HIV Infection, Fertility, and the Non-Pecuniary Returns to Secondary Schooling in Botswana

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About me

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Economics of population health, quasi-experimental epidemiology, HIV treatment and prevention

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Health Economics & Epidemiology Research Office (HE2RO), University of Witwatersrand, South Africa

Motivation

- How much should we invest in schooling?
  - Primary vs. secondary vs. higher-education
  - Wage vs. non-pecuniary returns
  - Causal effect on health? Mechanisms?

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  - Wage vs. non-pecuniary returns
  - Causal effect on health? Mechanisms?
- How can we prevent new HIV infections?
  - 2.1M per year; 88% in SSA; 25% in young women
  - Biomedical vs. behavioral vs. structural prevention
  - Education: a “social vaccine” against HIV?

Mmegi daily, Botswana

Mmegionline
News we need to know daily

Tuesday 31 October 2006

Opinion/Letters

School fees and HIV/AIDS

10/31/2006 6:23:06 PM (GMT +2)

The Government of Botswana's decision to reinstate secondary school fees after a 20-year hiatus may have negative implications for the country's fight against HIV/AIDS. In the experience of other developing countries, the introduction of even modest school fees has led to falling enrollment, as the most vulnerable students drop out of school. Often parents pull girls out of school first, preferring to invest their limited resources in sons, who tend to attain higher salaries in the future.

Boosting secondary school enrollment should be a central element of Botswana's multi-sectoral approach to HIV prevention. School fees could be a dangerous step backwards. Government and civil society should maintain the highest vigilance to make sure that no child is deprived of the right to attend school if their parents are unable to pay.

Jacob Bor is Programmes Coordinator for Grassroot Soccer, an NGO that uses the power of soccer to train youth in life skills and HIV prevention. He is a resident of Botswana.*

Effect theoretically ambiguous

- Schooling could be harmful
  - Prolong pre-marital sex (Case & Paxson 2013)
  - Men could have more paid sex (Kohler & Thornton 2011)
  - Increase size, reach of sexual network

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  - Increase size, reach of sexual network
- Protective
  - Information about HIV (Aguero & Bharadwaj 2014)
  - Abstinence during school (Alsan 2012)
  - More choices in market for sex partners (Pettifor 2012)
  - Changes in fertility preferences (Ozier 2012, Lange 2014)
  - Bargaining power & economic independence (Baird 2012)
  - Cognitive skills (Cutler & Lleras-Muney 2010)

Schooling and HIV: causal?

- Conflicting evidence from association studies
  - "Harmful" (Dallabetta '93, Kirunga '97, Fortson '08)
  - "Protective" (Bärnighausen 2007, Hargreaves 2008)

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  - Schooling-*plus*: Hallfors 2011, Abdool Karim 2015
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- Quasi-experimental evidence on risk behaviors
  - Alsan & Cutler 2014; Aguero & Bharadwaj 2014

Natural experiment in Botswana

- Sparsely-populated
- Former British Protectorate (1966)
- Diamonds, middle-income democracy
- 25% of adults HIV+
- ARVs since 2002

Education policy reform

"The National Commission on Education recommends that junior secondary education should be extended from two to three years."

- *Government of Botswana, Revised National Policy on Education, 1996*

	Before 1996	After 1996
K-12 Education Structure	7-2-3	7-3-2
Primary School (years)	(7)	(7)
Secondary School (years)	Junior (2)	Junior (3)
	Senior (3)	Senior (2)
Total Years of Schooling	12	12

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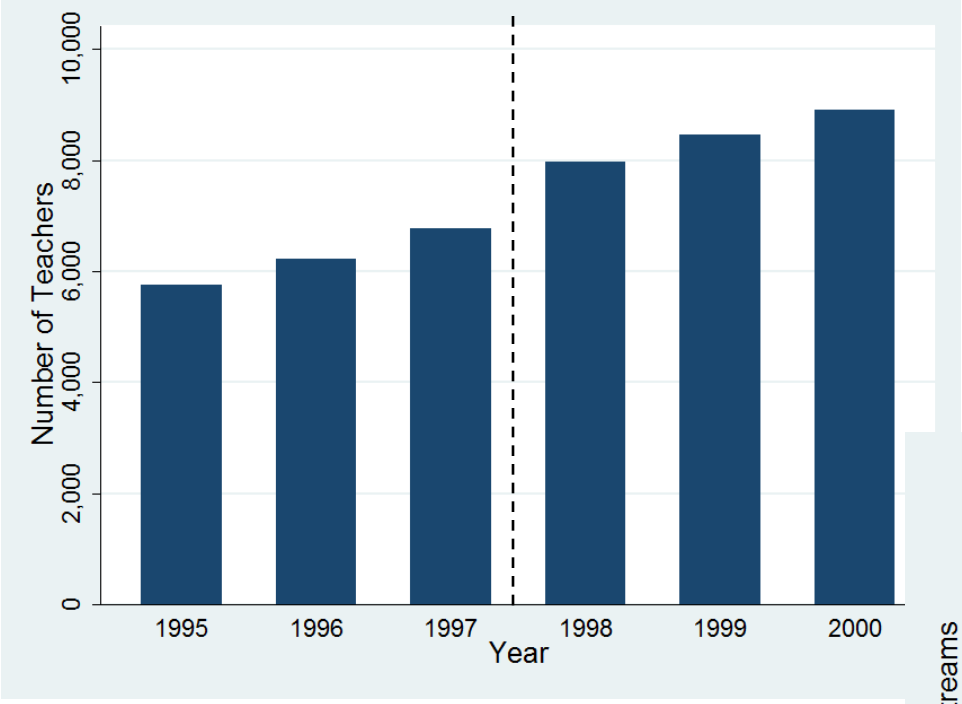
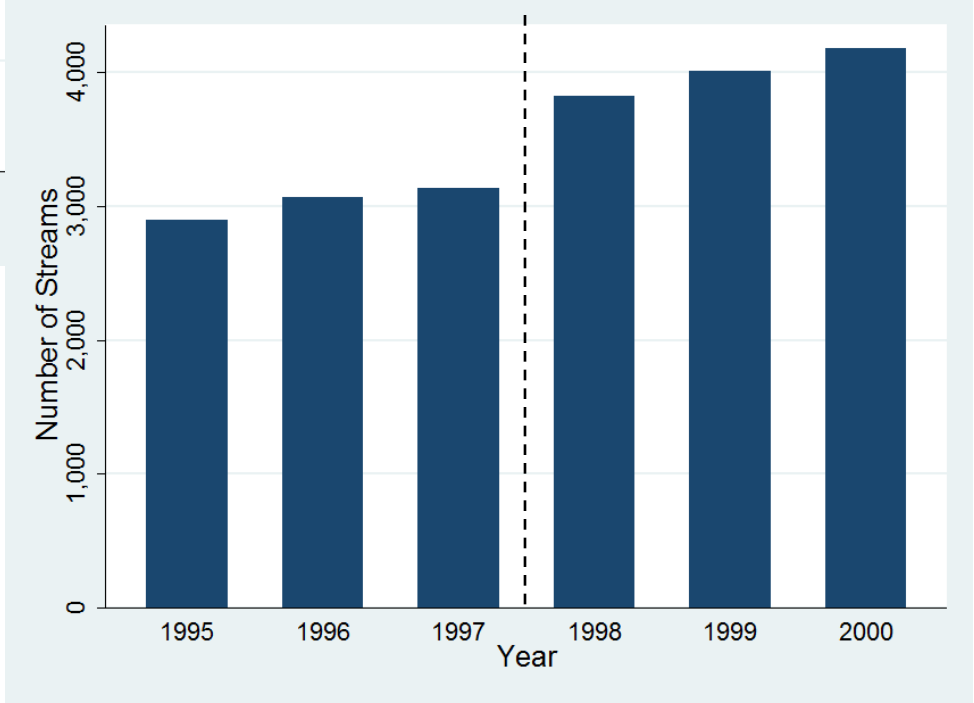
Reduced costs, raised benefits of completing grade 10

