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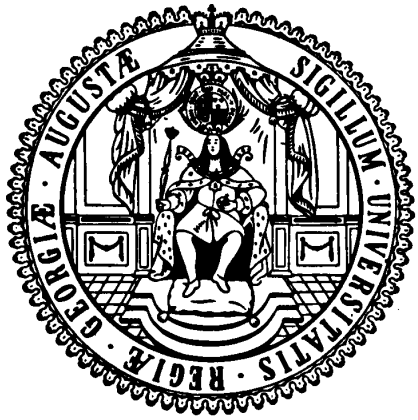

Discussion Papers

No. 291

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October 2022

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Parental Health, Children's Education and Unintended Consequences of State Support: Quasi-experimental evidence from KwaZulu-Natal, South Africa

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Abstract

This study investigates whether eligibility for antiretroviral therapy (ART) of HIV positive parents improved their children's educational attainment in KwaZulu-Natal, South Africa, employing a regression discontinuity design. We find that there is a positive impact of ART eligibility on paternal health, but this does not translate into general improvements of children's education. Instead, impacts differ by the previous reception of state support. Previous recipients of health-contingent state support can lose the state support after initiation of ART, as their health improves after ART is initiated. For these parents, we see a negative impact of ART eligibility on children's education, potentially driven by the negative impact on the household's wealth. In contrast, there is a positive impact of ART eligibility on children's education for fathers who previously received non-health-contingent state support.

Keywords: Education, Health, Regression Discontinuity Design, Antiretroviral Therapy, South Africa

JEL codes: I12, I21

Introduction

Parental health can be a key determinant of the next generation's well-being. It affects the parent's ability to earn income and take care of their children, and might impact children's physical or mental health, the household's health expenditure, as well as investments in children's human capital (Alam and Mahal, 2014; Sherr et al., 2014). This study investigates the impact of a potentially positive health shock, parental eligibility for HIV/AIDS treatment, on children's educational attainment in KwaZulu-Natal, South Africa.

Over the past decades, the HIV/AIDS epidemic has been a large contributor to the burden of disease in sub-Saharan Africa. South Africa was particularly affected, with AIDS-related deaths peaking at 270,000 in 2006 (UNAIDS, 2021). Six years later, this number had halved, and by 2020, it had reduced to 83,000 (UNAIDS, 2021). One large driver of the fall in AIDS-related deaths is the rapid expansion and improvement of antiretroviral therapy (ART) in South Africa and worldwide. ART slows down the progression of HIV, and is presumed to have averted 5.5 million deaths globally between 1995 and 2012 (UNAIDS, 2013). It immensely reduces the risk of HIV transmission and improves the patients' ability to cope with the disease, thus enhancing overall health and productivity (UNAIDS, 2013).

While ART enables patients to return to a nearly normal life, the wider impact on the patients' families is not yet comprehensively studied. Our study investigates the role of ART for children's education. For this, we combine clinical and household panel data from KwaZulu-Natal, South Africa, between 2000 and 2017. We make use of a natural experiment to develop a quasi-experimental study design: In the past, WHO clinical guidelines defined ART eligibility based on the CD4 cell count, a biomarker in the blood. The CD4 cell count decreases over the course of HIV/AIDS, and a low CD4 cell count was used as indicator for a late stage of the disease. WHO guidelines recommended that only patients below a certain CD4 cell count should be eligible for ART. This setting allows us to compare children of parents with CD4 cell counts slightly below the threshold with children of parents who just missed the threshold, using a regression discontinuity design.

We find that eligible parents just below the CD4 threshold initiate ART much faster, and eligible fathers are less likely to report a clinic visit in the past 12 months than their ineligible counterparts just above the CD4 threshold. However, the transmission into gains in children's education is mediated by the role of state support: There is no overall significant impact of ART eligibility, but we find a negative impact on children's education when parents received a disability grant prior to the ART eligibility assessment. This goes along with reductions in the household's asset index for these parents, an effect which is especially strong when fathers are affected. This negative impact is due to the linkage of the disability grant to the CD4 cell count: When the CD4 cell count improved, as it happens under ART, patients could lose the disability grant. The negative impact on the asset index underlines this mechanism, which could in turn lead to the negative impact on children's education. This is not the case for other state grants, which are not linked to the CD4 cell count.

Our study contributes to the understanding of the role of parental health for household well-being in general, and for children's education in particular. Panel surveys show that children's educational outcomes often worsen after a parent became ill, with a varying role of children's and parents' gender across studies (Alam, 2015; Bratti and Mendola, 2014; Luca and Bloom, 2018; Sun and Yao, 2010). The economic implications of health shocks might play a major role in this relationship, as improved access to health insurance reduces child labor (Landmann and Frölich, 2015) and moderates the negative impact of health shocks on education (Woode, 2017). Our findings demonstrate the role of financial support as a mediator of the impact of health shocks.

Furthermore, the access to ART poses a special case in this literature, as it provides a positive instead of a negative health shock. The impacts of health shocks might not be symmetrical, for example if labor market frictions prevent the transmission of health improvements into employment and economic well-being. Yet, a causal identification is difficult, as ART initiation is not exogenous. The existing studies compare adults initiating ART at different points in time (Zivin et al., 2009), or analyze the local roll-out of ART using a difference-in-differences design (Baranov and Kohler, 2018; Lucas et al., 2019). We make two contributions to this evidence: Firstly, we focus our analysis on the time ART was offered directly to the individual, to estimate the impact in the absence of any indirect effects of ART availability. Secondly, our identification strategy allows us to

causally estimate the impact on children's education with the comparatively weak assumptions of a regression discontinuity design (Bärnighausen et al., 2017).

The remainder of the paper is structured as follows: First, we shed more light on HIV/AIDS and the roll-out of ART, the situation in South Africa, and the potential impacts on children's education. Next, we describe our data and empirical approach. Then, we present our findings, potential mechanism and robustness checks. Finally, we conclude with a summary and discussion.

Background

HIV/AIDS and ART

Antiretroviral therapy slows down the progression of HIV infection to AIDS (Hammer et al., 1997) and reduces the occurrence of opportunistic infections (Detels et al., 2001). After initiation of ART, patients rapidly gain weight (Coetzee et al., 2004). Compared to pre-ART patients, their physical and emotional well-being improves (Booysen et al., 2007; Louwagie et al., 2007; Rosen et al., 2010), with the largest increases in well-being observed shortly after treatment initiation (Booysen et al., 2007; Jelsma et al., 2005). Also, ART reduces the risk of HIV transmission during sexual intercourse (Detels et al., 2001) and pregnancy (WHO, 2010).

CD4 cell counts decrease during the onset of HIV (Fahey et al., 1990) and were established as a proxy to measure the progression of AIDS. Analogously, they rapidly improve within the first weeks of ART (Hammer et al., 1997; Wools-Kaloustian et al., 2006). Also, the CD4 cell count at initiation strongly influences the success of ART: Patients with initially lower CD4 cell counts are at higher risk of detrimental side-effects of ART, further progression of AIDS, or even death (Coetzee et al., 2004; Egger et al., 2002; Murphy et al., 2001).

HIV/AIDS and ART in KwaZulu-Natal

In 2003, the prevalence of HIV/AIDS among the adult population in South Africa was 21.5%, with a substantial variation across regions and sociodemographic groups (WHO, 2005). One of the most affected regions was KwaZulu-Natal, where the prevalence was highest among women aged 25-29 years (51%) and men aged 30-34 years (44%) (Welz

et al., 2007). Individuals with a lower education and in the middle of the wealth distribution were at especially high risk of contracting HIV (Bärnighausen et al., 2007).

In 2004, the nationwide roll-out of ART started and ART became available in KwaZulu-Natal (Houlihan et al., 2011). National treatment guidelines followed the WHO recommendations and were mostly based on the patient's CD4 cell count. The first guidelines defined patients with a CD4 cell count ≤200 or WHO stage IV (independent of CD4 cell count) as eligible for ART (Plazy et al., 2015). The eligibility rules were updated in 2010, 2011 and 2015, and finally discarded in 2016, when all people living with HIV became eligible for ART irrespective of their CD4 cell count (Meyer-Rath et al., 2017).

