Two-way Fixed Effects and Event Studies

Ian McCarthy | Emory University
Workshop on Causal Inference with Panel Data

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The Idea of TWFE

What is TWFE?

Want to estimate δ:

$$y_{it} = \alpha + \delta D_{it} + \gamma_i + \gamma_t + \varepsilon,$$

where γ_i and γ_t denote a set of unit i and time period t dummy variables (or fixed effects).

TWFE in Practice

```
library(fixest)
twfe ← feols(perc_unins ~ expand | State + year, data=reg.dat)
twfe$coeftable
```

```
##               Estimate  Std. Error  t value     Pr(>|t|)
## expandTRUE -0.01840269 0.003702314 -4.97059 1.220461e-06
```

Event Studies

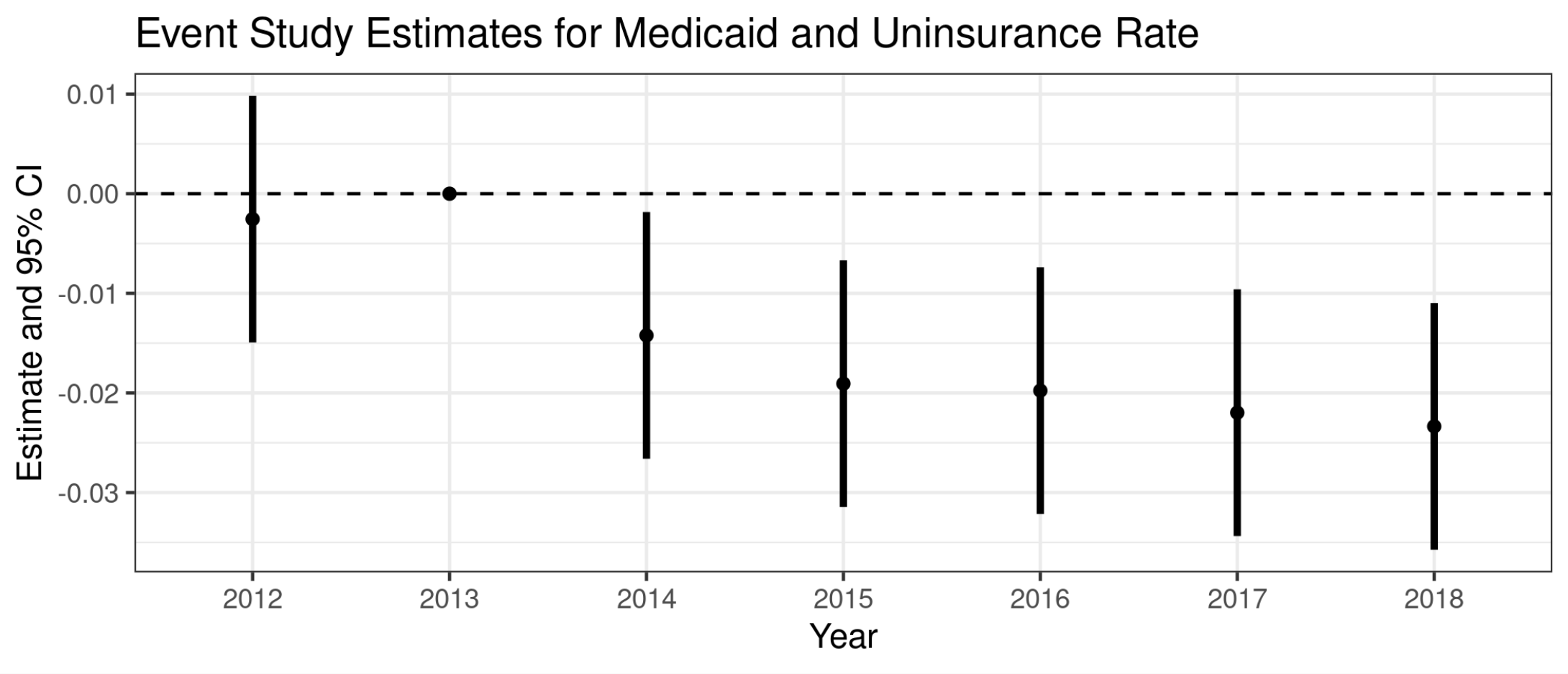
What is an event study?

