Gov 51: Introduction to Causality

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What is a causal effect?

factual   vs.   counterfactual

- Does the minimum wage increase the unemployment rate?

    - Unemployment rate went up after the minimum wage increased
    - Would it have gone up if the minimum wage increase not occurred?

- Does race affect one's job prospect?

    - Jamal applied for a job but did not get it
    - Would Jamal have gotten a job if he were white?

- **Fundamental problem of causal inference**:

    - Can never observe counterfactuals, must be inferred.

Criminal record experiment

- Does having a criminal record affect job prospects?

- Experimental setting:
  - Randomly assign 4 hired "confederates" (2 white, 2 black) to apply to different jobs in Milwaukee.
  - Men were matched on physical appearance, self-presentation, age, etc.
  - Confederates would alternate indicating they had a criminal record.

- Outcome of interest: receiving a callback from a potential employer.

A tale of two applications

	Criminal Record	Callback?
Applicant 1	Ex-felon	No
Applicant 2	No criminal record	Yes

- Did the first applicant not callback the applicant **because** they had a criminal record?

Notation

- **Unit** (indexed by *i*): job application for employer
- **Treatment variable** T_i: criminal record or not
- **Treatment group** (treated units): applications with criminal record
- **Control group** (untreated units): applications without criminal record
- **Outcome variable** Y_i: callback

	T_i (ex-felon)	Y_i (callback)
Ex-felon applicant	1	0
Non-ex-felon applicant	0	1

Causal effects & counterfactuals

- What does "T_i causes Y_i" mean? ⤳ **counterfactuals**, "what if"

- Would an employer treat criminal & noncriminal applicants differently?

- Two **potential outcomes**:
  - $Y_i(1)$: would employer i callback if applicant is an ex-felon?
  - $Y_i(0)$: would employer i callback if applicant is **not** an ex-felon?

- **Causal effect**: $Y_i(1) - Y_i(0)$
  - $Y_i(1) - Y_i(0) = -1$ ⤳ criminal record prevents callback
  - $Y_i(1) - Y_i(0) = 0$ ⤳ criminal record has no impact on callback
  - $Y_i(1) - Y_i(0) = +1$ ⤳ criminal record leads to callback

Potential outcomes

	T_i (ex-felon)	Y_i (callback)	$Y_i(1)$	$Y_i(0)$
Ex-felon applicant	1	0	0	???
Non-ex-felon applicant	0	1	???	1

- **Fundamental problem of causal inference**:
  - We only observe one of the two potential outcomes.
  - Observe $Y_i = Y_i(1)$ if $T_i = 1$ or $Y_i = Y_i(0)$ if $T_i = 0$
- To infer causal effect, we need to infer the missing counterfactuals!

How can we figure out counterfactuals?

- Find a similar unit! ⤳ **matching** (Mill's method of difference)

- Did applicant fail to get a job offer because of his criminal record?

    - ⤳ find a non-ex-felon who is just like ex-felon applicant.

- NJ increased the minimum wage. Causal effect on unemployment?

    - ⤳ find a state similar to NJ that didn't increase minimum wage.

- The problem: imperfect matches!

    - Say we match i (treated) and j (control)
    - $Y_i(1)$ may not be the same as $Y_j(1)$ due to **selection bias**
    - Those who take treatment may be different that those who take control.