STA 235H - Observational Studies

Fall 2022

McCombs School of Business, UT Austin

What happens when the ignorability assumption doesn't hold?

- Imagine **we can't randomize**

Observational Study

Can we compare two groups to get a causal effect?

What happens if the ignorability assumption doesn't hold?

- Now, let's assume $(Y(0), Y(1)) \not\perp\!\!\!\perp Z$

$$\tau = E[Y_i(1)] - E[Y_i(0)] \neq E[Y_i|Z = 1] - E[Y_i|Z = 0]$$

Correlation does not imply causation

What happens if the ignorability assumption doesn't hold?

- Now, let's assume $(Y(0), Y(1)) \not\perp\!\!\!\perp Z$

$$\tau = E[Y_i(1) - Y_i(0)] =$$

$$= E[Y_i(1) - Y_i(0)|Z = 1]Pr(Z = 1) + E[Y_i(1) - Y_i(0)|Z = 0](1 - Pr(Z = 1))$$

What happens if the ignorability assumption doesn't hold?

- Now, let's assume $(Y(0), Y(1)) \not\perp Z$

$$\tau = E[Y_i(1) - Y_i(0)] =$$

$$= \underbrace{E[Y_i(1) - Y_i(0)|Z = 1]}_{\text{ATT}} Pr(Z = 1) + \overbrace{E[Y_i(1) - Y_i(0)|Z = 0]}^{\text{ATC}} (1 - Pr(Z = 1))$$

- Weighted average of the ATT and ATC.

What happens if the ignorability assumption doesn't hold?

- After some simple math, you can get to:

$$\tau = E[Y_i(1) - Y_i(0)] = ATE$$

$$ATE = E[Y_i|Z=1] - E[Y_i|Z=0]$$

$$- (E[Y_i(0)|Z=1] - E[Y_i(0)|Z=0])$$

$$- (1 - Pr(Z=1))(ATT - ATC)$$

Check out Scott Cunningham's "Causal Inference: The Mixtape" (Ch. 4.1.3) for the decomposition

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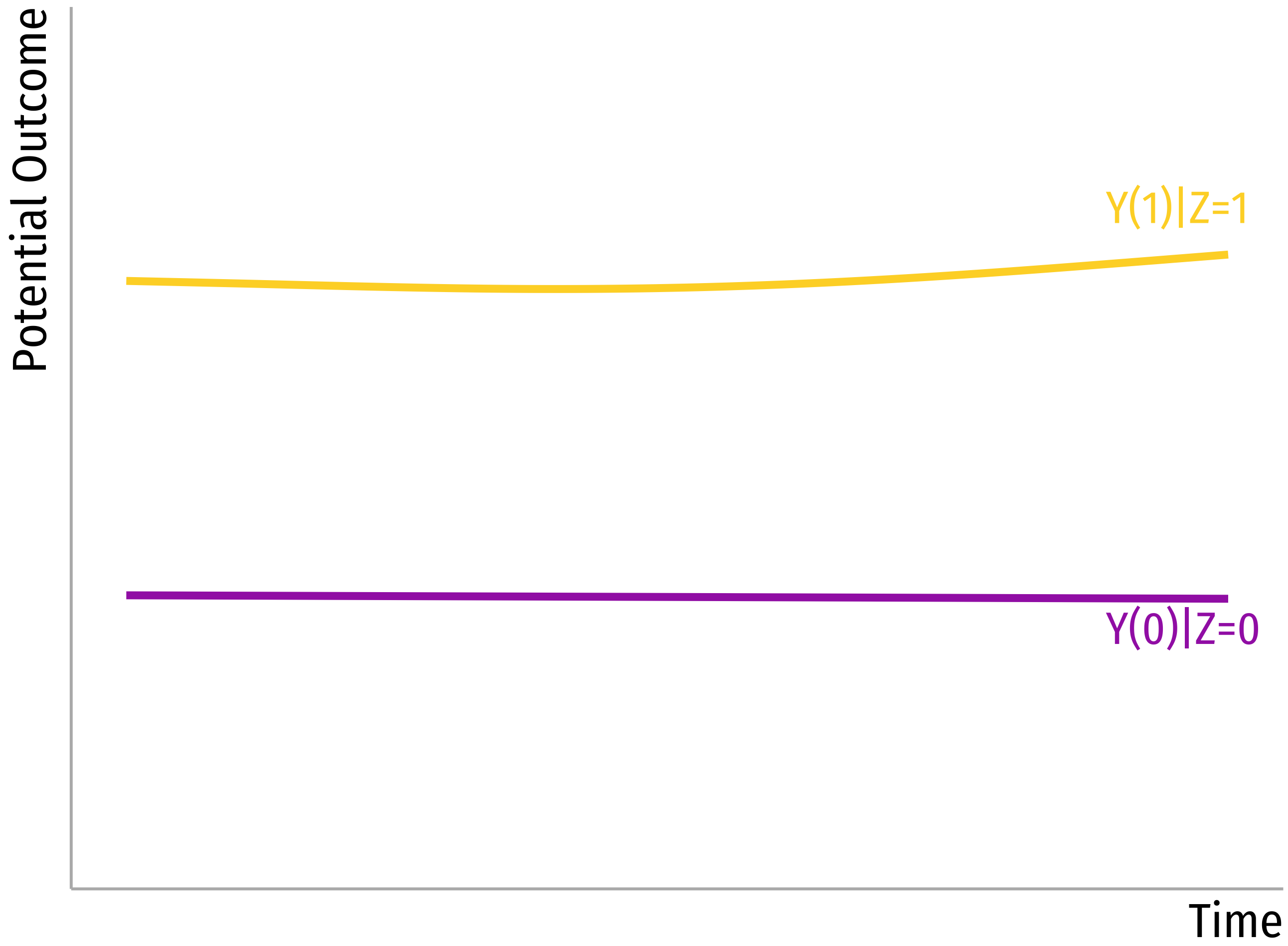
$$\tau = E[Y_i(1) - Y_i(0)] = ATE$$