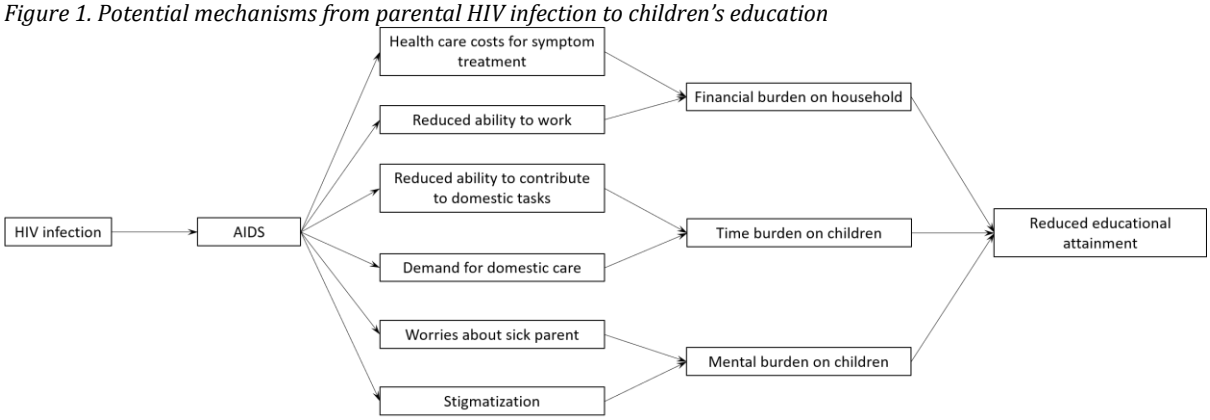
Longitudinal analyses show that after eight years, about 82% of the individuals living with HIV in our study population had learned their HIV status (Haber et al., 2017). Only 45% accessed an HIV clinic, 39% became eligible for ART, and 35% initiated ART (Haber et al., 2017). The median time from HIV infection to the first CD4 test are nearly five years, with faster transition times for women than for men and for individuals with higher education levels (Maheu-Giroux et al., 2017). After the CD4 test, less than half of the individuals who were not eligible return for the recommended retest within one year, with a larger loss among men and younger individuals (Lessells et al., 2011). Among eligible patients, only 61% are still in care after five years, with the highest loss due to mortality (Mutevedzi et al., 2013). Disengagement from care takes place mainly within the first three months of ART initiation and increased over time (Mutevedzi et al., 2013). However, overall the retention in care between the first positive HIV test and the virologic suppression improved over time (Haber et al., 2017).

The role of adult HIV/AIDS and ART for children's education

To conceptualize how parental ART might affect children's education, we take one step back and discuss how parental HIV/AIDS can affect children's education in the absence of treatment, as depicted in Figure 1 (for a review, see Sherr et al., 2014): As adults get sicker over time, they are less able to earn income (Levinsohn et al., 2011) and to contribute to domestic tasks and caregiving. The co-infections caused by a suppressed immune system require medical care. With further progression, adults might get so sick that they require constant care at home. The household's financial burden increases (Alam and Mahal, 2014), and children might need to take over new responsibilities to

step in for the sick adult or to take care of them (Robson et al., 2006; Skovdal and Ogutu, 2009). This also implies less monetary and time resources to invest in children's education. In addition, children might face a substantial mental burden due to worries about their sick parent (Cluver et al., 2012; Skovdal and Ogutu, 2009), stigmatization of HIV/AIDS-affected families (Cluver et al., 2012; Skovdal, 2012; Hosegood et al., 2007), and new responsibilities such as care-taking or income earning (Cluver et al., 2012; Skovdal and Ogutu, 2009; Robson et al., 2006).

Figure 1. Potential mechanisms from parental HIV infection to children's education



Most studies on the relationship between adult HIV/AIDS and children's education are purely observational (Goldberg and Short, 2016; Guo et al., 2012), but there is an indication for a negative effects of adult HIV/AIDS on children's school participation (Cluver et al., 2012), attendance (Cluver et al., 2012; Robson et al., 2006) and progress (Mitchell et al., 2016). Similarly, in the case of parental deaths, drops in children's school attendance and participation occur already before HIV-infected adults decease, with mixed evidence whether the rates recover after the death or not (Evans and Miguel, 2007; Ainsworth et al., 2005; Yamano and Jayne, 2005).

To which extent ART can leverage this burden is still under examination. As discussed above, the patient's health improves rapidly after ART initiation. Similarly, studies show that productivity, working hours and employment rates increase after ART initiation (Larson et al., 2013; Linnemayr et al., 2013; Rosen et al., 2010; Thirumurthy and Zivin, 2012). Yet, longitudinal data from South Africa demonstrate that a full recovery of employment might take several years, given a drop in employment prior to ART initiation and high unemployment rates in general (Bor et al., 2012). This might explain the different impacts on households across settings: In Kenya, for example, nutritional outcomes improve and children's time devoted to domestic and market-related activities

reduces after an adult introduced ART (D'Adda et al., 2009; Thirumurthy and Zivin, 2012; Zivin et al., 2009). In South Africa, however, there is indication for increased food insecurity within the first year on ART (Patenaude et al., 2018). In addition, although ART is provided for free, the direct and indirect costs associated with treatment uptake can be quite substantial and result in financial distress (Chimbindi et al., 2015).

Evidence on the effect of adult ART initiation on children's education is scarce. An early study by Zivin et al. (2009) analyzes trends of households with a member initiating ART in Kenya. They find that children from these households increased their school attendance relative to later-stage ART households, and that improvements in adult health were associated with these results. Two further studies focus on the impact of ART arrival by using a difference-in-differences design, comparing changes for households close to ART clinics with changes for households further away: Baranov and Kohler (2018) find that in Malawi, households closer to ART clinics increase spending on education after ART becomes available, an effect particularly driven by HIV-positive households. However, also HIV-negative households are affected: their grade completion rates increase after ART roll-out, what the authors trace back to updated beliefs on mortality risks. In Zambia, Lucas et al. (2019) estimate the HIV status of households based on socioeconomic characteristics. Using the same identification strategy as Baranov and Kohler (2018), they find that ART roll-out does not affect school enrollment, but increases the likelihood to be grade-for-age for children from (likely) HIV-affected households. We extent this literature by going beyond the introduction of ART as a new treatment possibility, and investigate the impact of individual access to ART directly. Moreover, all existing studies rely on some form of parallel trends assumptions. By employing a regression discontinuity design, we exchange these comparatively strong assumptions for the weaker assumption of continuity of expected outcomes across the threshold.

The role of state support

In our setting, many families rely on state support in form of state grants to meet their daily needs (Booysen, 2004). These state grants might help to surpass the period between ART initiation, with non-trivial indirect costs of accessing treatment, and a recovery in employment. One of the grants that the South African government offers is the disability grant, which considers the inability to work due to HIV/AIDS. Disability grants are mostly

temporary, with a re-assessment of the eligibility criteria after six months (de Paoli et al., 2012).

During our study period, there were no detailed national guidelines for grant eligibility. However, qualitative evidence suggests that many health practitioners took into account the same CD4 threshold as for the ART eligibility, namely 200 cells/µl (de Paoli et al., 2012; Hardy and Richter, 2006). This created a conflict between maintaining ART and receiving the disability grant: As patients take up treatment, their CD4 cell count and their health improve, putting them at risk of losing the disability grant. Qualitative evidence suggests that individuals might therefore adopt excessive drinking or interrupt ART, trying to decrease their CD4 cell count before the next assessment (Peltzer, 2012). Indeed, it has been found that patients who ever received a disability grant have a 20% slower CD4 recovery rate than patients who never received this grant (Haber et al., 2018).

In 2008, the government emphasized that the ability to work, not the CD4 count, should be the determining factor for eligibility (Knight et al., 2013). Still, as health improves rapidly after the initiation of ART, individuals will be at risk of losing the disability grant soon after the initiation of ART. For patients who already received a disability grant before the CD4 assessment, this might be particularly burdensome, as they might have financially depended on this grant beforehand. Hence, for previous recipients of the disability grant, there might be a negative link between parental ART eligibility and children's education, by impeding health improvements or by cutting an important income source during the time of recovery.

Method

Data

Since 2000, the Africa Health Research Institute (former: Africa Centre for Population Health) has collected longitudinal socio-economic, demographic, clinical and laboratory data from the northern area of KwaZulu-Natal, South Africa (Muhwava et al., 2008; Tanser et al., 2008). The area is predominantly rural, but also includes some peri-urban settlements and an urban township (Tanser et al., 2008). Circulatory migration to urban areas is common (Muhwava et al., 2008), and main income sources are wage employment and state grants (Tanser et al., 2008). The participation rate in the household surveys is

