What to do with cross-sectional time-series data?

2023 CIS PhD winter retreat

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ETH zürich

Introduction

Outline

About me

St. Gallen, ETH, UC Berkeley, ...?

3rd year @ ICR

Nationalism, ethnic politics and sometimes partisanship

I love panel data < 3

Goals for today

Give you an overview of DiD literature

Discuss useful developments

Help you choose the right model for your data

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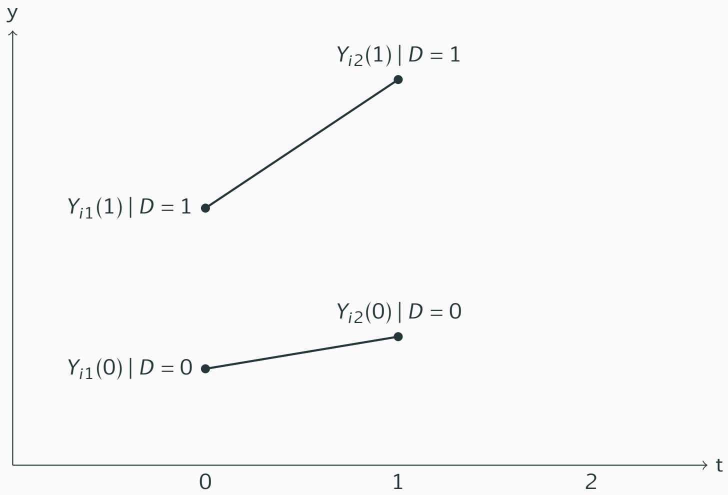
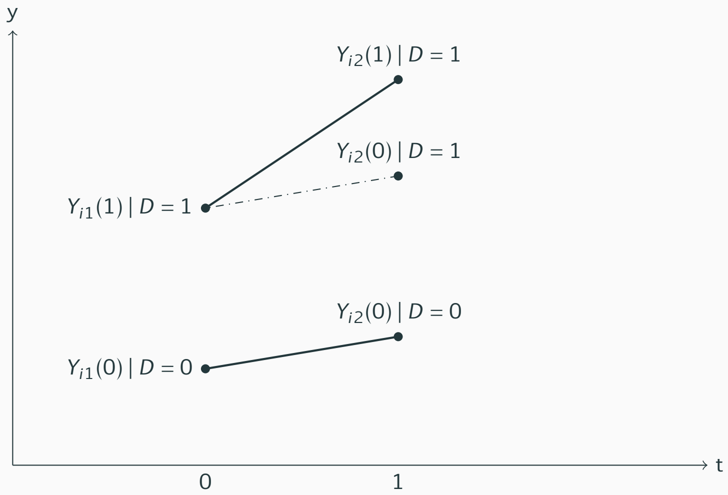
- Discuss useful developments
- Help you choose the right model for your data

Basic DiD Dust-Off

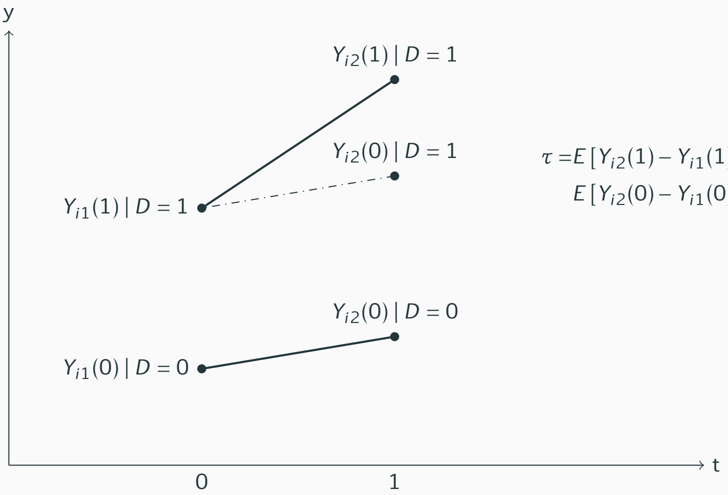
DiD setup



Counterfactual outcome

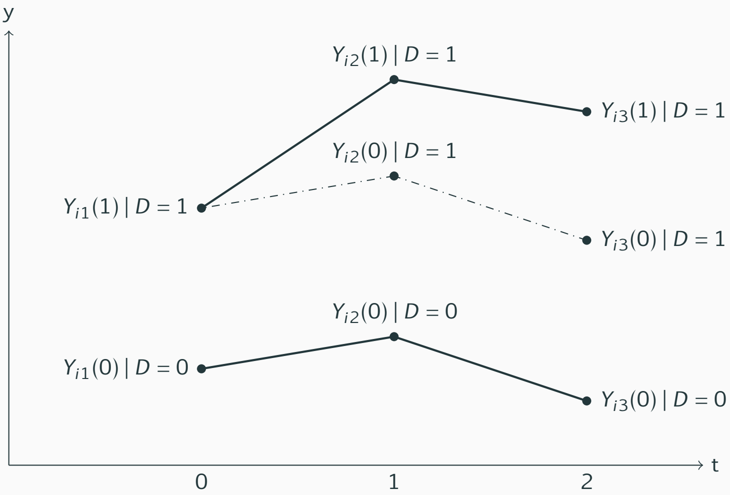


Inference with DiD



$$\tau = E[Y_{i2}(1) - Y_{i1}(1) \mid D = 1] - E[Y_{i2}(0) - Y_{i1}(0) \mid D = 0]$$

Three-period DiD



Inferential problem

Counterfactual outcomes as **missing data**

How to produce valid counterfactual outcome $\hat{Y}(0)|D = 1$?