$$\begin{aligned} ATE = & \underbrace{E[Y_i|Z=1] - E[Y_i|Z=0]}_{\text{Obs diff in means}} \\ & - \underbrace{(E[Y_i(0)|Z=1] - E[Y_i(0)|Z=0])}_{\text{Selection bias}} \\ & - \underbrace{(1 - Pr(Z=1))(ATT - ATC)}_{\text{Heterogeneous treat. effect bias}} \end{aligned}$$

- **Selection Bias:** Difference between groups if they both were under control (e.g. baseline differences).
- **Heterogeneous Treatment Effect Bias:** Difference in returns to treatment for the two groups (weighted by the control population).

Check out Scott Cunningham's "Causal Inference: The Mixtape" (Ch. 4.1.3) for the decomposition

How would bias look like?



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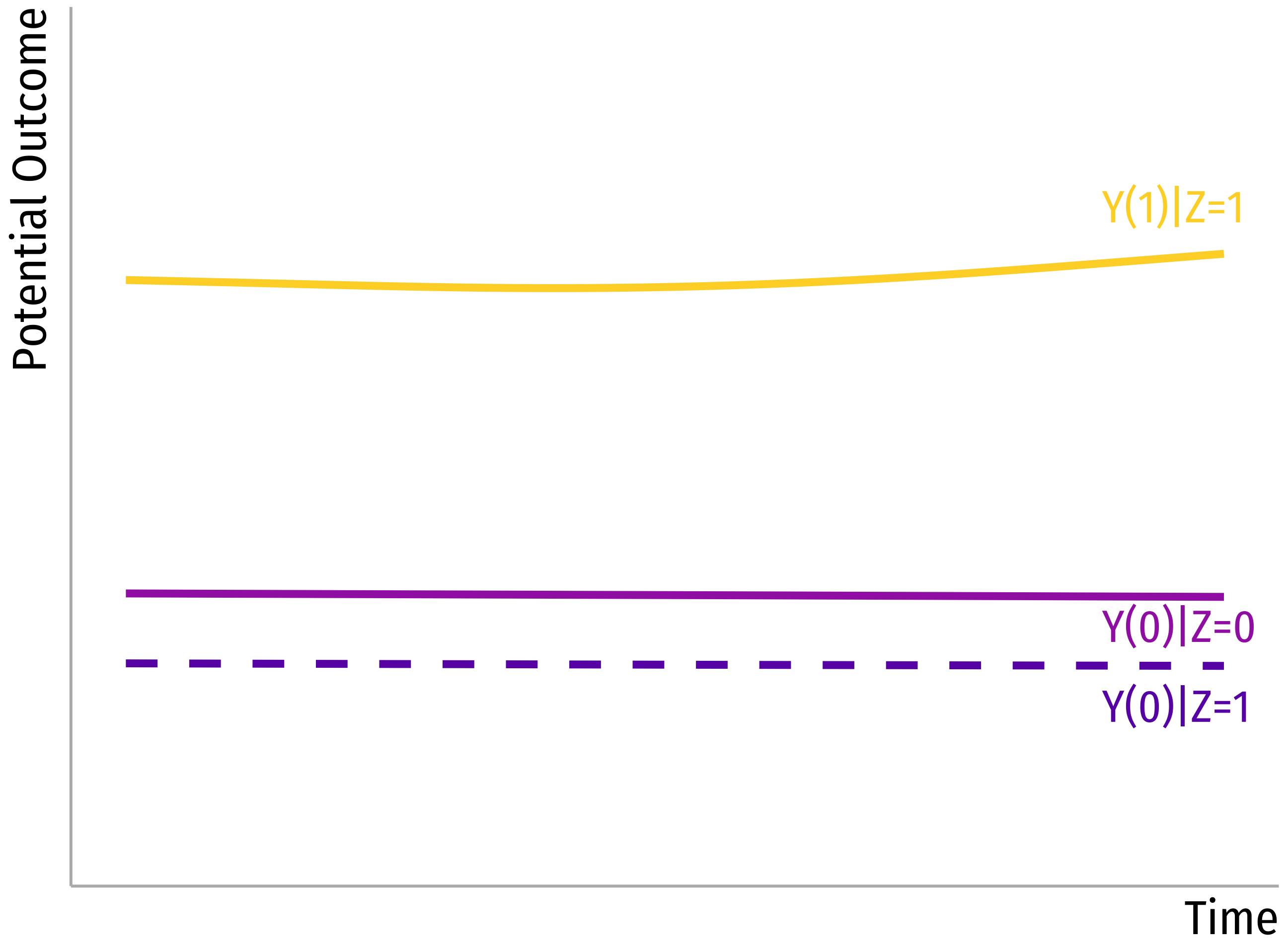

