherhood and promotes educational attainment. The estimates suggest that an additional designated abortion hospital per 100 000 females reduces teen motherhood by 5.2 percentage points, which translates to a 10.06 percent over the control mean. Furthermore, this study shows that one more abortion hospital raises the years of education, secondary school completion, college attendance, and probability of being employed by 0.22 percentage points, 4.2 percentage points, 2.8 percentage points, and 7.8 percentage points, respectively.

4.2 Policy implication

The findings from Chapter 2 provide two possible interpretations. First, general education alone does not necessarily reduce HIV stigma (and, thus, prevalence) but changes peoples' (knowledge and, thus) willingness to express discriminatory attitudes toward PLWHA. Second, education changes knowledge and stigma, but it alone may not necessarily change sexual behavior (and, thus, prevalence). Unless actual behavior changes, HIV prevalence does not go down. Education policy contributed partially to the decrease in HIV stigma, but it seems that there should be better policies to mitigate HIV prevalence by increasing test uptake. Hence, policymakers should develop programs to address fears and misconceptions around HIV and the effects of HIV stigma. Furthermore, governments should take advantage of schools, the media, and other institutions (hospitals and workplaces) to address fears and misconceptions most people have on how HIV is transmitted by providing comprehensive information about the disease.

While a reduction in teen motherhood and increase in educational attainment and is undoubtedly a positive development, the results should not be misunderstood as either an encouragement of abortion or a call for policy intervention in women's fertility choices. The same impacts could, in principle, be obtained through more socially acceptable methods like effective birth control and creating better environments for vulnerable or poor girls who are at a greater risk of becoming teen mothers.

4.3 Limitations and future research

The analysis in Chapter 2 has a few setbacks. First, a major limitation of chapter 2 is that HIV stigma outcomes were self-reported, and some individuals may choose not to faithfully report their opinions. Second, I acknowledge that the pupil-teacher ratio slightly increased soon after the implementation of the educational reform, which might have lowered the quality of education received by the treated cohorts. However, data limitations prevented me from accounting for this ratio change in this study.

My analysis in Chapter 3 is presented with the following limitations. First, in this chapter, I exploit variation in reform intensity at the provincial level, which might be too distanced from the respondent. Thus, I could not verify the robustness of the intensity variable at a more disaggregated level. Second, misreporting is another serious limitation in my study, especially on sexual intercourse-related questions like age at first sexual intercourse. Hence, I did not find evidence that the law increased the sexual intercourse before age 20 which is the likely negative effect (moral hazard) of abortion legalization. Another weakness of this paper is that there is no direct evidence that the law increased the likelihood of abortion.

Nevertheless, these results are pretty promising that abortion laws can alter teen motherhood, educational attainment and employment status. Given the high crime and HIV rates in South Africa, it would be good to study the impacts of the policy on crime rates and HIV outcomes.

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