$\rightarrow$ Find unbiased function $g(Y)$, s.t. $E[\hat{Y}(0)|D = 1 - Y(0)|D = 1] = 0$

$\rightarrow$ Exploit parallel trends assumption and SUTVA

Solutions in basic DiD

Traditionally, use linear $g(\dot{})$ on **all** within-individual variation.

All ITEs need to have same weight

Easily estimated with TWFE, DiM, first-difference

The brilliance of DiDs

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Limitations of basic DiD setting

¡1-¿

Mid 2010s

Econometricians question the validity of TWFE

Main culprit: DiD with staggered adoption.
(e.g., Goodman-Bacon 2021, Sun and Abrams 2021, Callaway and Sant'Anna 2021

→ Econometric lit. kinda left applied research behind . . .

Problems identified

Researchers refer to theory of 2-period DiD, do completely different things.

TWFE makes problematic comparisons.

Overall TWFE ATT is weighted average of cohort-specific ATTs.

→ Cohort-ATTs can get weird weights.

The breakthrough

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New Approaches to DiD

Example: Non-absorbing state treatment

- N. treated units > 1
  - T = 2
    - Classic DiD (Sec. 4.2)
  - T > 2
    - Non-absorbing state treatment
      - `GSC` (Sec. 4.43)
      - `fect` (Sec. 4.42)
      - `PanelMatch` (Sec. 4.43)
    - Absorbing-state treatment
      - Staggered treatment
        - `did`, `did2s`, `didimputation`, `DRDID`, `fixest`, `wfe` (Sec. 4.3.1-2)
      - Contemporaneous treatment
        - Classic DiD with multiple periods (Sec 4.3.1)
- N. treated units = 1
  - SCM (Sec. 4.1)

Go-to packages in (early) 2023

Staggered DiD settings

`did` package

Non-absorbing state DiDs

`felm` package

`PanelMatch` package

```r
# Load packages
library(tidyverse)
library(fixest)
library(did)
library(fect)
library(PanelMatch)
```

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- `did` package

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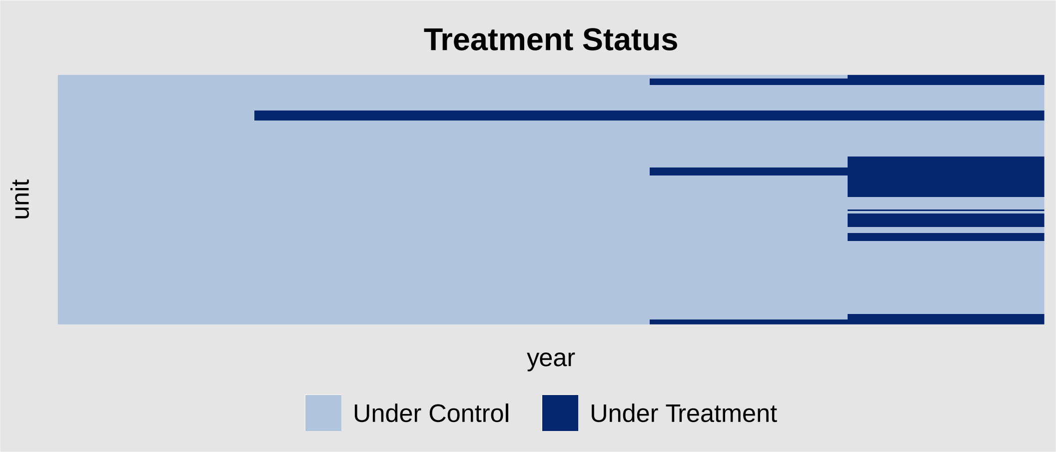

Example: Staggered treatment

```r
# Fit models
mod_twfe <- feols(lemp ~ post | countyreal + year, dat_did)
mod_nvt <- att_gt("lemp", "year", "countyreal", "first.treat",
                  data = dat_did, control_group = "nevertreated")
mod_nyt <- att_gt("lemp", "year", "countyreal", "first.treat",
                  data = dat_did, control_group = "notyettreated")
```

Example: Staggered treatment cont'd

```
# Compare estimates
data.frame(twfe = mod_twfe$coefficients,
           "did never" = aggte(mod_nvt, type = "simple")$overall.att,
           "did notyet" = aggte(mod_nyt, type = "simple")$overall.att)
```

```
##             twfe   did.never  did.notyet
## post -0.03654894 -0.03995128 -0.03976363
```