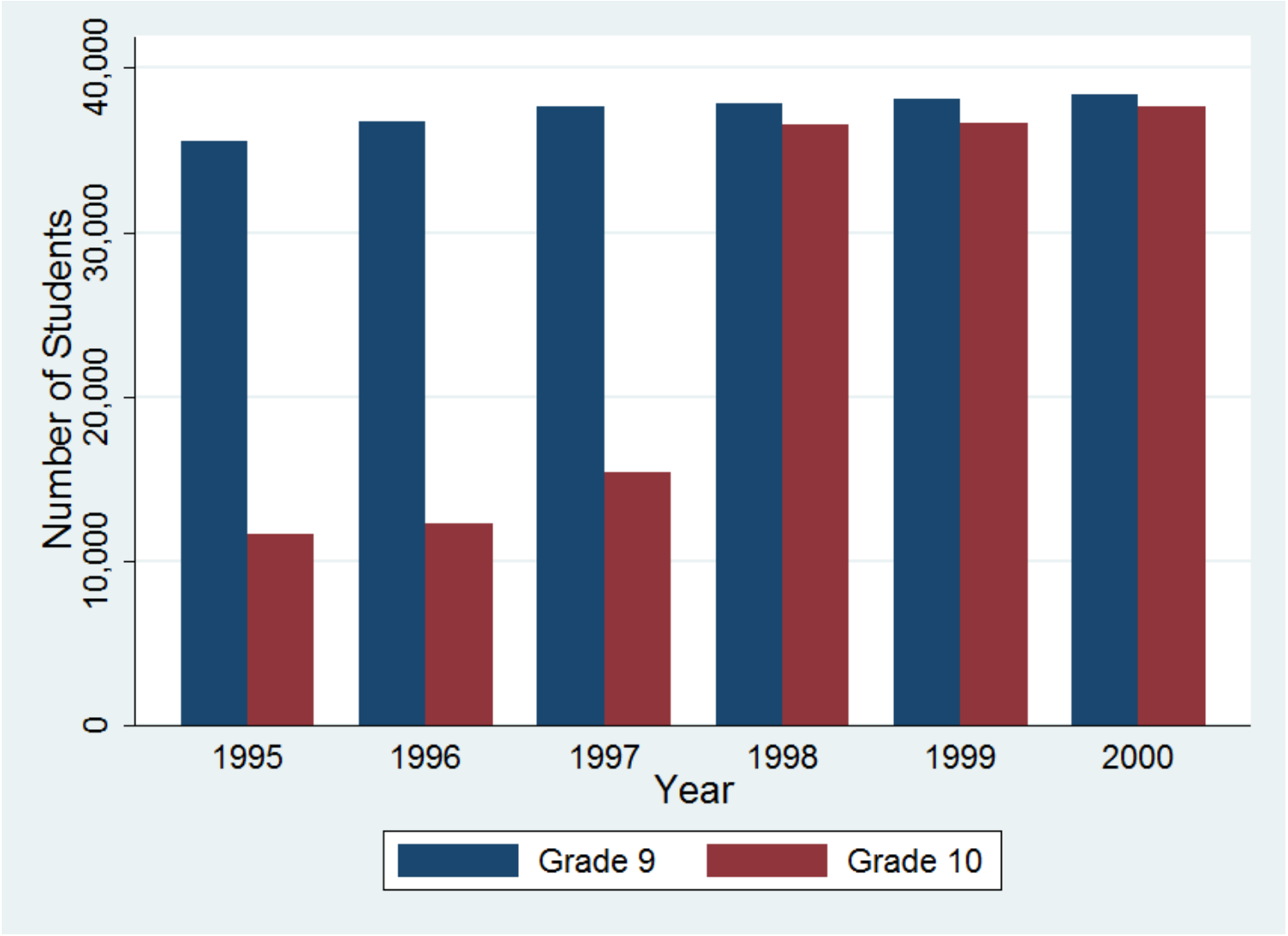
Teachers trained, classrooms built





Source Education Statistics 1995-2000, Statistics Botswana

Enrollment in ninth and tenth grade in Botswana, 1995-2000

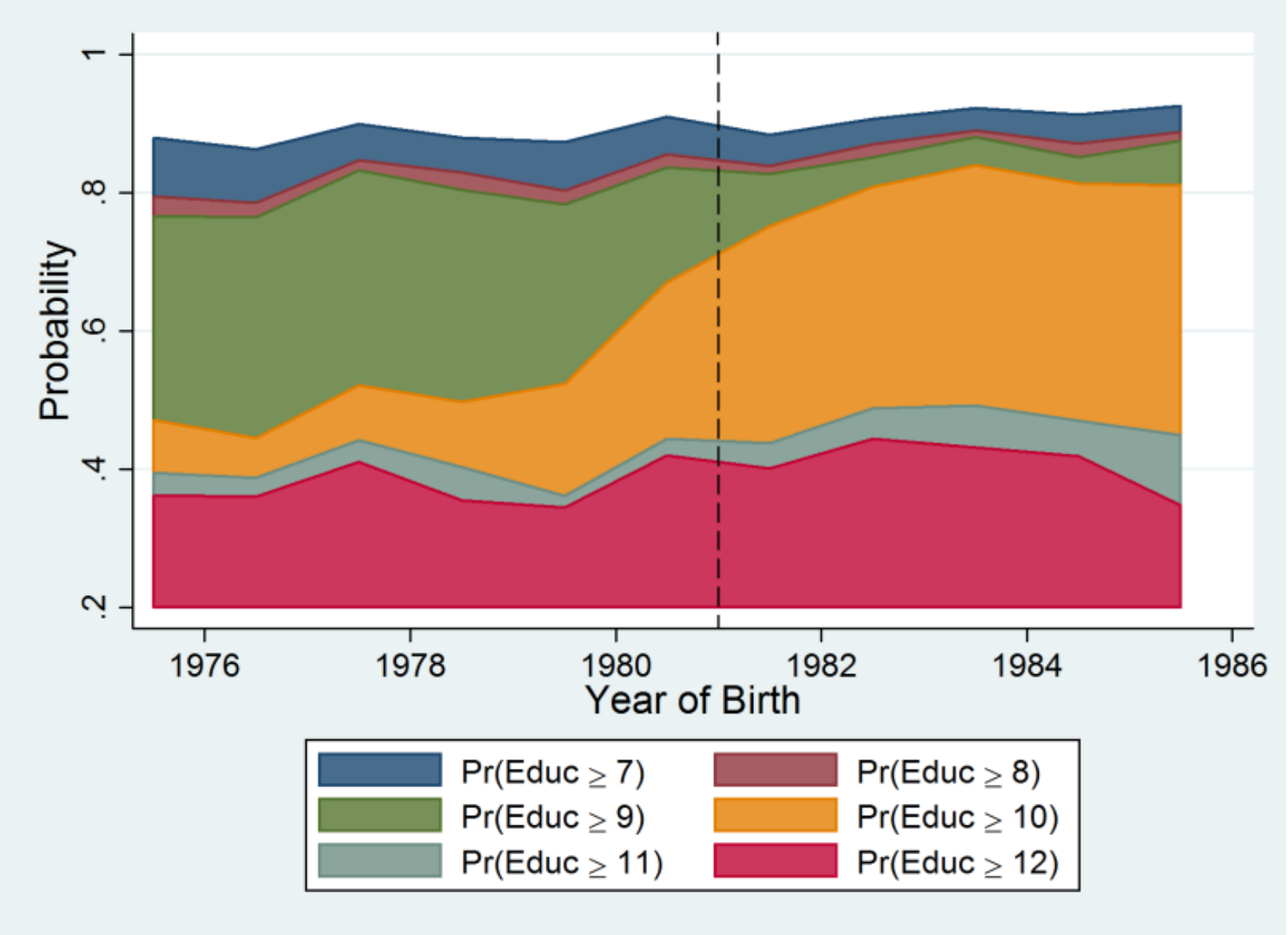


Source Education Statistics 1995-2000, Statistics Botswana

A natural experiment

- Reform affected specific birth cohorts
  - Persons entering grade 10 $\geq$ 1998
    - i.e., persons born $\geq$ 1981, assuming *de jure* progression
  - Some geographic variation
    - pre-reform likelihood of completing exactly 9 years
- Prior evidence of labor market impacts
  - Increased LFP, wages for women (Borkum 2009)

Years of schooling by birth cohort



De Neve et al. 2015

Study questions

1. What happens to HIV infection risk if we give people an extra year of secondary schooling?
2. Mechanisms
   - HIV knowledge and attitudes
   - Risky sexual behavior, extensive / intensive margins
   - Economic empowerment, fertility
   - Cognitive skills
3. Cost-effectiveness as HIV prevention

Results preview

1. Large reductions in HIV risk: 8.1% pts (se 3.1)
2. Mechanisms
   - No effect on knowledge; large effects on behaviors
   - Condom use, HIV testing, but not partner reduction
   - Changes in norms about women carrying condoms
   - Reductions in fertility, gains in women's LFP
3. Secondary schooling cost-effective *as HIV prevention*, never mind other benefits

