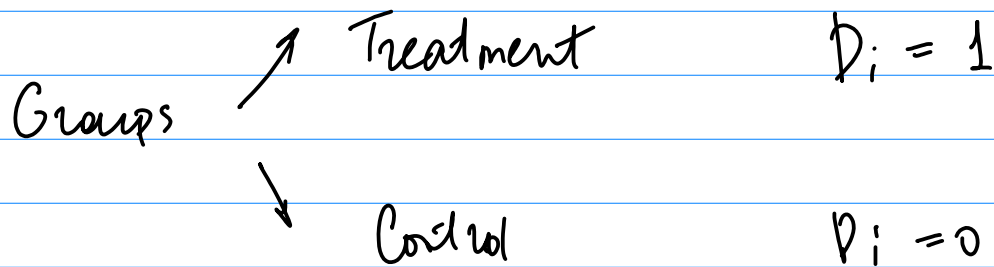


# Policy Evaluation



$$Y_i(1) - Y_i(0) \quad - \text{ ind. treatment effect}$$

$$ATE = E(Y_i(1) - Y_i(0))$$

$$Y_i = \begin{cases} Y_i(1), & D_i = 1 \\ Y_i(0), & D_i = 0 \end{cases}$$

$$Y_i = Y_i(0) + D_i \cdot (Y_i(1) - Y_i(0))$$

$$\begin{aligned} & E(Y_i | D_i = 1) - E(Y_i | D_i = 0) = \\ &= E(Y_i(1) | D_i = 1) - E(Y_i(0) | D_i = 0) = \\ &= E(Y_i(1) | D_i = 1) - E(Y_i(0) | D_i = 1) \\ &\quad + E(Y_i(0) | D_i = 1) - E(Y_i(0) | D_i = 0) = \\ &= E(Y_i(1) - Y_i(0) | D_i = 1) + \\ &\quad + [E(Y_i(0) | D_i = 1) - E(Y_i(0) | D_i = 0)] \end{aligned}$$

$$ATE_T = E(Y_i(1) - Y_i(0) | D_i = 1)$$

$$\text{Selection bias} = [E(Y_i(0) | D_i = 1) - E(Y_i(0) | D_i = 0)]$$

$$\text{Random assignment: } E(Y_i(0) | D_i = 1) =$$

$$= E(Y_i(0) | D_i = 0) = E(Y_i(0))$$

↳ no selection bias  $\Rightarrow$

$$ATE_T = E(Y_i | D_i = 1) - E(Y_i | D_i = 0)$$

$$\hat{ATE_T} = \bar{Y}_1 - \bar{Y}_0$$

$$\hat{Y}_i = \hat{\beta}_1 + \hat{\beta}_2 \cdot D_i$$

$$\hat{\beta}_2 = \bar{Y}_1 - \bar{Y}_0$$

~~Difference~~ in diff (DID)

$$Y_i = \alpha_s + \mu_t + \delta \cdot D_i + \epsilon_i$$

$\alpha_s$  - state effect

$\alpha_0$  - contr.

$\alpha_1$  - treat.

$\mu_t$  - time effect

$\mu_0$  - before

$\mu_1$  - after

$$Y_i = \alpha_s + \mu_t + \delta \cdot D_i + \epsilon_i$$

$$E(Y_i \mid S=1, t=0) = \mu_0 + \alpha_1$$

$$E(Y_i \mid S=1, t=1) = \mu_1 + \alpha_1 + \delta$$

$$\Delta_{\text{TREAT}} = \mu_1 - \mu_0 + \delta$$

$$E(Y_i \mid S=0, t=0) = \mu_0 + \alpha_0$$

$$E(Y_i \mid S=0, t=1) = \mu_1 + \alpha_0$$

$$\Delta_{\text{CONTR}} = \mu_1 - \mu_0$$

$$\delta = \Delta_{\text{TREAT}} - \Delta_{\text{CONTR}}$$

$$\hat{\delta} = [\bar{Y}_{t,A} - \bar{Y}_{t,B}] - [\bar{Y}_{c,A} - \bar{Y}_{c,B}]$$

$$\Delta Y_i = \beta_0 + \delta \cdot D_i + u_i$$

$$\delta Y_i = Y_{i1} - Y_{i0}$$

# Matching

Treatment

Control

"green" bonds

"brown" bonds

## I) Simple Matching

$$\Delta^M = \sum_k w_k (\bar{y}_{1,k} - \bar{y}_{0,k})$$

$w_k$  - share of objects in  $k$ th group

Alternative:

$$\Delta^M = \frac{1}{N_T} \sum (y_i - \frac{1}{N_{c,i}} \sum_{j \in (D=0)} y_j)$$

$N_T$  - # in Treatment group

$N_{c,i}$  - # obs in  $c_{th}$  part  
of control group for  $i$ th obs.

## II) Nearest - neighbour matching

$$A_i = \{ j \mid \min_j \|x_i - x_j\| \}$$