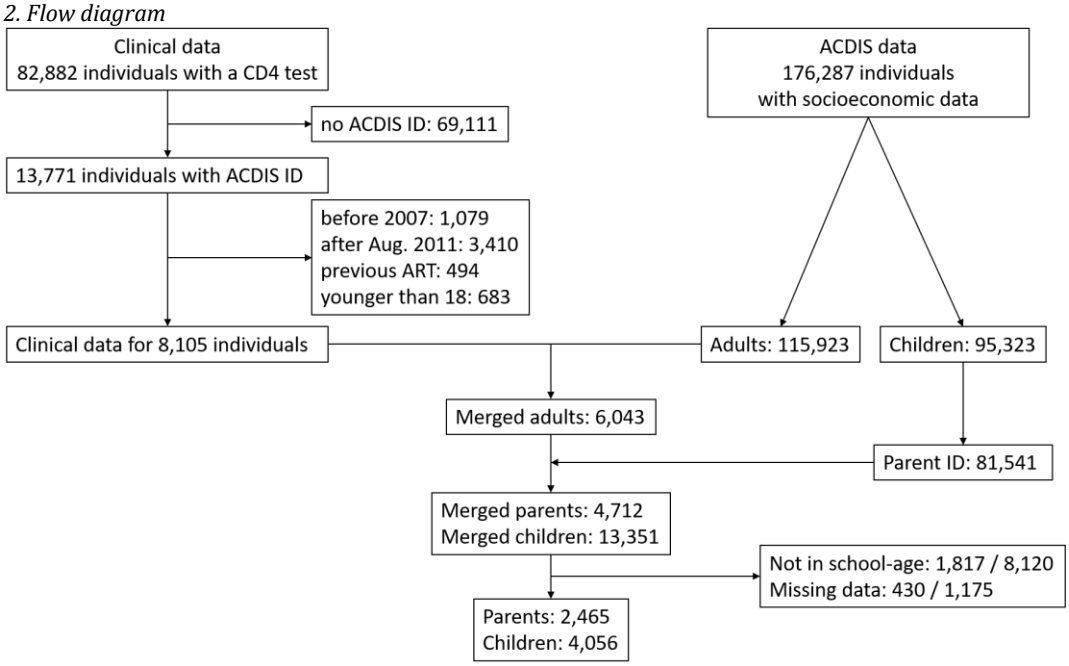
above 98%, but participation in the individual-level components below 50% in a given year (Gareta et al., 2021).

A clinical dataset includes ART data and CD4 cell counts since 2007, including data collected retrospectively back to the roll-out in 2004 (Plazy et al., 2015; Houlihan et al., 2011). The coverage area includes 16 primary health clinics, with about 40% of the patients covered by the demographic surveillance area (Houlihan et al., 2011). The dataset contains HIV-positive patients only (Houlihan et al., 2011).

Most of our data falls within the first guideline period before August 2011, such that we restrict our sample to this period. During this time, eligibility was determined by a CD4 cell count ≤200 cells/μl or WHO stage IV (independent of CD4 cell count) (Plazy et al., 2015). For pregnant women and patients with TB, the threshold was raised to 350 cells/μl in April 2010 (Plazy et al., 2015). All patients below the threshold were offered antiretroviral drugs, accompanied by regular group and individual sessions and health monitoring (Houlihan et al., 2011). Patients who were not eligible initially were asked to return after six to twelve months for another CD4 measurement (Houlihan et al., 2011). However, there was a substantial loss in retention in care for patients who did not become eligible during the first test (Lessells et al., 2011). We consider only the first CD4 test in our analyses.

The clinical data can be matched with the demographic surveillance data based on a joint identifier, which itself is based either on the national identification number, or the first name, surname, age, and gender (Bor et al., 2011; Cooke et al., 2010). The resulting data on adults can be matched with their children based on parental identification numbers. We restrict our sample to children who were of school age when the first CD4 test was conducted. If both parents conducted a CD4 test, only the parent with the earlier test is matched to the child. After excluding observations with missing data (e.g., no educational data after the CD4 test), we obtain a sample of 4,056 children and 2,465 parents. A flow diagram is depicted in Figure 2.

Figure 2. Flow diagram



Note: In the ACDIS data, the sum of adults and children is larger than the number of individuals as some children became adults during the observation period.

Outcomes

The dependent variable of interest is children's educational attainment, defined as the highest school grade attained. School attendance is compulsory in South Africa, starting on the first school day in the year the child turns seven and ending on the last school day of the year the child turns fifteen or reaches the ninth grade (*South African Schools Act No 84 of 1996*, 2011). However, children can already be admitted to grade 1 if they are turning six by June 30th in the respective school year (*South African Schools Act No 84 of 1996*, 2011).

We also investigate impacts on parental health and economic burden. In a subset of our data, parents reported whether they were admitted to a hospital in the last 12 months, and visited a clinic or private practice in the last 6 months. We use the household's asset index quintile as predefined in the ACDIS household data as proxy for the household's economic situation.

Identification strategy

The clinical guidelines which defined ART eligibility based on a CD4 cell count threshold allow us to use a regression discontinuity design to assess the impact of ART eligibility. For this approach, we assume that in the absence of the eligibility rule, patients with a

CD4 cell count just below 200 cells/µl and patients with a CD4 cell count just above 200 cells/µl would on average have the same outcomes (conditional on the CD4 cell count) (Hahn et al., 2001). Thus, we attribute any observed differences in outcomes of the two groups (controlling for the CD4 cell count) to the impact of eligibility.

To estimate the impact of ART eligibility on our main outcome, children's educational attainment, we estimate the following equation:

$$Y_{it} = \alpha + \beta\, Eligible_p + \gamma\, Eligible_p * Deviation_p + \delta\, Deviation_p + \theta C_{it} + \pi P_{pt} + \lambda_t + \varepsilon_{it} \quad (1)$$

with Y_{it} as child i's educational attainment at date t, $Eligible_p$ as an indicator whether parent p's first CD4 test was ≤200 cells/µl, and $Deviation_p$ as difference of the CD4 test to the threshold. The interaction of $Eligible_p$ and $Deviation_p$ allows for a different linear trend in CD4 cell counts to the left and the right of the threshold. We control for children's age and gender (C_{it}), parents' age, gender, and education (P_{pt}), and fixed effects for the visit year and years since the CD4 test (λ_t). In further regressions, we examine heterogeneous impacts of eligibility by children's and parents' gender, interacting the eligibility indicator with the respective characteristic. Standard errors are clustered at the level of the parent. Observations are weighted with a triangular kernel to give more weight to the observations closer to the cutoff.

The estimated effect is local in the sense that it reflects the impact of eligibility at the threshold of 200 cells/µl, while the impact might differ for patients with a much lower or much higher CD4 cell count (Hahn et al., 2001). In addition, patients initially not eligible for ART are asked to return after 6-12 months for a re-assessment, as the progression of HIV/AIDS will lead to a further depletion of CD4 cells, such that they will sooner or later become eligible. Hence, β estimates the local impact of early versus deferred eligibility for ART.

We assess the impact of eligibility on parental health, survival, and economic burden using the following equation:

$$Y_{pt} = \alpha + \beta\, Eligible_p + \gamma\, Eligible_p * Deviation_p + \delta\, Deviation_p + \pi P_{pt} + \lambda_t + \varepsilon_{pt} \quad (2)$$

with Y_{pt} as the outcomes for parents: Hospital visit in the past 12 months, clinical or private practice visit in the past six months, and household asset index. Given the recall period of the health care outcomes, we only include observations at least one year after the CD4 test to ensure that outcomes capture the situation after the CD4 test.

We test for heterogeneities by child and parental gender and type of state support. For the latter, we use the last information available prior to the CD4 test to separate our analyses from impacts of ART eligibility on reception of state support. As the disability grant precludes the reception of any other type of state support, we can split all parents in three categories: Received no state support prior to the CD4 test, received a disability grant prior to the CD4 test, received any other type of state support (e.g., child foster grant) prior to the CD4 test.

For the identification of the effect, the choice of the area around the threshold is crucial. The smaller this area, the more credible the assumption that patients below and above the threshold are comparable conditionally on the CD4 cell count (and the control variables). At the same time, the sample size, and with it the statistical power, drastically reduces closer to the threshold. To balance this tradeoff, we employ a data-driven bandwidth selection by minimizing the asymptotic coverage error of the confidence intervals[1]. The bandwidth selection was applied using the Stata package rdrobust as described in Calonico et al. (2017). As this procedure is sensitive to the outcome of interest, the sample and the choice of control variables, we estimate the optimal bandwidth for each of the specifications separately.

Similarly, the approach hinges on the assumption that no exact manipulation of the CD4 cell count was possible. While in principle, patients might be able to adopt strategies which reduce their CD4 cell count, they cannot manipulate their CD4 cell count exactly and thus cannot determine their eligibility. However, medical staff might report wrong CD4 cell counts such that patients become (in)eligible for ART, which would bias the estimates if this manipulation is correlated with our outcomes of interest. While we cannot prove that this was not the case, we can test for (one-sided) manipulation of CD4 cell counts by examining the distribution of CD4 cell counts around the threshold as described in Cattaneo et al. (2018). Furthermore, we employ balance checks and run placebo-regressions on the time before the first CD4 test to investigate whether differences were prevalent before the individuals were tested.