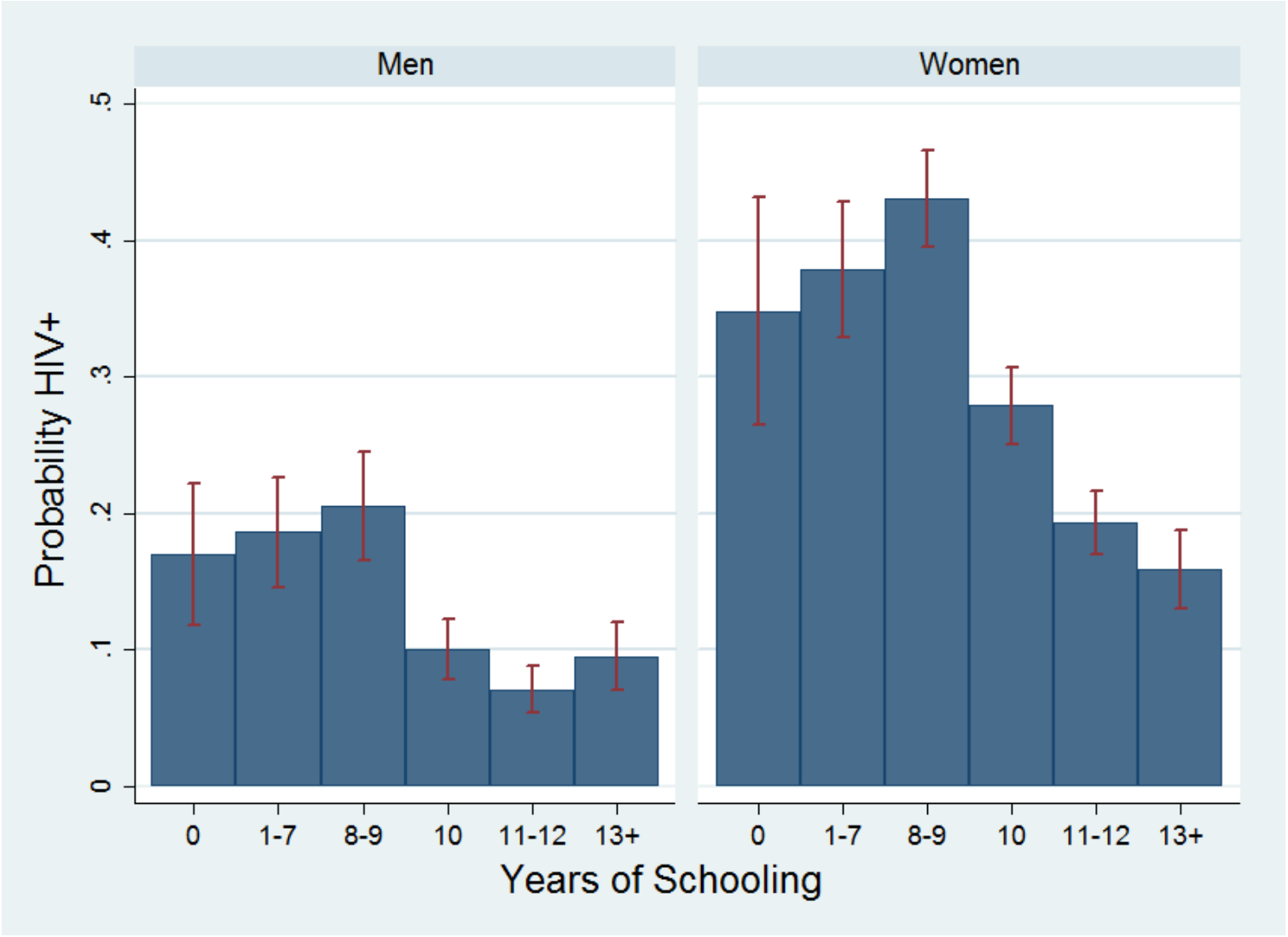
Data

- Nationally-representative HIV biomarker surveys
  - Botswana AIDS Impact Surveys II (2004) and III (2008)
  - Two-stage random sampling, similar to DHS
  - HIV test consent rates: 61% (2004) and 67% (2008)
  - Citizens of Botswana, at least 18 years, born after 1975
  - N = 7018
- Outcomes
  - HIV biomarkers, fertility
  - Sexual behaviors, HIV knowledge and attitudes, HIV testing, discussion about HIV
  - Literacy, labor force participation

Sample summary statistics

Variables	Percent / Mean (SD)			
Survey Year	**BAIS II (2004)**		**BAIS III (2008)**	
Subsample	**Female**	**Male**	**Female**	**Male**
HIV Positive (%)	28.3	11.1	27.3	12.4
Age	22.7 (3.1)	22.6 (3.2)	24.9 (4.2)	24.7 (4.3)
Years of Schooling	10.0 (3.0)	9.7 (4.0)	10.5 (3.2)	10.3 (3.8)
Has At Least Ten Years of Schooling (%)	62.4	65.2	72.6	73.0
Ever Had Sex (%)	88.2	77.9	92.7	83.1
Age at First Intercourse	18.0 (2.0)	17.8 (2.5)	18.2 (2.5)	18.5 (3.0)
Ever Married (%)	4.93	1.00	7.10	2.60
Literacy (%)	83.0	80.0	91.1	86.0
Total N with HIV Result	1,760	1,354	2,205	1,699

Association between HIV risk and educational attainment



Source: Botswana AIDS Impact Surveys II (2004) and III (2008)

Empirical approach

Diff-in-diff / 2SLS

- Control flexibly for age
- Control for survey wave
- Identify off of age-X-survey groups (i.e. birth cohorts) affected by reform, i.e. YOB>1980, controlling for continuous f(YOB).

First stage and reduced form estimated by OLS

$$(1) \quad Educ_i = \beta_0 + \beta_1 1[YOB>1980]_i + \beta_2 f(YOB) + \beta_3 1[age]_i + \beta_4 1[districtofbirth]_i + \varepsilon_i$$