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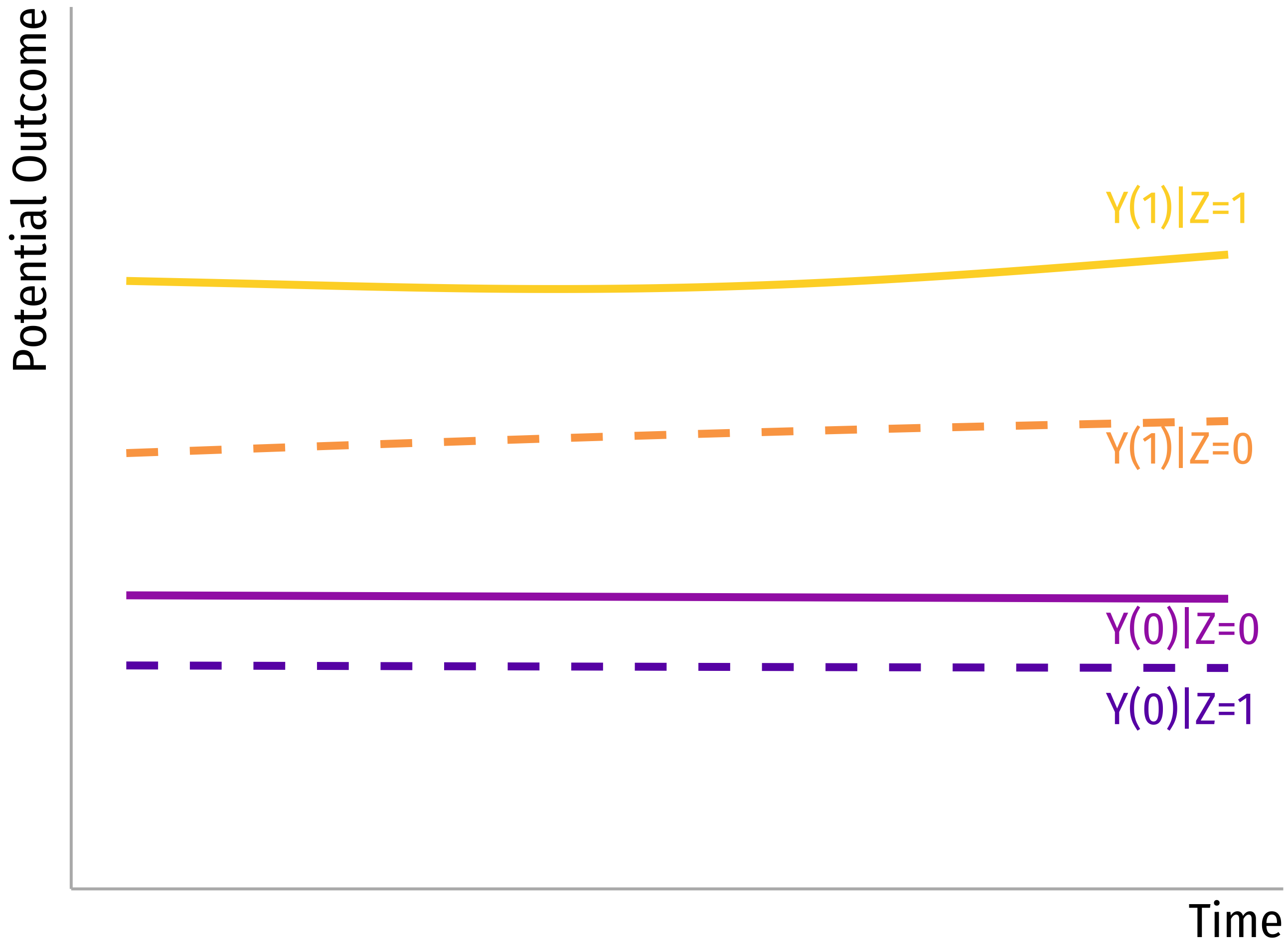