Insights

TWFE's bias is generally conservative

Example: Staggered treatment cont'd

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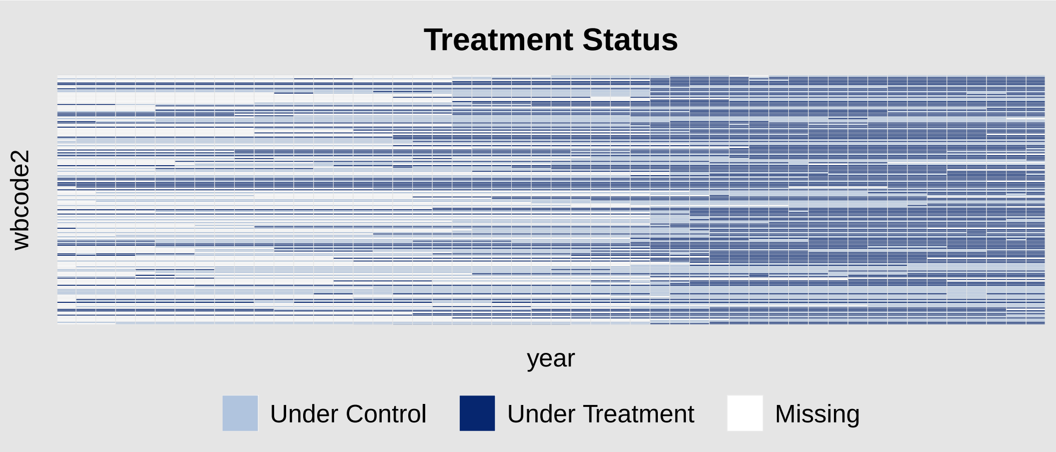

Example: Non-absorbing state treatment

```r
# Fit baseline model
mod_twfe <- feols(y ~ dem | wbcode2 + year, dat_dem)

# Fit other models
mod_ife <- fect(y ~ dem , dat_dem, index = c("wbcode2", "year"), se = F,
                method = "ife", na.rm = T)
mod_mc <- fect(y ~ dem , dat_dem, index = c("wbcode2", "year"), se = F,
               method = "mc", na.rm = T)
matched <- PanelMatch(lag = 5, lead = 0:5, unit.id = "wbcode2", time.id = "year",
                      covs.formula = ~I(lag(y, 1:4)),
                      treatment = "dem", outcome.var = "y", qoi = "att",
                      data = dat_dem, refinement.method = "mahalanobis")
mod_pm <- PanelEstimate(matched, dat_dem, pooled = T)
```

Example: Non-absorbing state treatment cont'd

```
# Compare estimates
data.frame(twfe = as.numeric(mod_twfe$coefficients[1]),
           "fect ife" = as.numeric(mod_ife$att.avg),
           "fect mc" = as.numeric(mod_mc$att.avg),
           "panelmatch" = as.numeric(summary(mod_pm)$summary[, 1]))
```

```
## Weighted Difference-in-Differences with Mahalanobis Distance
## Matches created with 5 lags
##
## Standard errors computed with 1000 Weighted bootstrap samples
##
## Estimate of Average Treatment Effect on the Treated (ATT) by Period:
##        twfe fect.ife fect.mc panelmatch
## 1 -10.11222 1.214884 2.08486    1.84098
```

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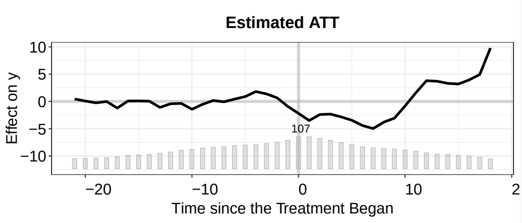

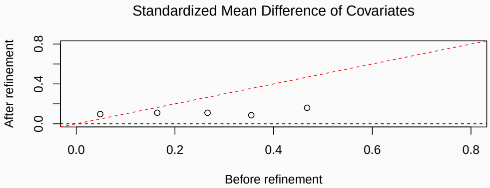

Your Turn!

Tell us your data struggles

Do you work with TSCS data?

Have you encountered limitations in TWFE models?

Has the absence of methods held you from researching sth?

...

Wrap-up

DiD as prediction exercise

Problems with estimation led to rethink DiD

Counterfactual outcomes as **non-linear prediction task**

$\longrightarrow$ Generalized synthetic control

Counterfactual outcomes as **missing data**

$\longrightarrow$ Matrix completion method

Counterfactual outcomes as **matching problem**

$\longrightarrow$ PanelMatch method

Outcome of the literature

Different perspectives led to different solutions to problems.

Broad set of concrete tools to apply DiD logic in broad set of cases.

Great set of R packages!

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Debate: Let's talk causality!

How causality is often discussed

Your X is not exogenous to Y: I don't believe you.

There might be confounders: I don't believe you.

$\rightarrow$ If a statistic is not **unbiased**, it might be anything.

A better way of discussing causality (?)

Your estimate is confounded: What is the chance that your results have another sign?

Your X is not exogenous: Are you sure the variation means what you argue?

What kind of bias do you have, and what does it tell on the "true" τ?

$\rightarrow$ Focus on substantive meaning of estimates and biases!

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