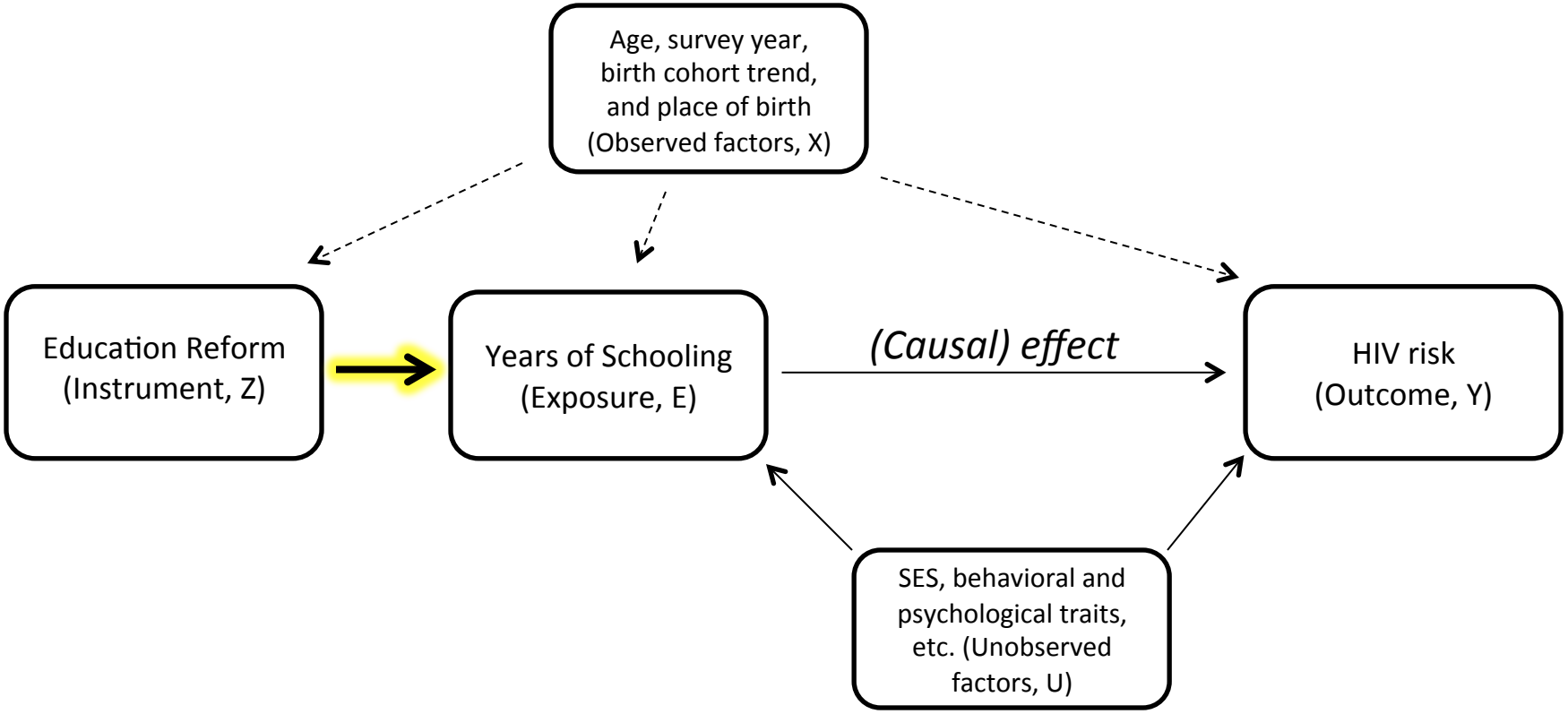
$$(2) \quad HIVinfected_i = \gamma_0 + \gamma_1 1[YOB>1980]_i + \gamma_2 f(YOB) + \gamma_3 1[age]_i + \gamma_4 1[districtofbirth]_i + v_i$$

Local average treatment effects estimated by 2SLS

$$(3) \quad HIVinfected_i = \alpha_0 + \alpha_1 Educ_i\_hat + \alpha_2 f(YOB) + \alpha_3 1[age]_i + \alpha_4 1[districtofbirth]_i + \zeta_i$$

with $Educ_i\_hat$ predicted in (2).

Assumptions underpinning the study



2SLS identifies local average treatment effect (LATE) if:

(1) Valid first stage: Z causally affects E, conditional on X.

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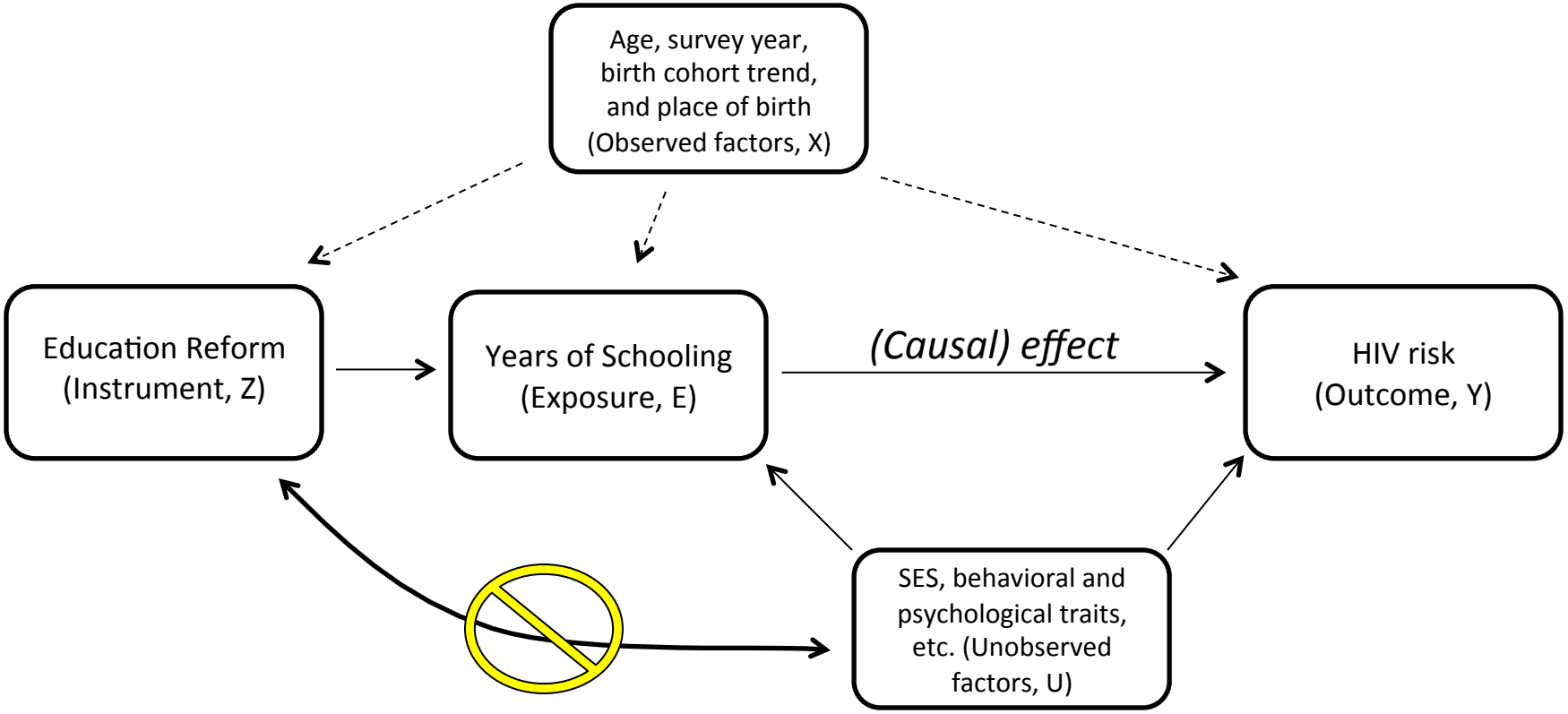

2SLS identifies local average treatment effect (LATE) if:

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(2) As-good-as-random assignment: Z is uncorrelated with U, conditional on X.