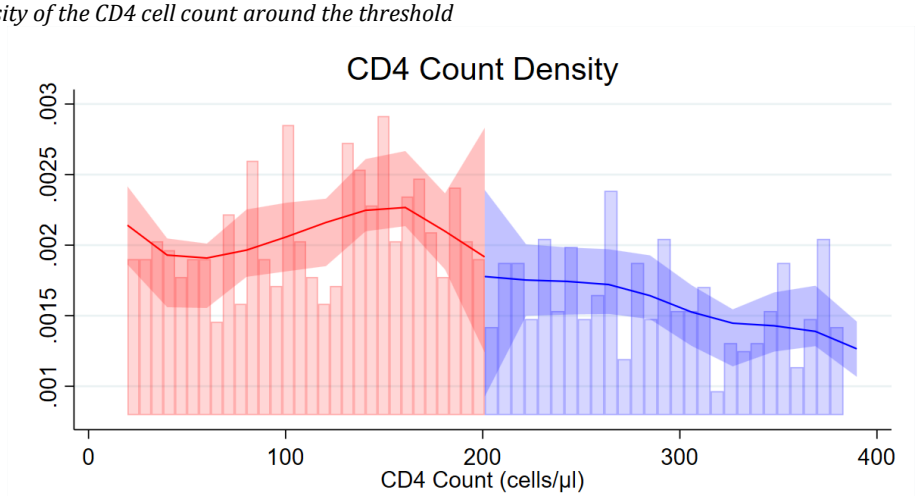
[1] This optimizer is used for inference rather than the point estimate (Cattaneo and Vazquez-Bare, 2017).

Results

CD4 cell count, treatment uptake and parental health

At first, we examine the distribution of CD4 cell counts around the threshold. Figure 3 displays the distribution of the CD4 cell counts and estimates for their density. The CD4 cell counts are relatively evenly distributed around the threshold. We cannot reject the null hypothesis of a joint distribution across the threshold (p-value 0.51).

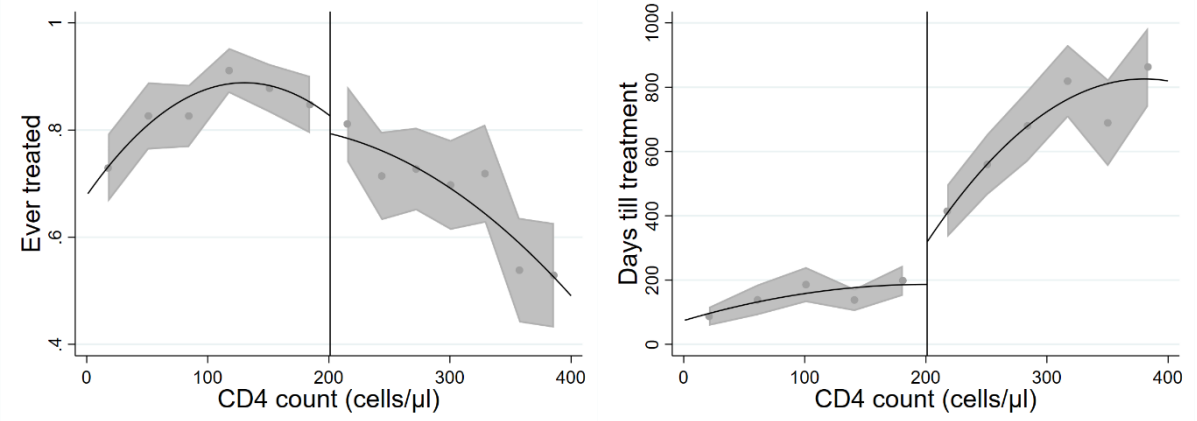
Figure 3. Density of the CD4 cell count around the threshold



Note: The bars represent the histogram for the CD4 cell counts. The lines refer to fitted curves from both sides of the threshold as described in Cattaneo (2018). The shaded areas represent the 95% confidence intervals for both curves.

Next, we assess whether the eligibility for ART transfers into an increased initiation of ART. As depicted in Figure 4, there is no clear jump in the share of individuals ever treated at the threshold. The share of individuals ever treated decreases at higher CD4 cell counts, as well as for individuals with a CD4 cell count close to zero, who are likely to be at a very late stage of the disease progression. However, among the individuals who were ever treated, the duration between the first CD4 measurement and the treatment start is much shorter for eligible patients. Moreover, the time till treatment initiation does not vary strongly across CD4 cell counts for eligible patients, but there is a quite steep trend among ineligible patients, with shorter waiting times visible for CD4 cell counts approximately between 200 and 300 cells/µl. In sum, this underlines the interpretation of any effect sizes as the impact of early versus deferred treatment.

Figure 4. Share of ever treated individuals and average days between CD4 test and treatment start by CD4 cell count



Note: The dots refer to the mean outcomes for evenly-spaced bins of the CD4 cell count. The shaded areas refer to the 95% confidence intervals around the means. The lines are fitted regression lines using a quadratic function of CD4 cell counts and no control variables.

For a subsample of parents, we also have information on visits to hospitals (in the past 12 months), clinics, or private practices (both in the past six months). As depicted in Table 1, eligible fathers are less likely to have visited a clinic in the past six months, but we cannot detect significant effects on visits to hospitals or private practices.

Table 1. Impact on parental health

	(1) Hospital	(2) Hospital	(3) Clinic	(4) Clinic	(5) Private pract.	(6) Private pract.
Eligible	-0.081	-0.120	-0.096	-0.375***	-0.054	-0.234
	(0.0631)	(0.1157)	(0.0815)	(0.1413)	(0.0679)	(0.1536)
Deviation	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004
	(0.0028)	(0.0028)	(0.0038)	(0.0037)	(0.0025)	(0.0025)
Eligible # Deviation	0.004	0.004	0.005	0.004	0.006*	0.006*
	(0.0031)	(0.0032)	(0.0045)	(0.0045)	(0.0032)	(0.0032)
Eligible # Mother		0.043		0.308**		0.199
		(0.1062)		(0.1328)		(0.1451)
R2	0.102	0.103	0.096	0.108	0.043	0.048
Cluster	219	219	203	203	235	235
Observations	592	592	559	559	625	625
Bandwidth	38	38	36	36	42	42

Regression for parental health controlling for year of visit, years since the CD4 test and parents' age, gender and education. Deviation is the CD4 cell count minus the threshold of 200 cells/µl. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Balance and pre-trends

The optimal bandwidth for the main regression specification is estimated as +/-58 cells/µl. Demographic characteristics within this bandwidth are depicted in Table 2. We see significant differences with respect to the parent's sociodemographic characteristics and visit year. Eligible parents are on average older, and are less likely to be mothers. When clustering standard errors at the parent level, only the difference for mothers remains significant.

Table 2. Balance checks

	Not eligible		Eligible			
Variable	Mean	S.D.	Mean	SD.	p-value (unadjusted)	p-value (clustered)
Education	6.62	2.82	6.54	2.84	0.3487	0.5737
Age	13.52	2.81	13.45	2.88	0.3868	0.5700
Girl	0.50	0.50	0.49	0.50	0.7361	0.8926
Parent's age	39.24	7.77	39.89	8.41	0.0079	0.4092
Mother	0.89	0.32	0.82	0.38	0.0000	0.0918
Parent's education	7.97	3.67	8.22	3.45	0.0255	0.5271
Years since test	3.28	2.46	3.22	2.45	0.3951	0.5155
Visit year	2,012.33	2.58	2,012.26	2.61	0.3720	0.5698
Cluster	229		312			
Observations	1885		2503			

Data-driven bandwidth: +/- 58. P-values for t-tests reported, once without and once with adjustment for clustered standard errors.

As a further falsification check, we run our regression specification for the time before the first CD4 test. As depicted in Table 3, there are no significant pre-trends between children with eligible and children with ineligible parents.

Table 3. Pre-trends

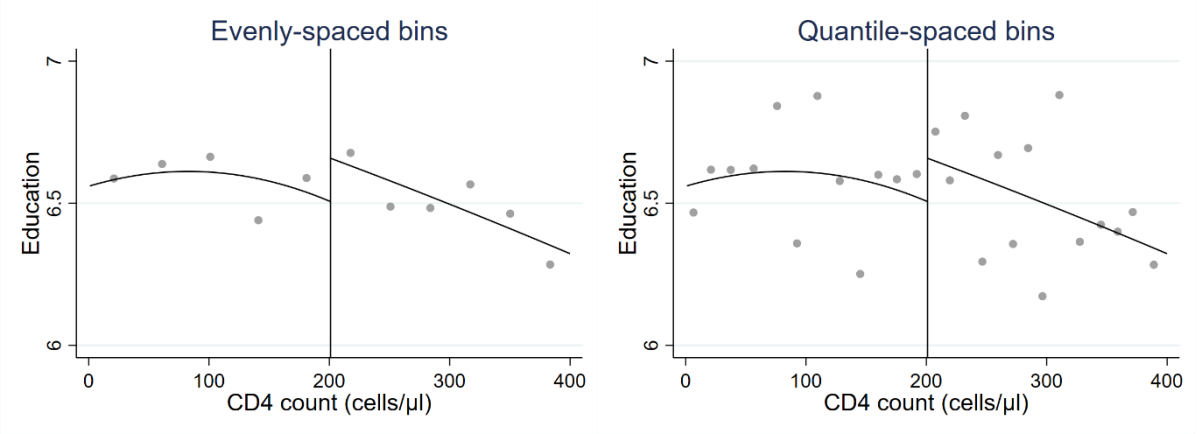
	(1) Education	(2) Education	(3) Education
Eligible	0.043	-0.086	0.234
	(0.2290)	(0.2421)	(0.2518)
Deviation	0.007	0.007	0.006
	(0.0088)	(0.0088)	(0.0088)
Eligible # Deviation	-0.011	-0.012	-0.011
	(0.0107)	(0.0108)	(0.0107)
Eligible # Girl		0.263	
		(0.2271)	
Eligible # Mother			-0.233
			(0.2284)
R2	0.787	0.787	0.787
Cluster	343	343	343
Observations	2077	2077	2077
Bandwidth	43	43	43

Regression for children's education controlling for year of visit, children's age and gender, and parents' age, gender and education. Deviation is the CD4 cell count minus the threshold of 200 cells/µl. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Impact on education

A visual inspection of the raw data indicates a possible drop in education right below the threshold, but else quite similar levels of education (Figure 5).

