# The Impact of College Education on Fertility

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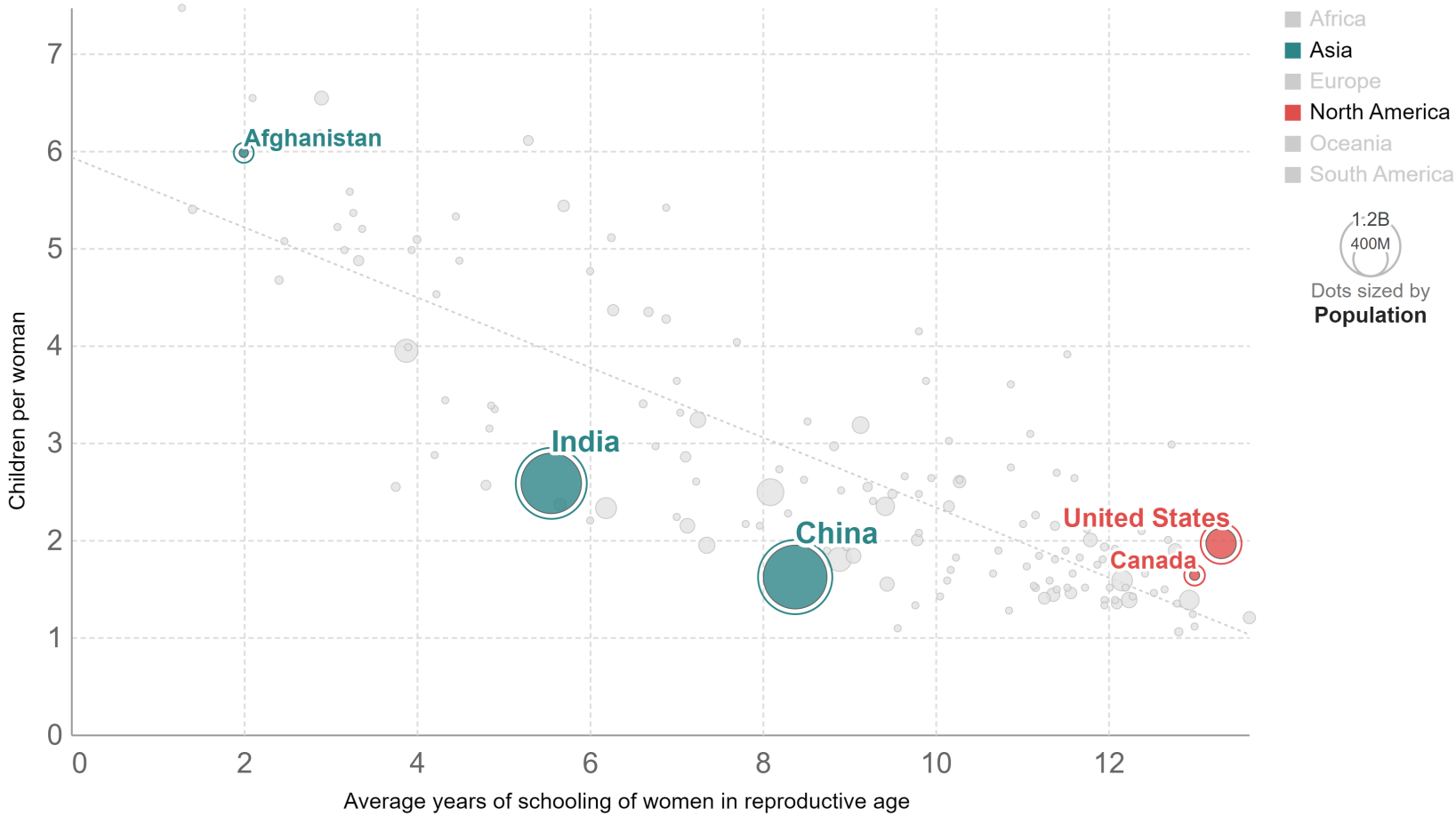
# Women's educational attainment vs. fertility

Shown on the x-axis is the average number of years of schooling of women in the reproductive age (15 to 49 years).