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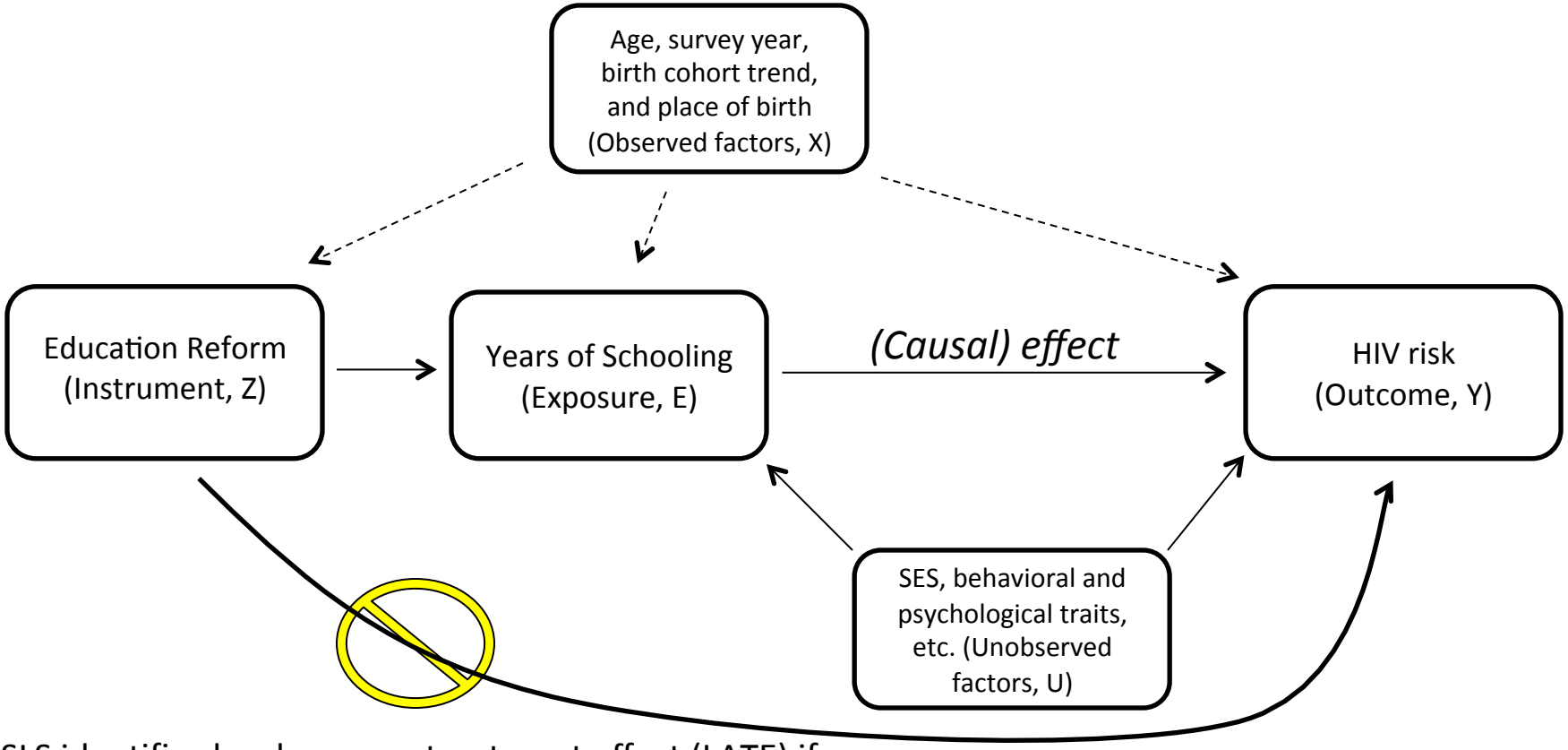

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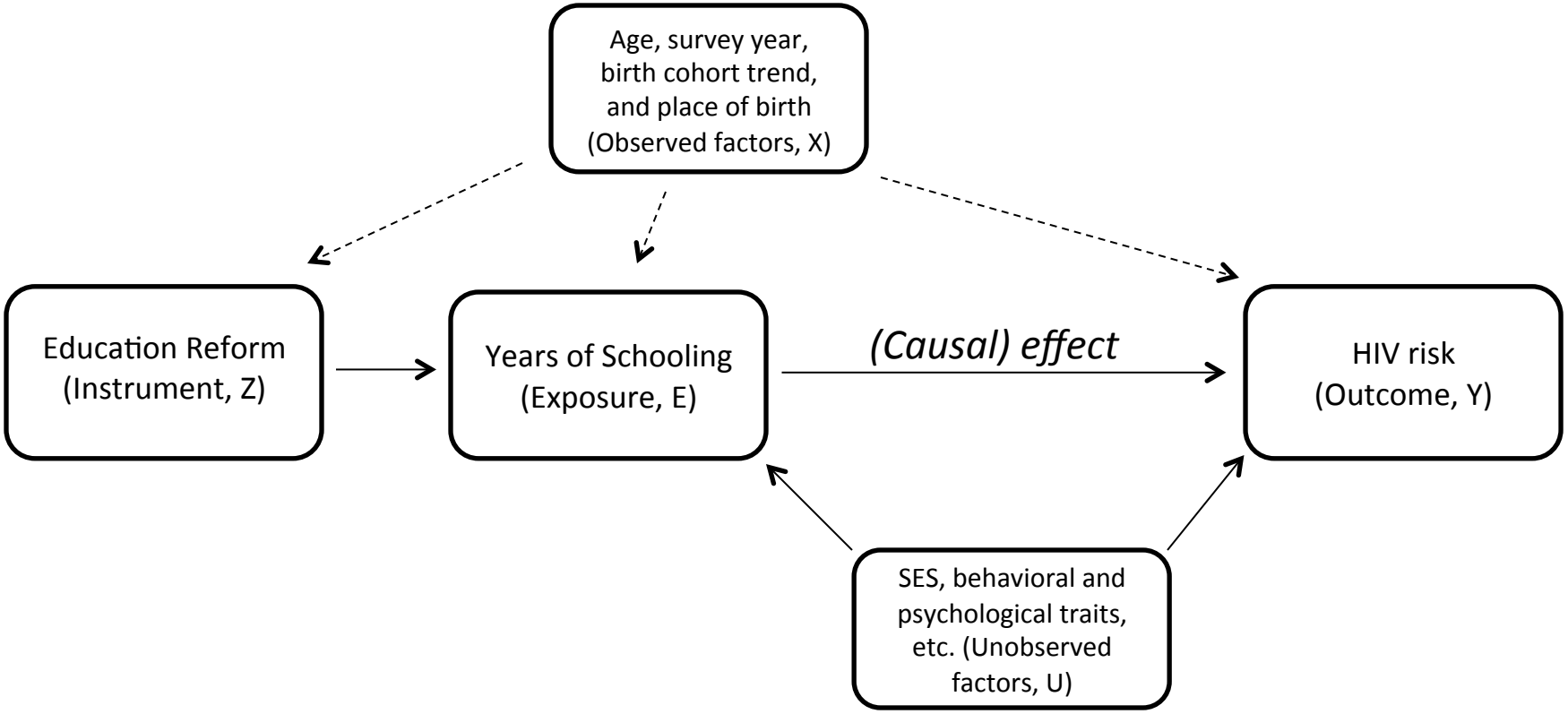