Figure 5. Average educational attainment by CD4 cell count



When controlling for sociodemographic characteristics, years since the test and visit year, we cannot detect an overall effect of parental ART eligibility on children's education, as shown in Table 4. However, when we restrict the sample to children who are in compulsory schooling, there are significant differences by the gender of the parent: paternal ART eligibility decreases children's education by 0.6 years on average, but there is no impact of maternal ART eligibility.

Table 4. Main analyses

	(1)	(2)	(3)	(4)	(5)	(6)
		All children			Compulsory schooling	
Eligible	-0.126	-0.294	-0.415	-0.083	-0.201	-0.587**
	(0.2120)	(0.2261)	(0.2608)	(0.2099)	(0.2143)	(0.2614)
Deviation	0.001	0.001	0.001	0.001	0.002	0.002
	(0.0054)	(0.0054)	(0.0055)	(0.0054)	(0.0054)	(0.0054)
Eligible # Deviation	-0.004	-0.004	-0.004	-0.003	-0.004	-0.004
	(0.0070)	(0.0070)	(0.0070)	(0.0066)	(0.0065)	(0.0066)
Eligible # Girl		0.378**			0.268	
		(0.1915)			(0.1875)	
Eligible # Mother			0.339			0.580**
			(0.2469)			(0.2432)
R2	0.741	0.742	0.742	0.687	0.688	0.689
Cluster	541	541	541	493	493	493
Observations	4388	4388	4388	2822	2822	2822
Bandwidth	58	58	58	60	60	60

Regression controlling for year of visit, years since the CD4 test, children's age and gender, and parents' age, gender and education. Deviation is the CD4 cell count minus the threshold of 200 cells/µl. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

The impact of state support

As depicted in Table 5, the impact of ART eligibility differs significantly by grant status. There is no significant impact of ART eligibility for recipients without any grant, except for a negative impact on boys at a 10% significance level. For recipients of the disability grant, ART eligibility significantly decreases educational attainment of their children by 1.7 years (significant at the 5% level). For recipients of other grants, ART eligibility has a significantly larger impact on educational attainment than for respondents without any grant. However, due to the reverse signs of the coefficients, the overall impact of eligibility on this group is not significant. Still, for children of fathers who received any other grant, there is a significant increase in educational attainment of about 1 year when their father becomes eligible.

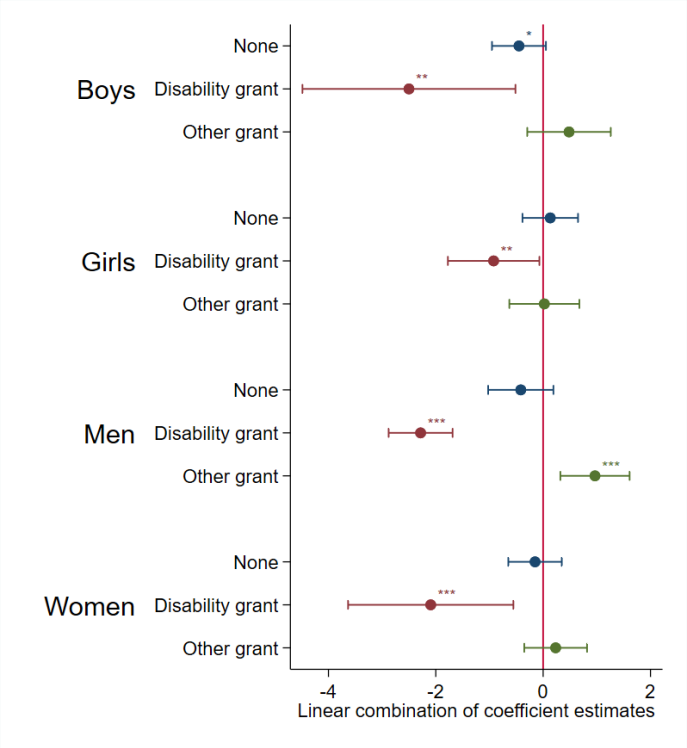
Table 5. Role of grants

	(1) Education	(2) By child's gender	(3) By parent's gender
Eligible	-0.184	-0.450*	-0.416
	(0.2395)	(0.2556)	(0.3094)
Deviation	-0.001	-0.000	-0.001
	(0.0064)	(0.0062)	(0.0066)
Eligible # Deviation	-0.001	-0.002	-0.001
	(0.0084)	(0.0082)	(0.0084)
Eligible # Disability grant	-1.474**	-2.050**	-1.866***
	(0.5733)	(0.9942)	(0.3244)
Eligible # Other grant	0.452*	0.933**	1.382***
	(0.2676)	(0.3901)	(0.3852)
Eligible # Female		0.583**	0.266
		(0.2333)	(0.2948)
Eligible # Female # Disability grant		0.995	-0.077
		(1.1567)	(0.8285)
Eligible # Female # Other grant		-1.043**	-0.998**
		(0.5042)	(0.4703)
R2	0.746	0.749	0.748
Cluster	429	429	429
Observations	3525	3525	3525
Bandwidth	52	52	52

Regression for children's education controlling for year of visit, years since CD4 test, children's age and gender, and parents' age, gender and education. Deviation is the CD4 cell count minus the threshold of 200 cells/µl. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Figure 6 displays the linear combinations of the coefficient estimates of Table 5 to demonstrate the overall impact of eligibility on the distinct groups. Children of former recipients of the disability grant experience a significant negative impact of eligibility on education, irrespective of their gender or the gender of their parents. The overall effects span from -0.9 years on average for girls to -2.5 years on average for boys. In contrast, if fathers with any other previous grant become eligible, educational attainment increases by one year on average.

Figure 6. Heterogeneous impact by grant and gender



Economic burden

The above findings suggest that the disability grant, which like ART eligibility is linked to the CD4 cell count, plays an intermediate role through decreased financial security. We further investigate this potential channel by analyzing the heterogeneous impact of grants on the household's economic situation measured by the household's asset index quintile (Table 6). There is a significant negative impact of eligibility for previous recipients of the disability grant on the household's asset index. We cannot detect any heterogeneous impact of other grants on the asset index.

Table 6. Asset index

	(1) Asset index	(2) Asset index	(3) Asset index
Eligible	-0.017	0.090	0.526
	(0.1898)	(0.2100)	(0.3289)
Deviation	-0.004	-0.001	-0.002
	(0.0058)	(0.0059)	(0.0060)
Eligible # Deviation	0.008	0.004	0.005
	(0.0077)	(0.0080)	(0.0081)
Eligible # Disability grant		-1.130***	-1.605***
		(0.2478)	(0.3260)
Eligible # Other grant		-0.210	-0.270
		(0.2462)	(0.3168)
Eligible # Mother			-0.535*
			(0.3080)
Eligible # Mother # Disability grant			0.626
			(0.4782)
Eligible # Mother # Other grant			0.125
			(0.4139)
R2	0.147	0.146	0.157
Cluster	408	369	369
Observations	1942	1789	1789
Bandwidth	50	50	50

Regression controlling for year of visit, and parents' age, gender and education. Deviation is the CD4 cell count minus the threshold of 200 cells/µl. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Robustness checks

Individuals not yet eligible for ART have shorter transitions to treatment the closer they are to the threshold. To exclude that this biases our results, we conduct a donut regression discontinuity design by dropping individuals within a bandwidth of +/-5. The differential impact of grants remain largely significant (Table 7). The only result that is not robust to this specification is the heterogeneous impact for recepients of other grants when not accounting for gender-specific effects (column 4). Moreover, the results remain stable when restricting the sample to CD4 tests before August 2010 to rule out any anticipatory effects of the guideline change in August 2011 (Table A 1).