Source: United Nations – Population Division (2019 Revision), Our World In Data (2017)

OurWorldInData.org/fertility-rate • CC BY

# What is the Impact of College Education on Fertility?

- $College_i = \begin{cases} 1 & \text{if a woman goes to college} \\ 0 & \text{otherwise} \end{cases}$
- $Fertility_i$: Number of children a woman gives birth to
-

$$\text{Fertility}_i = \theta_1 \text{College}_i + m_0(\boldsymbol{x}_i) + \epsilon_i \tag{1}$$

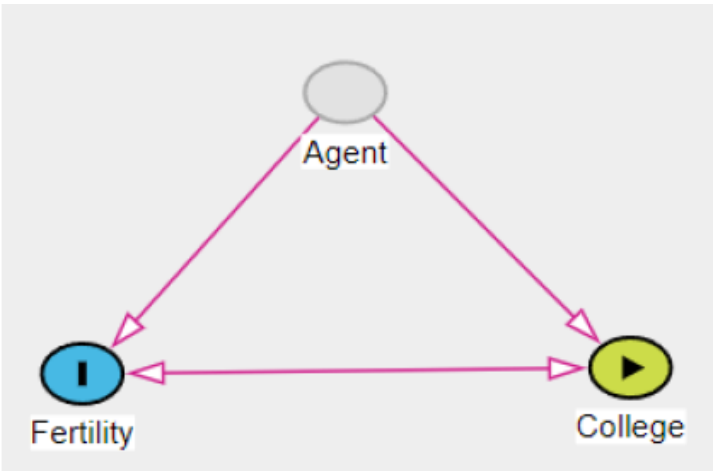



Figure 1: Assumed Causal Mechanism

# Key Papers in The Field

- "Education, HIV, and Early Fertility: Experimental Evidence from Kenya" (Duflo et. al. 2015)

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See section 2.2 of the paper for an argument against policy instruments.

# Overview of the Data

- Source: National Longitudinal Survey of Youth
- 8,984 males and females born in 1980-1984
- Information from 1997 and 2015 is taken (respondents were 12-16, 36-40 respectively)
- Key variables:
  - Outcome: Fertility
  - Treatment: College boolean
  - Instrument: Bullying
  - $\boldsymbol{w}$ : Determinants of bullying (9)
  - $\boldsymbol{x}$ : Confounders for Fertility-College relationship (7)
- Issues:
  - Small sample size (4,492 women)
  - A lot of missing observations

# The Average Respondent

- Exclusion: men
- Average respondent is a...
  - 32 year old ...
  - White ···
  - Christian ···
  - Mom of 1.4 children ···
  - Who was not bullied in school ···
  - Who went to college ···
  - Whose parents both finished highschool ···
  - ··· and whose family makes $75,000 a year.
- After missing data exclusions, sample size is 848

