Topics in Applied Econometrics

Difference-in-differences

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How to tackle an empirical project

1. What causal effects are we interested in?
2. What ideal experiment would capture this effect?
3. What is our identification strategy?
4. What is our mode of statistical inference?

Empirical setting into research design

- So far, we have compared treated to untreated or control units
- Another source of information: treated units *before treatment*
- *Example:* unemployment insurance
  - What is the effect of UI benefits on reemployment outcomes?
  - Compare unemployed to current workers
  - Compare unemployed to their past, working selves

Treatment timing

- Treatment happens at time t
- Potential outcomes are now Y_{1it}, Y_{0it}, Y_{1it-1}, Y_{0it-1}
- What is the effect of the treatment?
- To identify ATE, we need assumptions on the two counterfactual outcomes
- Parallel trends assumption
  - Without treatment, eventually treated units would have followed the same trend

$$\mathbb{E}(Y_{0it} \mid D_i = 1) = \mathbb{E}(Y_{0it-1} \mid D_i = 1) + \mathbb{E}(Y_{0it} \mid D_i = 0) - \mathbb{E}(Y_{0it-1} \mid D_i = 0)$$

Treatment effects

- What is the effect of the treatment?
- Parallel trends tell us the counterfactual outcome for the treated
- So we can't identify ATE, but we can identify... ATET!

$$
\begin{aligned}
ATET &= \mathbb{E}(Y_{1it} - Y_{0it} \mid D_i = 1) \\
&= \mathbb{E}(Y_{1it} \mid D_i = 1) - \mathbb{E}(Y_{0it} \mid D_i = 1) \\
&= \mathbb{E}(Y_{1it} \mid D_i = 1) - \left[\mathbb{E}(Y_{0it-1} \mid D_i = 1) + \mathbb{E}(Y_{0it} \mid D_i = 0) - \mathbb{E}(Y_{0it-1} \mid D_i = 0)\right] \\
&= \mathbb{E}(Y_{it} \mid D_i = 1) - \left[\mathbb{E}(Y_{it-1} \mid D_i = 1) + \mathbb{E}(Y_{it} \mid D_i = 0) - \mathbb{E}(Y_{it-1} \mid D_i = 0)\right]
\end{aligned}
$$

Validity the parallel trends assumption

- At its core, parallel trends cannot be proved
  - Cf. fundamental problem of causal inference
- However, arguments for parallel trends can be made
- E.g., long parallel pre-trends
- Longitudinal data are key