# Topics in Applied Econometrics

## Imperfect compliance

Attila Gyetvai

Duke Economics
Summer 2020

# 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?

# Treatment status vs. assignment

- Not everyone is treated who is supposed to be
- We should separate treatment status $D$ from assignment to treatment $Z$
- $Z_i = 1$ if $i$ is assigned to be treated $/$ 0 if $i$ is not assigned to be treated
- Note: we haven't yet used the language "control groups"
  - Assignment to control can also be imperfect, just like assignment to treatment
  - Now we can formalize control units: $Z_i = 0$
  - We are typically interested in the difference between treated and untreated units, not treatment and control
  - If the takeup of the treatment is perfect, all control units are untreated
- However, treatment takeup is seldom perfect

# Treatment status vs. assignment (cont'd)

- We can think of treatment takeup analogously to potential outcomes: would the unit be treated if it is assigned to treatment?
- $D_{1i}$: treatment status of $i$ when assigned to treatment
- $D_{0i}$: treatment status of $i$ when assigned to control
- Observed treatment status:

$$D_i = \begin{cases} D_{1i} & \text{if } Z_i = 1 \\ D_{0i} & \text{if } Z_i = 0 \end{cases}$$

# Compliance types

- The two potential treatment statuses and the two assignments create a $2 \times 2$ matrix of compliance types

| | $D_{0i} = 1$ | $D_{0i} = 0$ |
|---|---|---|
| $D_{1i} = 1$ | always-takers | compliers |
| $D_{1i} = 0$ | defiers | never-takers |

- In an ideal experiment, we only have compliers
- Also, we typically rule out defiers

# Observing compliance types

- Which compliance types can we observe in the data?
- $2 \times 2$ matrix of compliance types by treatment status and assignment to treatment (no defiers)

| | $Z_i = 1$ | $Z_i = 0$ |
|---|---|---|
| $D_i = 1$ | compliers / always-takers | always-takers |
| $D_i = 0$ | never-takers | compliers / never-takers |

# Potential outcomes revisited

- Potential outcomes can also be thought of in this matrix form
- $i$'s outcome if their assignment is $Z_i$ and treatment status is $D_i$

| | $Z_i = 1$ | $Z_i = 0$ |
|---|---|---|
| $D_i = 1$ | $Y_{1i}(1)$ | $Y_{1i}(0)$ |
| $D_i = 0$ | $Y_{0i}(1)$ | $Y_{0i}(0)$ |

- In short: $Y_{1i}(Z_i)$, $Y_{0i}(Z_i)$

# What can we learn with imperfect compliance?

- We still can compare outcomes of treated vs. untreated units
- . . . but we can also compare outcomes of units assigned to treatment vs. control

**Intent-to-treat effect (ITT)**

$$ITT = \mathbb{E}(Y_i \,|\, Z_i = 1) - \mathbb{E}(Y_i \,|\, Z_i = 0)$$

- In some settings, ITT is more important than ATE
- *Example:* mosquito nets (inspired by Cohen and Dupas, 2010, QJE)
  - Imagine that we equip some Kenyan households with mosquito nets to fend off bugs spreading malaria
  - Even if some households reject the donation, they benefit from an overall decrease of malaria cases in the area

# Treatment effect among compliers

- The assumptions behind ATE are sometimes unlikely to hold
- However, under a set of milder assumptions we can identify the effect among compliers, called LATE

**Local average treatment effect (LATE)**

$$LATE = \mathbb{E}(Y_{1i} - Y_{0i} \,|\, D_{1i} = 1, D_{0i} = 0)$$

  - "Local:" in the neighborhood of switching from untreated to treated, for those who comply

- However, we must be careful about LATE assumptions

# LATE assumptions

1. Independence: $(Y_{1i}, Y_{0i}, D_{1i}, D_{0i}) \perp\!\!\!\perp Z_i$
   - Assignment to treatment is independent of potential treatment status and potential outcomes
2. Exclusion: $Y_{1i}(1) = Y_{1i}(0)$ and $Y_{0i}(1) = Y_{0i}(0)$
   - Outcomes are only affected by treatment status, not assignment
3. Monotonicity: $D_{1i} \geq D_{0i}$
   - If $i$ is treated when not assigned, they must not be untreated when assigned
   - In other words: no defiers

- It is possible to further relax these assumptions

# Additional Slides

# References I

Cohen, J. and P. Dupas (2010). Free Distribution or Cost-Sharing? Evidence From a Randomized Malaria Prevention Experiment. *Quarterly Journal of Economics 125*(1), 1.