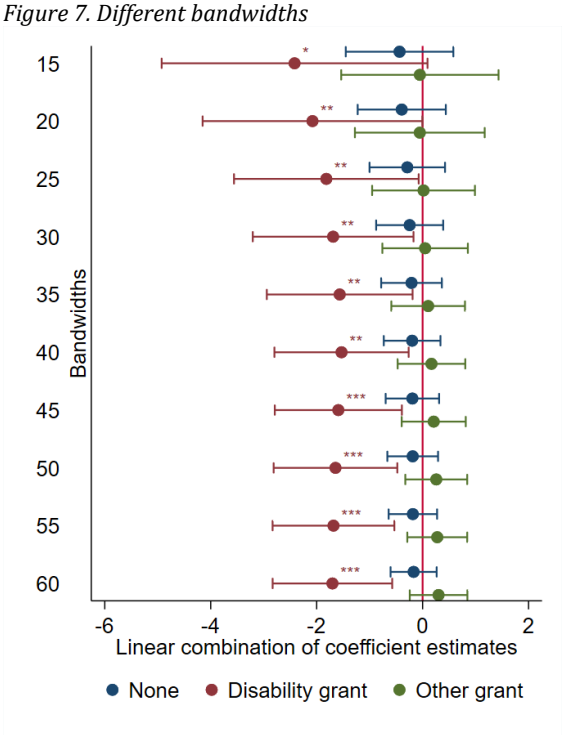
Table 7. Donut RDD

	(1) Education	(2) By child's gender	(3) By parent's gender
Eligible	-0.177	-0.445	-0.610*
	(0.2897)	(0.2960)	(0.3620)
Eligible # Disability grant	-1.057***	-1.228**	-1.635***
	(0.3781)	(0.6031)	(0.3538)
Eligible # Other grant	0.435	0.959**	1.574***
	(0.2811)	(0.4027)	(0.3899)
Eligible # Female		0.576**	0.463
		(0.2521)	(0.3100)
Eligible # Disability grant # Female		0.133	0.330
		(0.8425)	(0.5927)
Eligible # Other grant # Female		-1.156**	-1.228**
		(0.5233)	(0.4813)
R^2	0.745	0.748	0.747
Cluster	393	393	393
Observations	3262	3262	3262

Regression for children's education controlling for year of visit, children's age and gender, and parents' age, gender and education. Data-driven bandwidth: +/- 58 without observations in the bandwidth +/-5 (donut RDD). Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

The results are also robust to quadratic and cubic functions for the CD4 cell count (Table A 2 and Table A 3). We further test for alternative bandwidths between 10 and 60 in steps of 5. The heterogeneous negative impact for recipients of the disability grant is robust to all of these bandwidths, while the heterogeneous impact of other grants is robust to bandwidths between 35 and 60 and a bandwidth of 15, but switches sign in a bandwidth of 10 (Figure 7).

Figure 7. Different bandwidths



Discussion

Each year, access to ART saves millions of lives (UNAIDS, 2013). This positive, large impact on health is likely to affect other dimensions of well-being, too. One challenge for the examination of this channel is that ART initiation is not exogenous. Within the study setting, socio-economic factors and especially gender play an important role in HIV testing, linkage to care and retention in care (Lessells et al., 2011; Maheu-Giroux et al., 2017; Mutevedzi et al., 2010; Welz et al., 2007). We use policy guidelines on ART eligibility to employ a regression discontinuity design to identify the causal impact of ART eligibility on children's education.

We find that ART eligibility reduces clinical visits of fathers, but no overall effect on children's educational attainment. However, there is a considerable heterogeneity based on the reception of state support prior to the ART eligibility assessment: Children of parents who previously received a disability grant fare comparatively worse after their parents become eligible for ART, with a relative reduction of 1.7 years in educational attainment compared to their peers. Further analyses suggest that this heterogenous effect is due to household's worse economic situation as a consequence of losing the disability grant – eligible parents with a disability grant experience a decline in their asset index after they become eligible for ART. In contrast, children of parents who received any other type of state grant have a comparatively higher educational attainment after their parents become eligible for ART – an effect which is driven by fathers.

Taken together, these findings imply that the transmission of health improvements into children's educational attainment is mediated by the economic situation of the household. Without any previous grant, improvements in parental health do not spill over to educational attainments – possibly, because employment rates recover too slowly (Bor et al., 2012), while costs of accessing the ART clinics (Chimbindi et al., 2015) or meeting the additional food requirements for recovering patients (Patenaude et al., 2018) materialize immediately. For previous recipients of the disability grant, who are at risk of losing their grant after initiating ART, the co-occurrence of health benefits and a negative income shock even results in a decrease in children's educational attainment. In contrast, receiving other types of state support which are not linked to health seems to help the households to make use of the health improvements.

Our study speaks to the wider literature on financial support and health. Recent studies highlighted the role of financial support to foster health outcomes among the poor (Banerjee et al., 2021; Haushofer et al., 2020). Moreover, financial support can mitigate the negative impact of poor parental health on children's education (Chen et al., 2015), but might also have negative consequences, for example by crowding out adult employment (Dahl and Gielen, 2021). Our study demonstrates that this complex relationship also exists in the context of a positive health shock, underlining the importance to evaluate state support policies on their impact on all dimension of well-being.

There are several limitations to our study. Albeit both the clinical data set and the demographic panel data set are large, the final analysis sample comprises of relatively few observations for a regression discontinuity design. This implies that we cannot rule out impacts on education which are too small to be detected with our sample size. In addition, the regression discontinuity design estimates the impact of eligibility locally, i.e., at the threshold, and cannot be generalized into effect sizes further away without additional assumptions. Relatedly, the optimal bandwidths are sensitive to the exact regression specification. However, we can show that our main outcomes are robust to several bandwidths above and below the data-driven bandwidths as well as other functional forms.

The health and life expectancy improvements as a consequence of ART are impressive. Our findings indicate that the design of social policies can help or hinder to transmit improved health to wider socioeconomic impacts.

References

Ainsworth, M., Beegle, K., Koda, G., 2005. The Impact of Adult Mortality and Parental Deaths on Primary Schooling in North-Western Tanzania. Journal of Development Studies 41, 412–439. https://doi.org/10.1080/0022038042000313318

Alam, K., Mahal, A., 2014. Economic impacts of health shocks on households in low and middle income countries: a review of the literature. Globalization and Health 10, 21. https://doi.org/10.1186/1744-8603-10-21

Alam, S.A., 2015. Parental health shocks, child labor and educational outcomes: Evidence from Tanzania. Journal of Health Economics 44, 161–175. https://doi.org/10.1016/j.jhealeco.2015.09.004

Baranov, V., Bennett, D., Kohler, H.-P., 2015. The indirect impact of antiretroviral therapy: Mortality risk, mental health, and HIV-negative labor supply. Journal of Health Economics 44, 195–211. https://doi.org/10.1016/j.jhealeco.2015.07.008

Baranov, V., Kohler, H.-P., 2018. The Impact of AIDS Treatment on Savings and Human Capital Investment in Malawi. American Economic Journal: Applied Economics 10, 266–306. https://doi.org/10.1257/app.20150369

Bärnighausen, T. et al., 2017. Quasi-experimental study designs series—paper 7: assessing the assumptions. Journal of Clinical Epidemiology 89, 53–66. https://doi.org/10.1016/j.jclinepi.2017.02.017

Bärnighausen, T., Hosegood, V., Timæus, I.M., Newell, M.-L., 2007. The socioeconomic determinants of HIV incidence: evidence from a longitudinal, population-based study in rural South Africa. AIDS 21, S29–S38. https://doi.org/10.1097/01.aids.0000300533.59483.95

Booysen, F., 2004. Social grants as safety net for HIV/AIDS-affected households in South Africa. SAHARA-J: Journal of Social Aspects of HIV/AIDS 1, 45–56.