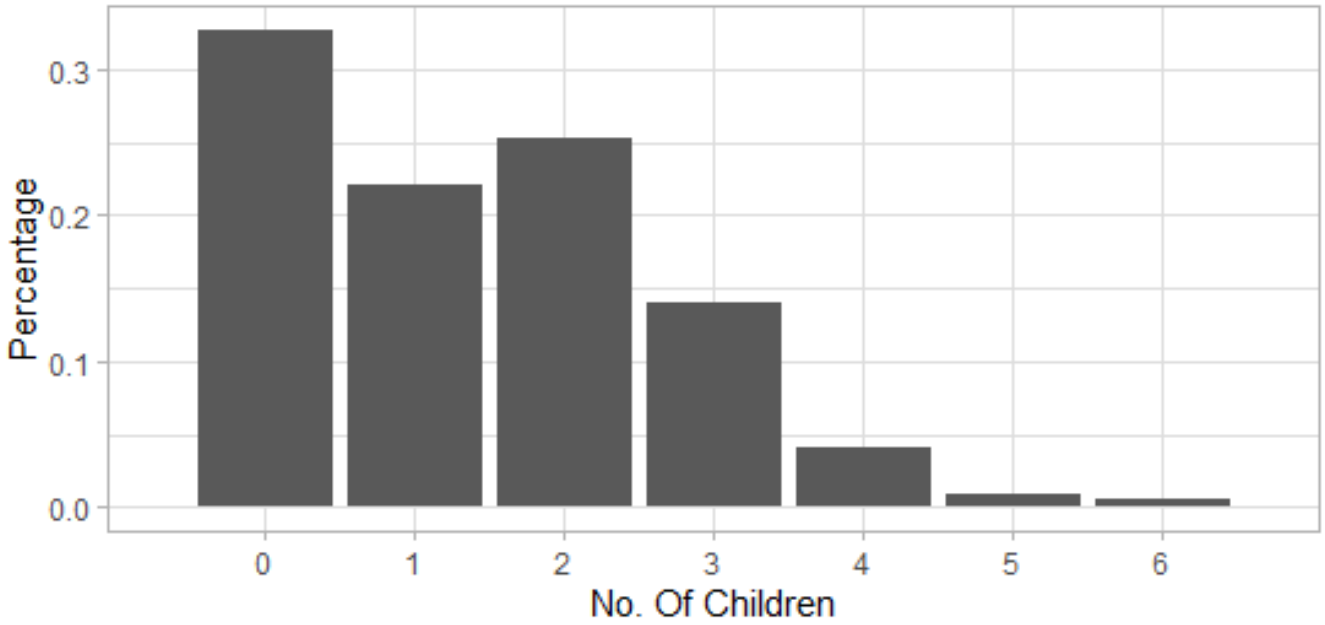
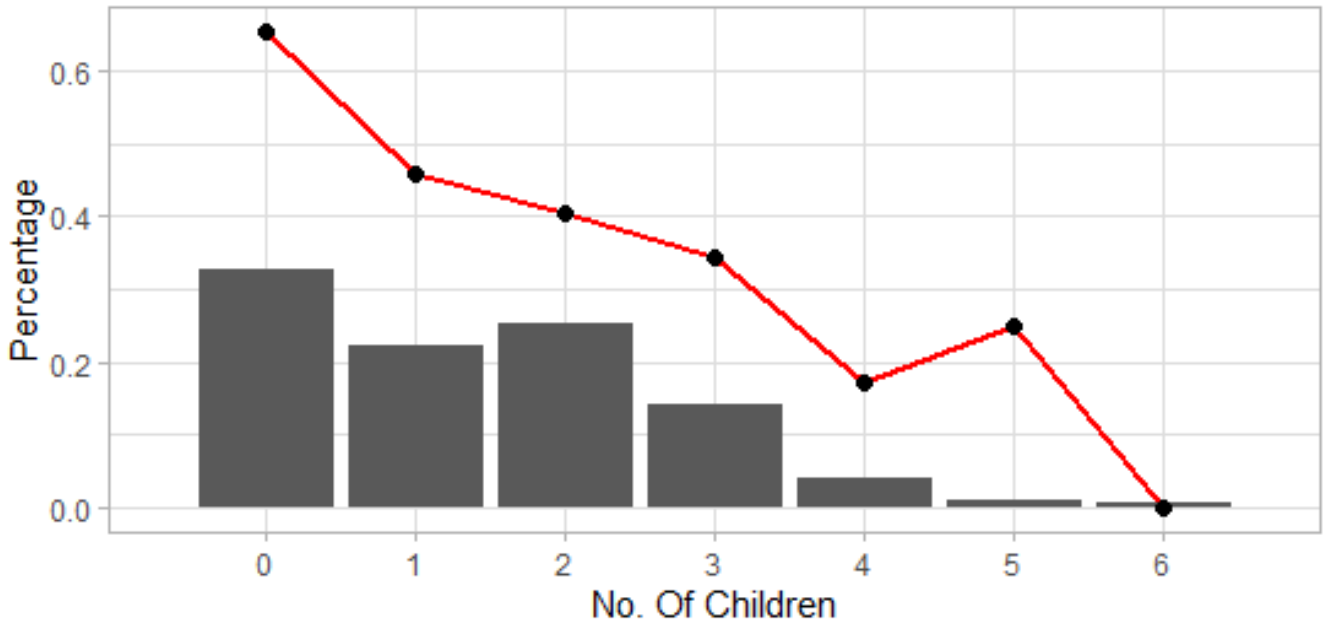