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(3) Exclusion restriction: Z affects Y only through E, conditional on X.
(4) Monotonicity: Z only affects E in one direction.

Regression results

Model	First Stage	Intent-to-Treat	2SLS
Dep. Variable	Schooling	HIV-Positive	HIV-Positive
Indep. variable	Reform	Reform	Schooling
Female	0.635***	-0.074**	-0.116**
Male	1.005***	-0.050*	-0.050*
Both Sexes	0.792***	-0.064***	-0.081***

*** p<0.01, ** p<0.5, * p<0.1

Sensitivity analyses: 2SLS regression results

Using sample weights	Imputed HIV status	IVProbit	Using YOB squared
-0.078**	-0.091**	-0.052***	-0.073**
Slope change in YOB	**Triple-Diff**	**Placebo**	**Anti-placebo**
-0.079***	-0.086***	-0.019	-0.072***

*** p<0.01, ** p<0.5, * p<0.1

Cost-effectiveness of secondary schooling as HIV prevention

- Secondary schooling is "very cost-effective" by standard benchmark of 1x per capita GDP (WHO)

Intervention	Circumcision	Treatment as Prevention	Pre-exposure Prophylaxis	Secondary School
Cost-effectiveness ratio (US$ per HIV infection averted)	551 - 1,096	8,375	12,500 – 20,000; 6,000 – 66,000	27,753*

*Other benefits of schooling are not captured in cost-effectiveness ratio.

De Neve et al., 2015.

Potential mechanisms

Proximate factors

1. Risk behaviors
2. Fertility as a proxy

Distal factors

1. Knowledge
2. Norms and attitudes
3. Cognitive skills
4. Economic empowerment

Behaviors

Risk behaviors, extensive margin: ever had sex, sexually active, number of partners, age of most recent partner

	Ever had sex	Sex in last 12mo	>2 partners in last 12mo	Age of most recent partner
MEN	0.06* (0.03) *0.93*	0.06* (0.03) *0.88*	0.11** (0.05) *0.23*	-0.56 (0.39) *22.8*
WOMEN	-0.01 (0.03) *0.96*	0.01* (0.04) *0.89*	0.04 (0.05) *0.12*	-0.31 (0.54) *30.1*

Behaviors

Risk behaviors, intensive margin: condom use, HIV testing, discusses HIV with others, OK for women to carry condoms

	Condom use at 1st sex	Ever tested for HIV	OK if women carry condoms	Discuss HIV with others
MEN	0.06* (0.03) *0.86*	0.12** (0.05) *0.57*	0.07** (0.03) *0.88*	0.09* (0.03) *0.47*
WOMEN	0.13*** (0.05) *0.83*	0.11* (0.06) *0.72*	0.09** (0.04) *0.93*	0.00 (0.06) *0.48*

Behaviors

Life course sexual behavior

- Sexual debut, fertility, marriage

	Age of sexual debut	Ever given birth	Number of births	Ever married
MEN	0.07 (0.21) *18.6*	--	--	0.01 (0.01) *0.03*
WOMEN	0.76*** (0.26) *18.6*	-0.16*** (0.06) *0.73*	-0.25** (0.11) *1.29*	0.02 (0.03) *0.07*

Behaviors

Life course sexual behavior

- Sexual debut by age X
- No evidence for incarceration effect

	First sex by age 16	First sex by age 18	First sex by age 20	First sex by age 22
MEN	0.03 (0.04) *0.23*	-0.04 (0.04) *0.49*	-0.05 (0.03) *0.85*	0.00 (0.02) *0.93*
WOMEN	-0.09*** (0.03) *0.19*	-0.12*** (0.04) *0.54*	-0.08*** (0.03) *0.85*	-0.02 (0.01) *0.96*

Knowledge

	Knows at least 2 ways to prevent HIV	Mentions condoms as prevention strategy	Any mis-conceptions about HIV
MEN	0.01 (0.04) *0.68*	0.00 (0.03) *0.84*	-0.04 (0.04) *0.60*
WOMEN	-0.02 (0.06) *0.70*	-0.04 (0.04) *0.88*	-0.06 (0.06) *0.56*

Distal factors

Economic empowerment & cognition

	Labor force participation	Log(wages)	Literacy	Newspaper as source of HIV information
MEN	0.05 (0.04) *0.85*	0.07* (0.04) --	0.08*** (0.02) *0.83*	0.06* (0.04) *0.22*
WOMEN	0.17** (0.08) *0.71*	0.24** (0.12) --	0.00 (0.04) *0.87*	0.07 (0.05) *0.22*

Summary

- Main results
  - Large protective effect of secondary school against HIV risk in Botswana
  - First evidence from quasi-experiment that secondary schooling reduces HIV infection risk
  - Cost-effective HIV prevention measure
- Mechanisms
  - No effect on HIV knowledge; large effects on norms and behaviors
  - Risk reduction *within* relationships, no evidence for effect on partner selection
  - Career vs. family: large increase in market labor supply and decrease in fertility for women

Generalizability

- Results are “local” to:
  - Compliers: people who would have otherwise stopped schooling at grade 9.
  - Epidemiological and labor market conditions.
  - Secondary school; results would likely differ for primary schooling.