Estimate something akin to...

$$y_{it} = \gamma_i + \gamma_t + \sum_{\tau=-q}^{-1} \delta_\tau D_{i\tau} + \sum_{\tau=0}^{m} \delta_\tau D_{i\tau} + x_{it} + \epsilon_{it},$$

where q captures the number of periods before the treatment occurs and m captures periods after treatment occurs.

How to do an event study?



Seeing things in action

Things to address

1. "Event time" vs calendar time
2. Define baseline period
3. Choose number of pre-treatment and post-treatment coefficients

Event time vs calendar time

Essentially two "flavors" of event studies

1. Common treatment timing
2. Differential treatment timing

Define baseline period

- Must choose an "excluded" time period (as in all cases of group dummy variables)
- Common choice is $t = -1$ (period just before treatment)
- Easy to understand with calendar time
- For event time...manually set time to $t = -1$ for all untreated units

Number of pre-treatment and post-treatment

- On event time, sometimes very few observations for large lead or lag values
- Medicaid expansion example: Late adopting states have fewer post-treatment periods
- Norm is to group final lead/lag periods together

Common treatment timing

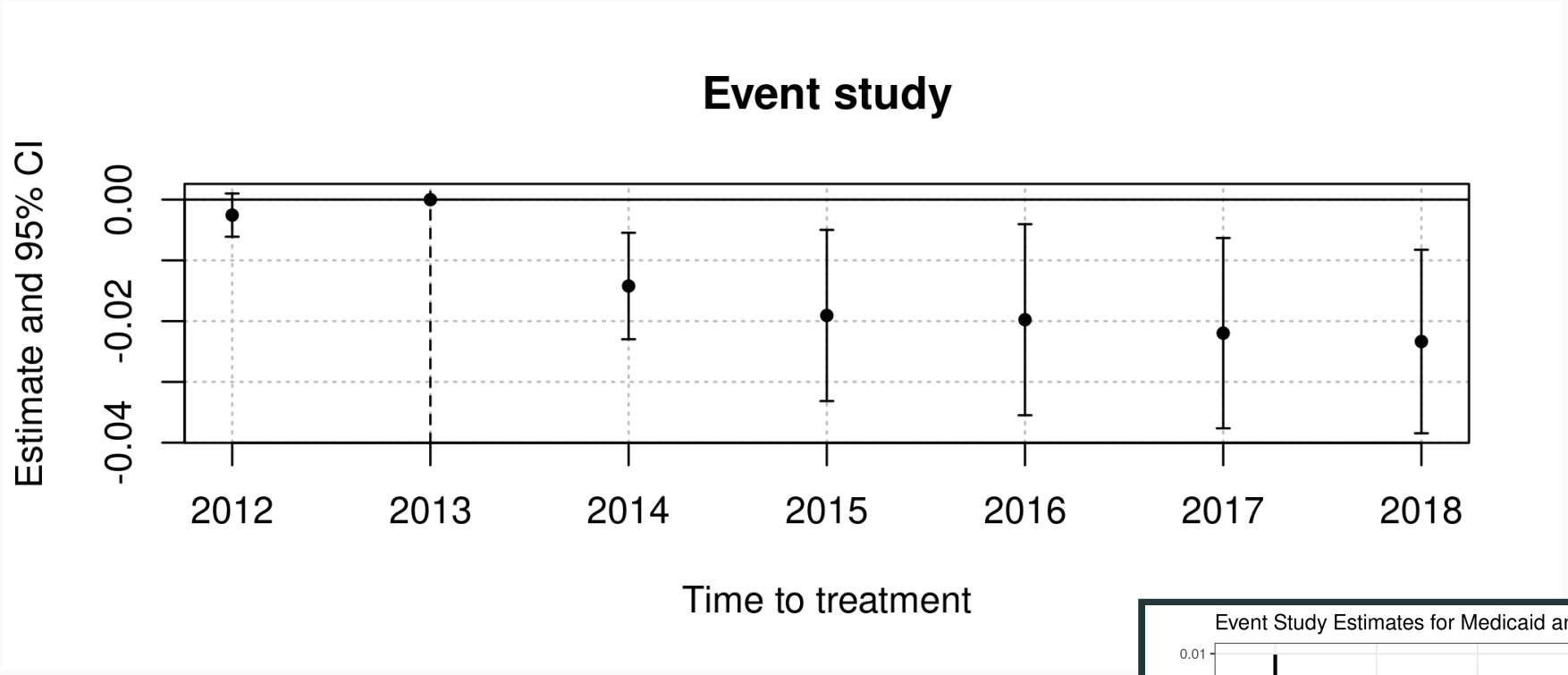
Stata

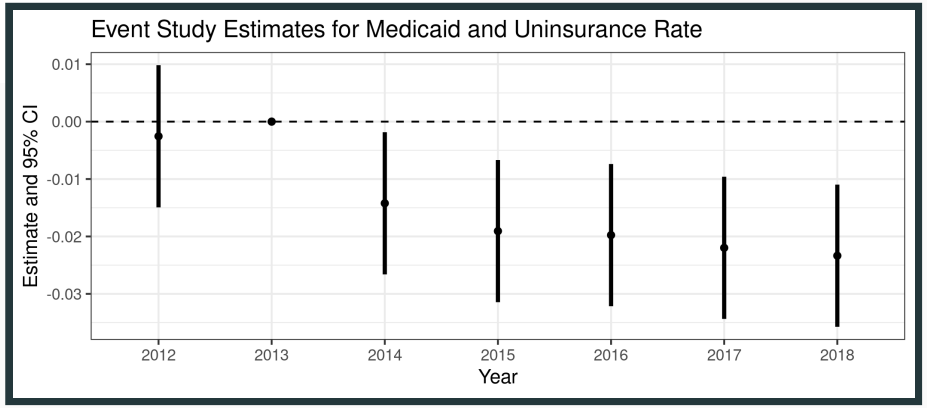
```
ssc install reghdfe

insheet using "https://raw.githubusercontent.com/imccart
gen perc_unins=uninsured/adult_pop
keep if expand_year=="2014" | expand_year=="NA"