Figure 2: Percentage of Women With X Children




*

Figure 3:
Percentage of Women With X Children
And
Percentage of Women With A College Education, Conditional on Having X Children

*Red shows an estimate of $\mathbb{E}[College|Fertility]$, which is not what we want to estimate!

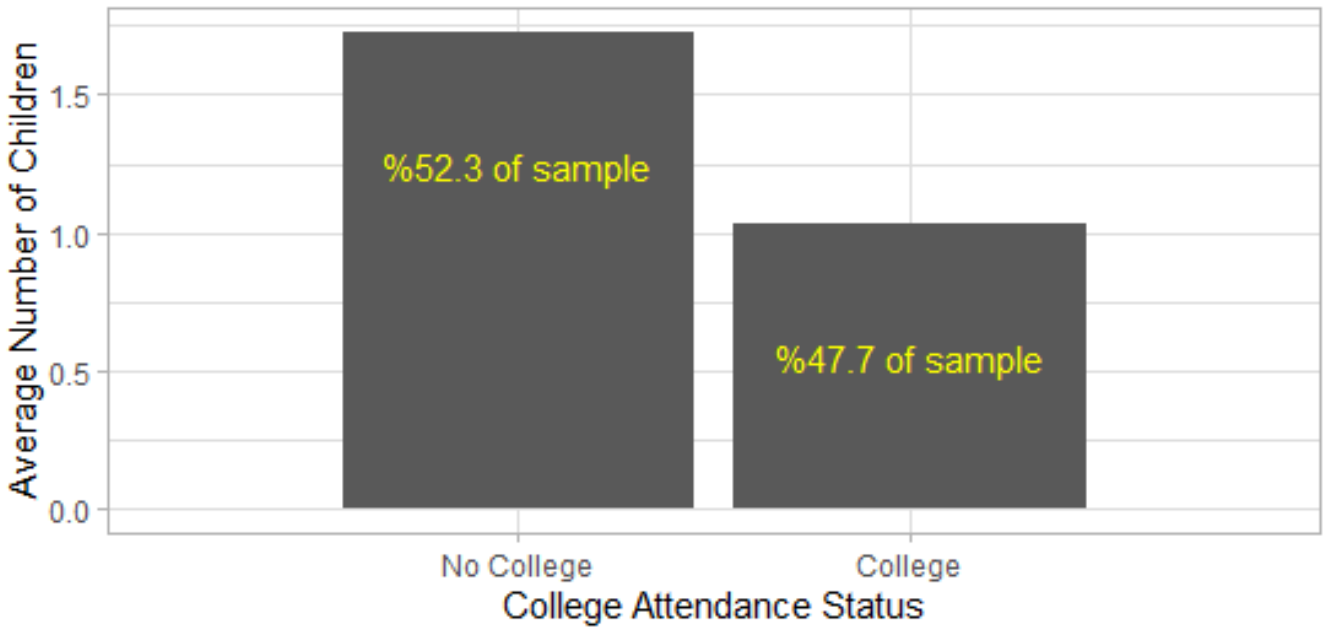



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Figure 4:
Average Number of Children Per Woman
Conditional On
College Attendance Status

†This shows an estimate of $\mathbb{E}[Fertility|College]$, which is what we want to estimate!