Implications

- For policy
  - Returns to secondary schooling under-estimated in settings with large HIV epidemics
  - HIV policy makers should consider secondary school alongside biomedical interventions
- For research
  - Supply-side interventions: hard to study, but potentially high impact
  - An emerging perspective: secondary school as a "critical window period" for life-course interventions with behavioral pathways lasting into adulthood

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Length of secondary schooling and risk of HIV infection in Botswana: evidence from a natural experiment

Jan-Walter De Neve, Günther Fink, S V Subramanian, Sikhulile Moyo, Jacob Bor

Summary

Background An estimated 2·1 million individuals are newly infected with HIV every year. Cross-sectional and longitudinal studies have reported conflicting evidence for the association between education and HIV risk, and no randomised trial has identified a causal effect for education on HIV incidence. We aimed to use a policy reform in secondary schooling in Botswana to identify the causal effect of length of schooling on new HIV infection.

Methods Data for HIV biomarkers and demographics were obtained from the nationally representative household 2004 and 2008 Botswana AIDS Impact Surveys (N=7018). In 1996, Botswana reformed the grade structure of secondary school, expanding access to grade ten and increasing educational attainment for affected cohorts. Using exposure to the policy reform as an instrumental variable, we used two-stage least squares to estimate the causal effect of years of schooling on the cumulative probability that an individual contracted HIV up to their age at the time of the survey. We also assessed the cost-effectiveness of secondary schooling as an HIV prevention intervention in

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See Comment page e428

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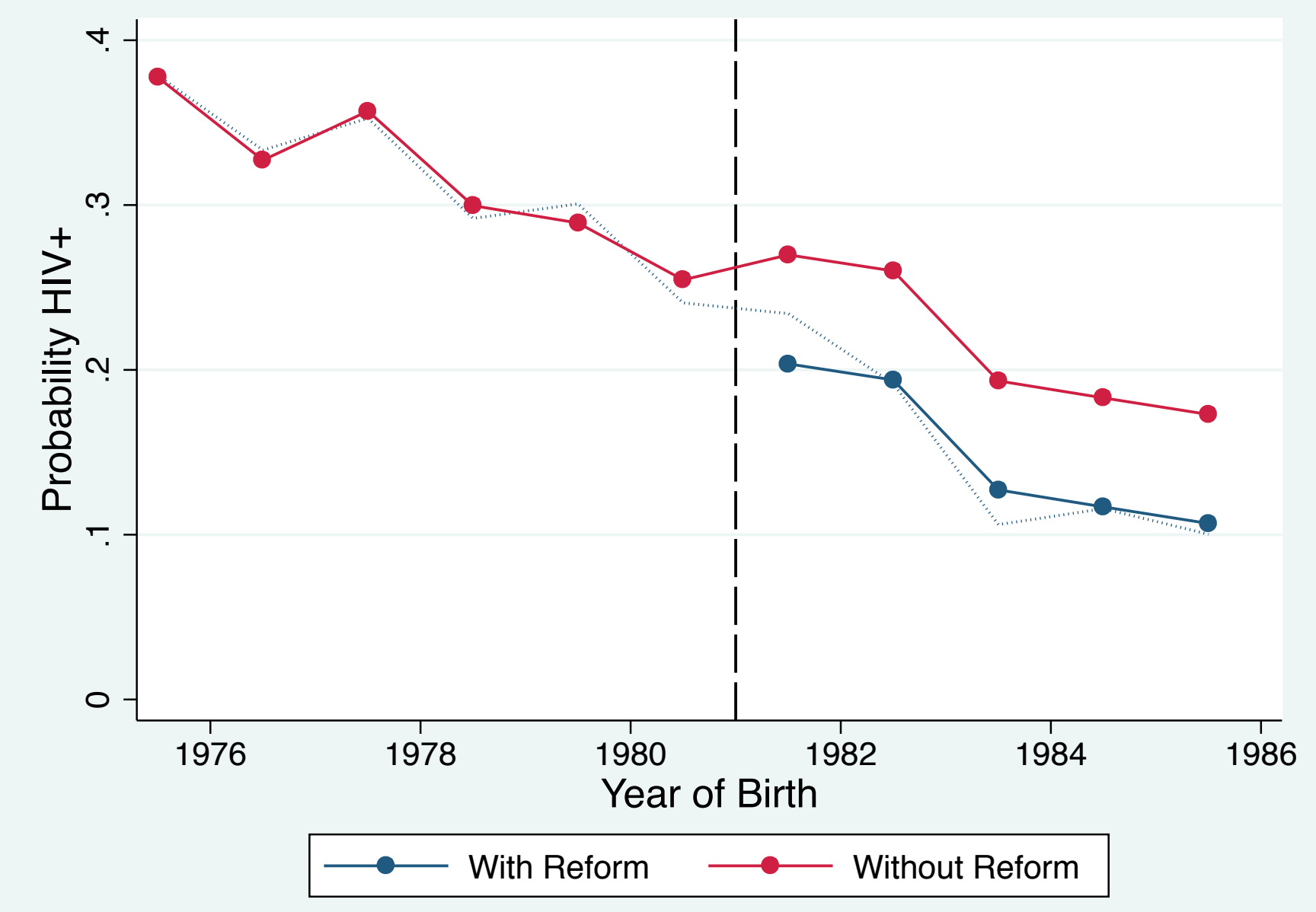
Reduced form figure



Empirical approach

First stage and reduced form (ITT) effects estimated using ordinary least squares (OLS)

$$Educ_i = \beta_0 + \beta_1 1[YOB>1980]_i + \beta_2\, f(YOB) + \beta_3 1[age]_i + \beta_4 1[districtofbirth]_i + \varepsilon_i$$

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Local average treatment effects estimated by two-stage least squares (2SLS)

$$HIVinfected_i = \alpha_0 + \alpha_1 Educ_i\_hat + \alpha_2 f(YOB) + \alpha_3 1[age]_i + \alpha_4 1[districtofbirth]_i + \zeta_i$$