Econometrics . 2022-6-17

Potential outcomes :

Y^1 : if treated $(A=1)$

Y^0 : if not treated $(A=0)$

Observed outcome :

$$Y = AY^1 + (1-A)Y^0$$

Individual causal effect :

$$Y_i^1 - Y_i^0$$

Average treatment effect (ATE).

(causal)

$$ATE = E[Y_i^1 - Y_i^0] = E[Y_i^1] - E[Y_i^0].$$

Example: Treatment: $A_i = \begin{cases} 1 & \text{for drug} \\ 0 & \text{for surgery.} \end{cases}$

Outcome: Y_i = number of years of life after treatment.

Potential outcome

Patient	Y_i^1 (drug)	Y_i^0 (surgery)	$Y_i^1 - Y_i^0$
P1	1	7	-6
P2	6	5	1
P3	1	5	-4
P4	8	7	1
Ave.	4	6	-2

ATE

Observed outcome

Patient	A_i	Y_i
P1	0	7
P2	1	6
P3	0	5
P4	1	8

	Ave. outcome
treat	7
control	6
diff	1

$$E[Y_i | A_i=1] - E[Y_i | A_i=0]$$

$$E[Y_i \mid A_i = 1] - E[Y_i \mid A_i = 0]$$ ← what we can observe.

$$= E[Y_i^1 \mid A_i = 1] - E[Y_i^0 \mid A_i = 0]$$

$$= \left(E[Y_i^1 \mid A_i = 1] - E[Y_i^0 \mid A_i = 1]\right) + \left(E[Y_i^0 \mid A_i = 1] - E[Y_i^0 \mid A_i = 0]\right)$$

$$= \text{ATT (average treatment effect of the treated)} + \text{selection bias.}$$

Randomized Control Trial (RCT).

- $\{Y_i^1, Y_i^0\} \perp\!\!\!\perp A_i$

  ↑ independent

- $ATT\ (= ATE) = E[Y_i | A_i = 1] - E[Y_i | A_i = 0]$

- $\Rightarrow$ "as-if" random assignment (natural experiment).

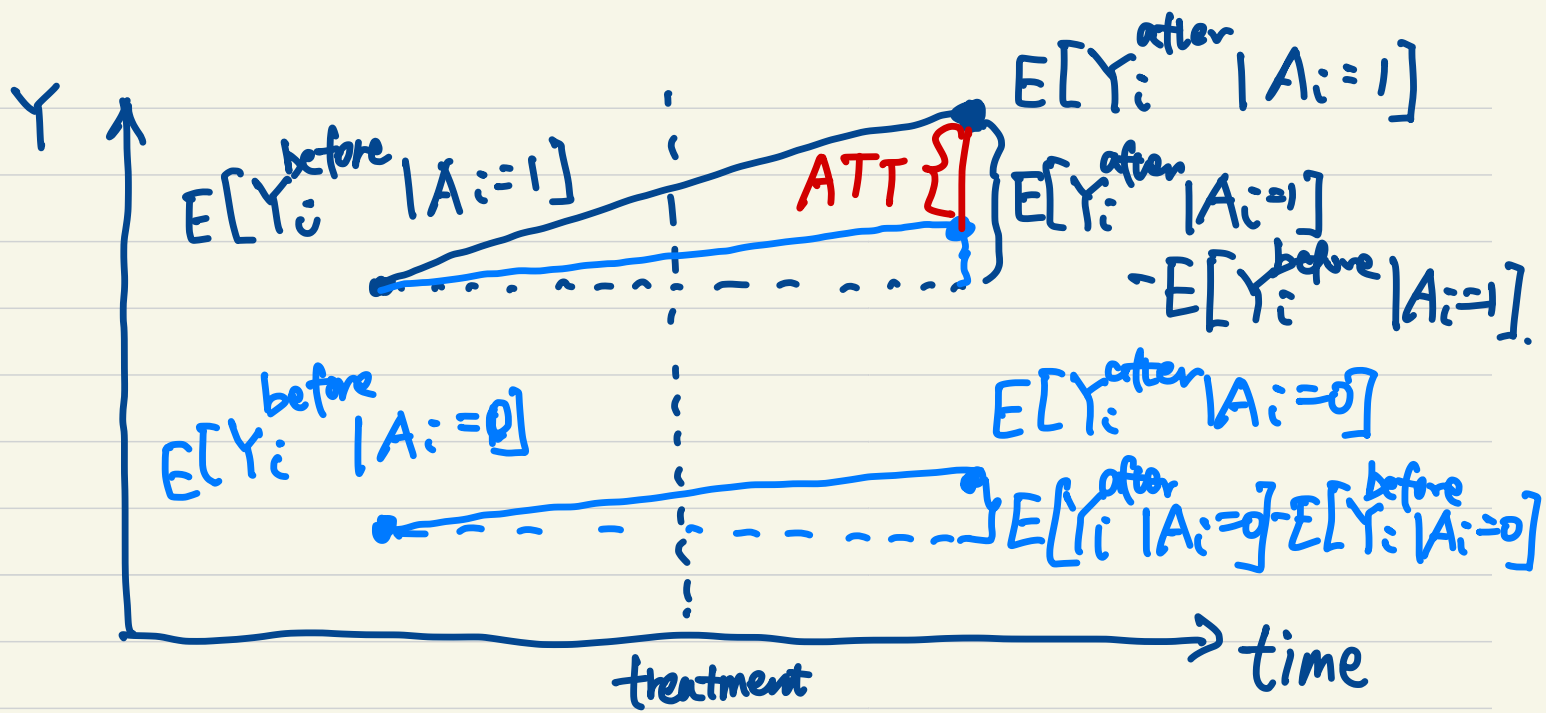
Useful methods for causal inference.

- Matching
- IV
- Difference in differences (DID or DD)
- Regression discontinuity design (RDD)
- Synthetic control

Difference in Differences.

Panel data.

	Before	treatment	After
treatment	Y_i^0		Y_i^1
control.	Y_i^0		Y_i^0



- "Common trend" of both groups.