# Methodology: Back to DAGs

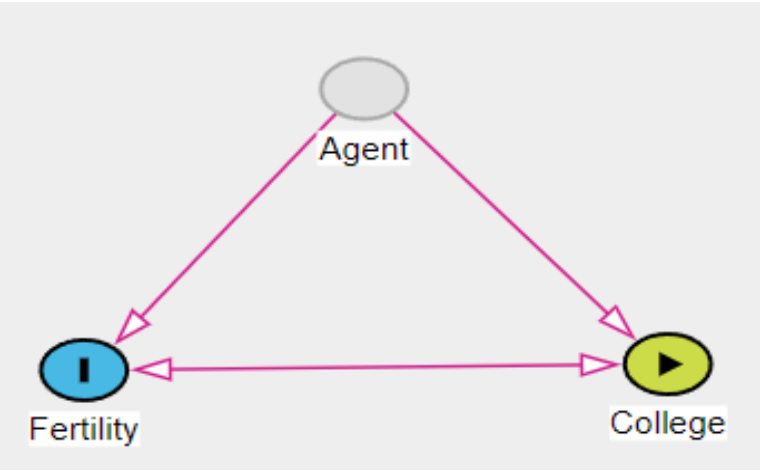


Figure 5: Simultaneity Bias

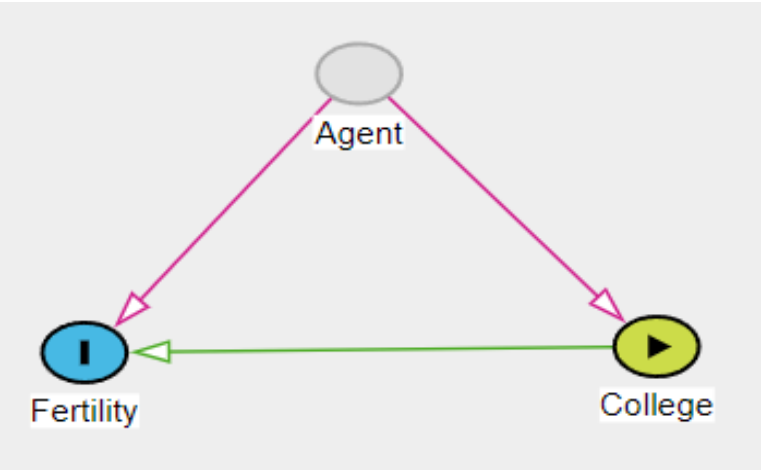


Figure 6: Desired Causality

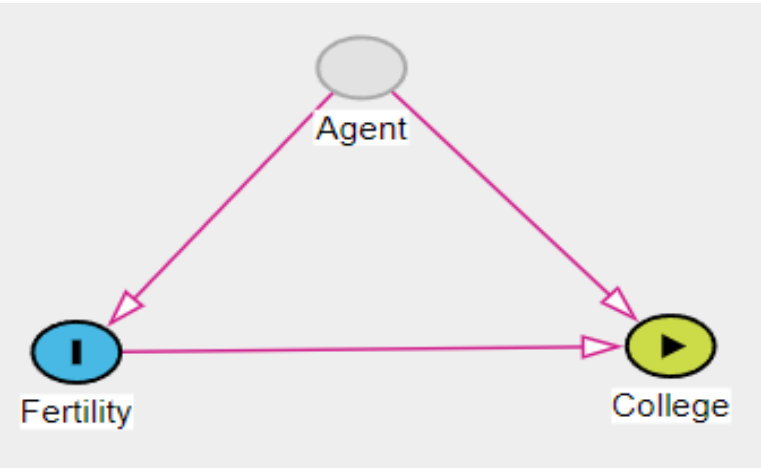


Figure 7: Reverse Causality

# 2SLS: Assuming Simultaneity

$$\text{College}_i = \text{Bullied}_i\alpha_1 + \boldsymbol{x}_i^\top\boldsymbol{\beta} + \boldsymbol{w}_i^\top\pi + \eta_i \tag{2}$$

$$\text{Fertility}_i = \widehat{\text{College}}_i\theta_1 + \boldsymbol{x}_i^\top\gamma + \boldsymbol{w}_i^\top\kappa + \epsilon_i \tag{3}$$