Example: Effect of types of advertising on sales

You want to know whether is more convenient to e-mail or physically mail potential customers to increase your subscribers.

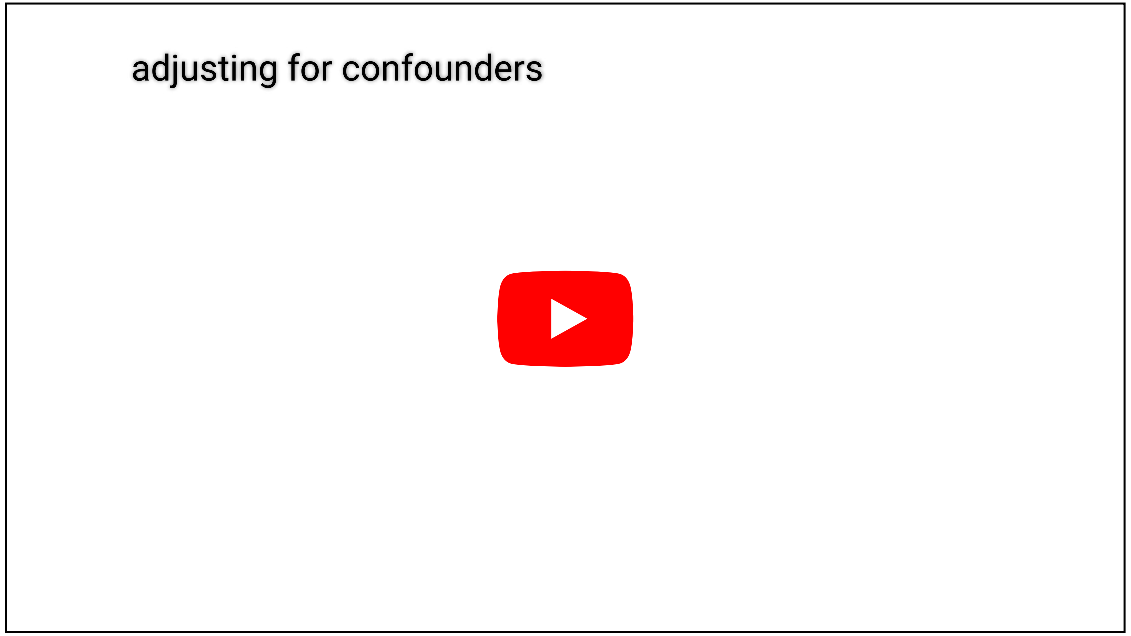
Example: Going to Office Hours

An important question could be: **Does going to office hours increase our GPA?**

- What could be an example of **selection bias**?
  - Remember that selection bias means differences in $Y(0)$ for people that go to office hours vs those that don't.
- What could be an example of **heterogeneous return to treatment bias**?
  - Remember that heterogeneous return to treatment bias means that $Y(1) - Y(0)$ is different for those that go vs those that don't go to office hours.

How do confounders affect our causal estimate?

What happens if we control by our confounders?



Next class

- Continue talking about **Observational Studies**
- Can we use **matching** for causal effects?
- Introduce **difference-in-differences**