Booysen, F.L.R., Van Rensburg, H.C.J., Bachmann, M., Louwagie, G., Fairall, L., 2007. The Heart in Haart: Quality of Life of Patients Enrolled in the Public Sector Antiretroviral Treatment Programme in the Free State Province of South Africa. Soc Indic Res 81, 283–329. https://doi.org/10.1007/s11205-006-9011-4

Bor, J., Bärnighausen, T., Newell, C., Tanser, F., Newell, M.-L., 2011. Social exposure to an antiretroviral treatment program in rural KwaZulu-Natal. Trop Med Int Health 16, 988–994. https://doi.org/10.1111/j.1365-3156.2011.02795.x

Bor, J., Tanser, F.C., Newell, M.-L., Bärnighausen, T., 2012. In A Study Of A Population Cohort In South Africa, HIV Patients On Antiretrovirals Had Nearly Full Recovery Of Employment. Health Aff 31, 1459–1469. https://doi.org/10.1377/hlthaff.2012.0407

Bratti, M., Mendola, M., 2014. Parental health and child schooling. Journal of Health Economics 35, 94–108. https://doi.org/10.1016/j.jhealeco.2014.02.006

Calonico, S., Cattaneo, M.D., Farrell, M.H., Titiunik, R., 2017. Rdrobust: Software for Regression-discontinuity Designs. The Stata Journal: Promoting communications on statistics and Stata 17, 372–404. https://doi.org/10.1177/1536867X1701700208

Cattaneo, M.D., Jansson, M., Ma, X., 2018. Manipulation Testing Based on Density Discontinuity. The Stata Journal 18, 234–261. https://doi.org/10.1177/1536867X1801800115

Cattaneo, M.D., Vazquez-Bare, G., 2017. The Choice of Neighborhood in Regression Discontinuity Designs. Observational Studies 3, 134–146. https://doi.org/10.1353/obs.2017.0002

Chimbindi, N. et al., 2015. Time and Money: The True Costs of Health Care Utilization for Patients Receiving "Free" HIV/Tuberculosis Care and Treatment in Rural KwaZulu-Natal. J Acquir Immune Defic Syndr 70, e52–e60. https://doi.org/10.1097/QAI.0000000000000728

Cluver, L., Operario, D., Lane, T., Kganakga, M., 2012. "I Can't Go to School and Leave Her in So Much Pain." Journal of Adolescent Research 27, 581–605. https://doi.org/10.1177/0743558411417868

Coetzee, D. et al., 2004. Outcomes after two years of providing antiretroviral treatment in Khayelitsha, South Africa. AIDS 18, 887–895. https://doi.org/10.1097/00002030-200404090-00006

Cooke, G.S., Tanser, F.C., Bärnighausen, T.W., Newell, M.-L., 2010. Population uptake of antiretroviral treatment through primary care in rural South Africa. BMC Public Health 10, 585. https://doi.org/10.1186/1471-2458-10-585

D'Adda, G., Goldstein, M., Zivin, J.G., Nangami, M., Thirumurthy, H., 2009. ARV Treatment and Time Allocation to Household Tasks: Evidence from Kenya. African Development Review 21, 180–208. https://doi.org/10.1111/j.1467-8268.2009.00207.x

de Paoli, M.M., Mills, E.A., Grønningsæter, A.B., 2012. The ARV roll out and the disability grant: a South African dilemma? J Int AIDS Soc 15, 6. https://doi.org/10.1186/1758-2652-15-6

Detels, R. et al., 2001. Effectiveness of potent antiretroviral therapies on the incidence of opportunistic infections before and after AIDS diagnosis. Aids 15, 347–355.

Egger, M. et al., 2002. Prognosis of HIV-1-infected patients starting highly active antiretroviral therapy: a collaborative analysis of prospective studies. Lancet (London, England) 360, 119–129.

Evans, D.K., Miguel, Edward., 2007. Orphans and Schooling in Africa: A Longitudinal Analysis. Demography 44, 35–57. https://doi.org/10.1353/dem.2007.0002

Fahey, J.L. et al., 1990. The Prognostic Value of Cellular and Serologic Markers in Infection with Human Immunodeficiency Virus Type 1. New England Journal of Medicine 322, 166–172. https://doi.org/10.1056/NEJM199001183220305

Gareta, D. et al., 2021. Cohort Profile Update: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. Int J Epidemiol 50, 33–34. https://doi.org/10.1093/ije/dyaa264

Goldberg, R.E., Short, S.E., 2016. What do we know about children living with HIV-infected or AIDS-ill adults in Sub-Saharan Africa? A systematic review of the literature. AIDS Care 28, 130–141. https://doi.org/10.1080/09540121.2016.1176684

Guo, Y., Li, X., Sherr, L., 2012. The impact of HIV/AIDS on children's educational outcome: A critical review of global literature. AIDS Care 24, 993–1012. https://doi.org/10.1080/09540121.2012.668170

Haber, N. et al., 2018. Disability for HIV and Disincentives for Health: The Impact of South Africa's Disability Grant on HIV/AIDS Recovery. arXiv:1810.01971 [econ, q-fin].

Haber, N. et al., 2017. From HIV infection to therapeutic response: a population-based longitudinal HIV cascade-of-care study in KwaZulu-Natal, South Africa. The Lancet HIV 4, e223–e230. https://doi.org/10.1016/S2352-3018(16)30224-7

Hahn, J., Todd, P., Klaauw, W., 2001. Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design. Econometrica 69, 201–209. https://doi.org/10.1111/1468-0262.00183

Hammer, S.M. et al., 1997. A controlled trial of two nucleoside analogues plus indinavir in persons with human immunodeficiency virus infection and CD4 cell counts of 200 per cubic millimeter or less. AIDS Clinical Trials Group 320 Study Team. The New England journal of medicine 337, 725–733. https://doi.org/10.1056/NEJM199709113371101

Hardy, C., Richter, M., 2006. Disability grants or antiretrovirals? A quandary for people with HIV/AIDS in South Africa. African Journal of AIDS Research 5, 85–96. https://doi.org/10.2989/16085900609490369

Hosegood, V., Preston-Whyte, E., Busza, J., Moitse, S., Timaeus, I.M., 2007. Revealing the full extent of households' experiences of HIV and AIDS in rural South Africa. Social Science & Medicine 65, 1249–1259. https://doi.org/10.1016/j.socscimed.2007.05.002

Houlihan, C.F. et al., 2011. Cohort profile: Hlabisa HIV treatment and care programme. Int J Epidemiol 40, 318–326. https://doi.org/10.1093/ije/dyp402

Jelsma, J., Maclean, E., Hughes, J., Tinise, X., Darder, M., 2005. An investigation into the health-related quality of life of individuals living with HIV who are receiving HAART. AIDS Care 17, 579–588. https://doi.org/10.1080/09540120412331319714

Johnston, D., 2015. Economics and HIV. CRC Press, London.

Knight, L., Hosegood, V., Timæus, I.M., 2013. The South African disability grant: Influence on HIV treatment outcomes and household well-being in KwaZulu-Natal. Development Southern Africa 30, 135–147. https://doi.org/10.1080/0376835X.2013.755767

Landmann, A., Frölich, M., 2015. Can health-insurance help prevent child labor? An impact evaluation from Pakistan. Journal of Health Economics 39, 51–59. https://doi.org/10.1016/j.jhealeco.2014.10.003

Larson, B.A. et al., 2013. Antiretroviral therapy, labor productivity, and gender: a longitudinal cohort study of tea pluckers in Kenya. AIDS 27, 115–123. https://doi.org/10.1097/QAD.0b013e32835a5b12

Lessells, R.J., Mutevedzi, P.C., Cooke, G.S., Newell, M.-L., 2011. Retention in HIV Care for Individuals Not Yet Eligible for Antiretroviral Therapy: Rural KwaZulu-Natal, South Africa: J Acquir Immune Defic Syndr 56, e79–e86. https://doi.org/10.1097/QAI.0b013e3182075ae2

Levinsohn, J.A., McLaren, Z., Shisana, O., Zuma, K., 2011. HIV Status and Labor Market Participation in South Africa. National Bureau of Economic Research.

Linnemayr, S., Glick, P., Kityo, C., Mugyeni, P., Wagner, G., 2013. Prospective cohort study of the impact of antiretroviral therapy on employment outcomes among HIV clients in Uganda. AIDS Patient Care and STDs 27, 707–714. https://doi.org/10.1089/apc.2013.0139

Louwagie, G.M. et al., 2007. Highly active antiretroviral treatment and health related quality of life in South African adults with human immunodeficiency virus infection: A cross-sectional analytical study. BMC Public Health 7, 244. https://doi.org/10.1186/1471-2458-7-244

Luca, D.L., Bloom, D.E., 2018. The Returns to Parental Health: Evidence from Indonesia (Working Paper No. 25304), Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w25304

Lucas, A.M., Chidothe, M., Wilson, N.L., 2019. Effects of adult health interventions at scale on children's schooling: Evidence from antiretroviral therapy in Zambia. Economics of Education Review 72, 107–120. https://doi.org/10.1016/j.econedurev.2019.04.006

Maheu-Giroux, M. et al., 2017. Determinants of time from HIV infection to linkage-to-care in rural KwaZulu-Natal, South Africa. AIDS 31, 1017–1024. https://doi.org/10.1097/QAD.0000000000001435

Meyer-Rath, G. et al., 2017. Changing the South African national antiretroviral therapy guidelines: The role of cost modelling. PLoS One 12, e0186557. https://doi.org/10.1371/journal.pone.0186557

Mitchell, J.M. et al., 2016. The effect of maternal and child early life factors on grade repetition among HIV exposed and unexposed children in rural KwaZulu-Natal, South Africa. Journal of Developmental Origins of Health and Disease 7, 185–196. https://doi.org/10.1017/S2040174415007230

Muhwava, W., Nyirenda, M., Mutevedzi, T., Herbst, K., Hosegood, V., 2008. Operational and Methodological Procedures of the Africa Centre Demographic Information System. Somkhele: Africa Centre for Health and Population Studies. Monograph Series 44.