Assumptions :

- Assuming a linear conditional expectation function in both stages.
- $\mathbb{E}[\epsilon_i|\boldsymbol{x}_i, \boldsymbol{w}_i] = 0$
- $\mathbb{E}[\epsilon_i \times \text{Bullied}_i|\boldsymbol{x_i}, \boldsymbol{w_i}] = 0$
- $\alpha_1 \neq 0$

# 2SLS Results

| | $\hat{\theta}$ | SE | t-stat | p-value |
|---|---|---|---|---|
| 2SLS | -1.09 | 0.99 | -1.09 | 0.28 |

‡

Hausman Test Results:
$H_0$ : 2SLS and OLS are consistent
$H_A$ : OLS is not consistent
P-value $>$ 0.4
Hausman Test Inconclusive.

‡Table 5.01 in paper

# Comparing 2SLS to OLS

| | $\hat{\theta}$ | SE | t-stat | p-value |
|---|---|---|---|---|
| 2SLS | -1.09 | 0.99 | -1.09 | 0.28 |
| OLS | -0.30 | 0.09 | -3.32 | 0.00 |

§

Why was the Hausman test inconclusive?

- OLS and 2SLS close in magnitude with 2SLS being more imprecise.
- The instrument is endogenous.

Is it better not to use an instrument? Yes.

§ Table 5.01 in paper

# Method 2: Partially Linear Model

$$\text{Fertility}_i = \theta_1 \text{College}_i + g_0(\boldsymbol{x_i}, \boldsymbol{w_i}) + \eta_i \quad (4)$$

$$\text{College}_i = m_0(\boldsymbol{x_i}, \boldsymbol{w_i}) + \epsilon_i \quad (5)$$

Assuming:

- $\mathbb{E}[\eta_i | \text{College}_i, \boldsymbol{x_i}, \boldsymbol{w_i}] = 0$
- $\mathbb{E}[\epsilon_i | \boldsymbol{x_i}, \boldsymbol{w_i}] = 0$

# Results

| | $\hat{\theta}$ | SE | t-stat | p-value |
|---|---|---|---|---|
| OLS | -0.30 | 0.09 | -3.32 | 0.00 |
| DDML: Lasso | -1.75 | 0.86 | -2.03 | 0.04 |
| DDML:RF | -0.72 | 1.28 | -0.56 | 0.57 |
| DDML: XgBoost | 6.00 | 2.76 | 2.17 | 0.03 |
| Sample Size | 848 | | | |

¶

¶Table 5.01 in paper

# Altering The Specification

$$\text{Fertility}_i = \theta_1 \text{College}_i + g_0(\boldsymbol{x_i}, \boldsymbol{w_i}) + \eta_i$$
$$\text{College}_i = m_0(\boldsymbol{x_i}, \boldsymbol{w_i}) + \epsilon_i$$

Such that:

$\boldsymbol{w}$ :

- *age*
- *race*
- Age mother was born
- Family Networth
- Percent of peers in a gang & Percent of peers who do drugs
- Has R been through hard times?
- Index of family Routines & Index of family risk

# Results: Altered Specification

| | $\hat{\theta}$ | SE | t-stat | p-value |
|---|---|---|---|---|
| OLS | -0.43 | 0.09 | -4.80 | 0.00 |
| DDML: Lasso | -0.49 | 0.09 | -5.45 | 0.00 |
| DDML:RF | -0.35 | 0.09 | -3.79 | 0.00 |
| DDML: XgBoost | -0.61 | 0.10 | -6.23 | 0.00 |
| Sample Size | 848 | | | |

‖Table 5.02 in paper

# Robustness Check: Excluding Outliers

Exclude Outliers **(37 values), and re-estimate model.