Murphy, E.L. et al., 2001. Highly Active Antiretroviral Therapy Decreases Mortality and Morbidity in Patients with Advanced HIV Disease. Ann Intern Med 135, 17–26. https://doi.org/10.7326/0003-4819-135-1-200107030-00005

Mutevedzi, P.C. et al., 2010. Scale-up of a decentralized HIV treatment programme in rural KwaZulu-Natal, South Africa: does rapid expansion affect patient outcomes? Bull World Health Organ 88, 593–600. https://doi.org/10.1590/S0042-96862010000800011

Mutevedzi, P.C., Lessells, R.J., Newell, M., 2013. Disengagement from care in a decentralised primary health care antiretroviral treatment programme: cohort study in rural South Africa. Tropical Medicine & International Health 18, 934–941. https://doi.org/10.1111/tmi.12135

Patenaude, B.N., Chimbindi, N., Pillay, D., Bärnighausen, T., 2018. The impact of ART initiation on household food security over time. Social Science & Medicine 198, 175–184.

Peltzer, K., 2012. Social grants for people living with HIV and on antiretroviral therapy in KwaZulu-Natal, South Africa: a longitudinal study. SAHARA-J: Journal of Social Aspects of HIV/AIDS 9, 6–14. https://doi.org/10.1080/17290376.2012.665253

Plazy, M. et al., 2015. Change of treatment guidelines and evolution of ART initiation in rural South Africa: data of a large HIV care and treatment programme. BMC Infectious Diseases 15. https://doi.org/10.1186/s12879-015-1207-2

Robson, E., Ansell, N., Huber, U.S., Gould, W.T.S., van Blerk, L., 2006. Young caregivers in the context of the HIV/AIDS pandemic in sub-Saharan Africa. Popul. Space Place 12, 93–111. https://doi.org/10.1002/psp.392

Rosen, S. et al., 2010. Economic Outcomes of Patients Receiving Antiretroviral Therapy for HIV/AIDS in South Africa Are Sustained through Three Years on Treatment. PLOS ONE 5, e12731. https://doi.org/10.1371/journal.pone.0012731

Sherr, L. et al., 2014. Evidence of impact: health, psychological and social effects of adult HIV on children. AIDS 28, S251–S259. https://doi.org/10.1097/QAD.0000000000000327

Skovdal, M., 2012. Pathologising healthy children? A review of the literature exploring the mental health of HIV-affected children in sub-Saharan Africa. Transcultural Psychiatry 49, 461–491. https://doi.org/10.1177/1363461512448325

Skovdal, M., Ogutu, V.O., 2009. "I washed and fed my mother before going to school": Understanding the psychosocial well-being of children providing chronic care for adults affected by HIV/AIDS in Western Kenya. Globalization and Health 5, 8. https://doi.org/10.1186/1744-8603-5-8

South African Schools Act No 84 of 1996, 2011.

Sun, A., Yao, Y., 2010. Health shocks and children's school attainments in rural China. Economics of Education Review 29, 375–382. https://doi.org/10.1016/j.econedurev.2009.04.006

Tanser, F.C. et al., 2008. Cohort Profile: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. Int J Epidemiol 37, 956–962. https://doi.org/10.1093/ije/dym211

Thirumurthy, H., Zivin, J.G., 2012. Health and labor supply in the context of HIV/AIDS: the long-run economic impacts on antiretroviral therapy. Economic development and cultural change 61, 73–96.

UNAIDS, 2021. HIV estimates with uncertainty bounds 1990-Present [WWW Document]. URL https://www.unaids.org/en/resources/documents/2021/HIV_estimates_with_uncertainty_bounds_1990-present (accessed 11.1.21).

UNAIDS, 2013. Global Report. UNAIDS report on the global AIDS epidemic 2013. UNAIDS.

Welz, T. et al., 2007. Continued very high prevalence of HIV infection in rural KwaZulu-Natal, South Africa: a population-based longitudinal study. AIDS 21, 1467–1472. https://doi.org/10.1097/QAD.0b013e3280ef6af2

WHO, 2010. Antiretroviral drugs for treating pregnant women and preventing HIV infection in infants, 2010 version. ed. World Health Organization, Geneva.

WHO, 2005. Country Profile - South Africa. World Health Organization.

Woode, M.E., 2017. Parental health shocks and schooling: The impact of mutual health insurance in Rwanda. Social Science & Medicine 173, 35–47. https://doi.org/10.1016/j.socscimed.2016.11.023

Wools-Kaloustian, K. et al., 2006. Viability and effectiveness of large-scale HIV treatment initiatives in sub-Saharan Africa: experience from western Kenya. AIDS 20, 41–48. https://doi.org/10.1097/01.aids.0000196177.65551.ea

Yamano, T., Jayne, T.S., 2005. Working-Age Adult Mortality and Primary School Attendance in Rural Kenya. Economic Development and Cultural Change 53, 619–653. https://doi.org/10.1086/426463

Zivin, J.G., Thirumurthy, H., Goldstein, M., 2009. AIDS treatment and intrahousehold resource allocation: Children's nutrition and schooling in Kenya. Journal of Public Economics 93, 1008–1015. https://doi.org/10.1016/j.jpubeco.2009.03.003

Appendix

Table A 1. Robustness to CD4 tests before August 2010

	(1) Education	(2) By child's gender	(3) By parent's gender
Eligible	-0.228	-0.559**	-0.409
	(0.2534)	(0.2769)	(0.3207)
Deviation	0.000	0.000	-0.000
	(0.0069)	(0.0066)	(0.0071)
Eligible # Deviation	-0.004	-0.004	-0.004
	(0.0088)	(0.0086)	(0.0090)
Eligible # Disability grant	-1.408**	-1.696*	-1.886***
	(0.5647)	(0.9951)	(0.3458)
Eligible # Other grant	0.467*	0.982**	1.119***
	(0.2759)	(0.4021)	(0.4277)
Eligible # Female		0.676***	0.206
		(0.2534)	(0.3221)
Eligible # Female # Disability grant		0.440	0.014
		(1.1741)	(0.8885)
Eligible # Female # Other grant		-1.107**	-0.705
		(0.5176)	(0.5113)
R2	0.748	0.752	0.751
Cluster	366	366	366
Observations	3056	3056	3056
Bandwidth	52	52	52

Regression for children's education controlling for year of visit, children's age and gender, and parents' age, gender and education. Sample restricted to parents with a CD4 test at least one year before the guideline change. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A 2. Robustness to squared function

	(1) Education	(2) Education	(3) By child's gender	(4) By parent's gender
Eligible	-0.211	-0.186	-0.381	-0.415
	(0.3041)	(0.2973)	(0.2998)	(0.3317)
Eligible # Disability grant		-1.496***	-2.196**	-1.392**
		(0.5296)	(0.8846)	(0.6021)
Eligible # Other grant		0.506**	0.930***	1.214***
		(0.2298)	(0.3429)	(0.4484)
Eligible # Female			0.444**	0.272
			(0.1990)	(0.2518)
Eligible # Female # Disability grant			1.334	-0.485
			(1.0152)	(0.8655)
Eligible # Female # Other grant			-0.908**	-0.779
			(0.4420)	(0.5144)
R2	0.745	0.749	0.752	0.752
Cluster	614	614	614	614
Observations	4961	4961	4961	4961
Bandwidth	71	71	71	71

Regression for children's education controlling for year of visit, children's age and gender, and parents' age, gender and education. Polynomials of the deviation from the cutoff and their interactions with eligibility omitted to improve readability. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.

Table A 3. Robustness to cubic function

	(1) Education	(2) Education	(3) By child's gender	(4) By parent's gender
Eligible	-0.336	-0.303	-0.454	-0.493
	(0.4145)	(0.3966)	(0.3910)	(0.4177)
Eligible # Disability grant		-1.495***	-2.171**	-1.221
		(0.5168)	(0.8597)	(0.7501)
Eligible # Other grant		0.494**	0.897***	1.184***
		(0.2266)	(0.3380)	(0.4481)
Eligible # Girl			0.420**	0.260
			(0.1945)	(0.2470)
Eligible # Girl # Disability grant			1.315	-0.649
			(0.9836)	(0.9589)
Eligible # Girl # Other grant			-0.851**	-0.755
			(0.4325)	(0.5140)
R2	0.745	0.750	0.752	0.752
Cluster	629	629	629	629
Observations	5070	5070	5070	5070
Bandwidth	74	74	74	74

Regression for children's education controlling for year of visit, children's age and gender, and parents' age, gender and education. Polynomials of the deviation from the cutoff and their interactions with eligibility omitted to improve readability. Clustered standard errors in parenthesis. * p<0.1 ** p<0.05 *** p<0.01.