| | $\hat{\theta}$ | SE | t-stat | p-value |
|---|---|---|---|---|
| OLS | -0.42 | 0.09 | -4.66 | 0.00 |
| DDML: Lasso | -0.51 | 0.09 | -5.52 | 0.00 |
| DDML:RF | -0.34 | 0.09 | -3.63 | 0.00 |
| DDML: XgBoost | -0.65 | 0.10 | -6.39 | 0.00 |
| Sample Size | 811 | | | |

††

**Defined by Mahalanobis Distance

††Table 5.11 in paper

# Limitations: Inappropriate Instrument

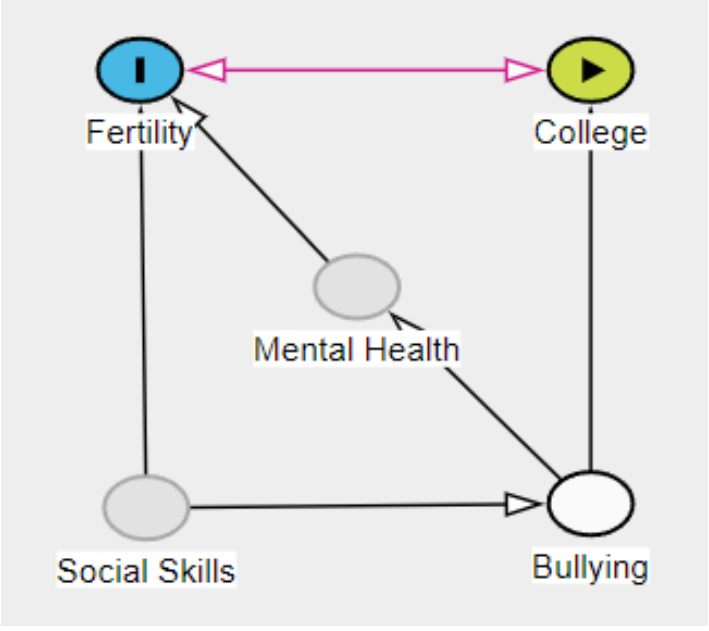


Figure 8: Violation of Exclusion Restriction

1. Unobservable Mediator
2. Unobservable Confounder

# Limitations: Wrong Assumed Causal Mechanism

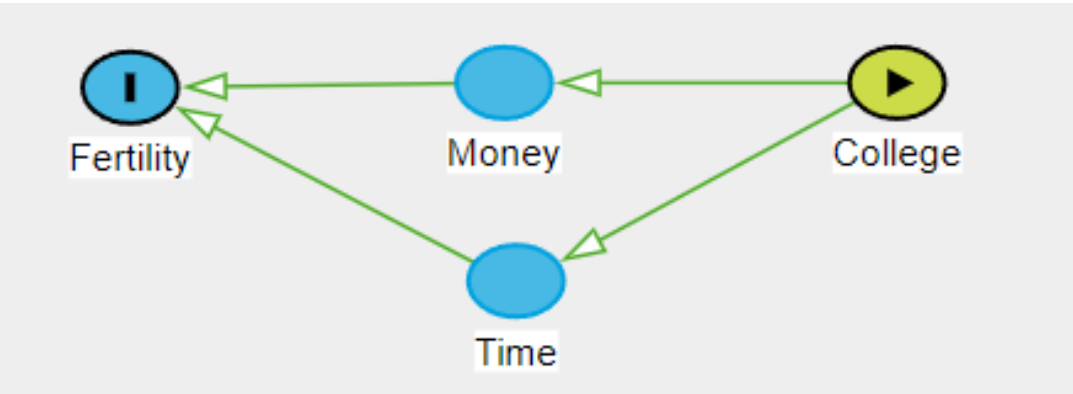


Figure 9: Alternative Causal Mechanism via Mediators

- ATE may be retrievable via Front door criterion. Otherwise, estimated causal effect may not make sense.

# Limitations: misc.

- Small sample size
- Heterogenous Treatment Effect

The End