drop if expand_ever=="NA"
gen post=(year>=2014)
gen treat=(expand_ever=="TRUE")
gen treat_post=(expand=="TRUE")

reghdfe perc_unins treat##ib2013.year, absorb(state)
gen coef = .
gen se = .
forvalues i = 2012(1)2018 {
    replace coef = _b[1.treat#`i'.year] if year == `i'
    replace se =  se[1.treat#`i'.year] if year == `i'
```

R

```
library(tidyverse)
library(modelsummary)
library(data.table)
library(fixest)
mcaid.data <- read_tsv("https://raw.githubusercontent.co
reg.dat <- as.data.table(mcaid.data) %>%
  filter(expand_year==2014 | is.na(expand_year), !is.na(
  mutate(perc_unins=uninsured/adult_pop,
         post = (year>=2014),
         treat=post*expand_ever)

mod.twfe <- feols(perc_unins~i(year, expand_ever, ref=20
                  cluster=~State,
                  data=reg.dat)
iplot(mod.twfe,
      ylab = 'Time to treatment'
```

Comparing results





Differential treatment timing

Stata

```
ssc install reghdfe

insheet using "https://raw.githubusercontent.com/imccart
gen perc_unins=uninsured/adult_pop
drop if expand_ever=="NA"
replace expand_year="." if expand_year=="NA"
destring expand_year, replace
gen event_time=year-expand_year
replace event_time=-1 if event_time==.

forvalues l = 0/4 {
    gen L`l'event = (event_time==`l')
}
forvalues l = 1/2 {
    gen F`l'event = (event_time==-`l')
}
```

R

```
library(tidyverse)
library(modelsummary)
library(data.table)
library(fixest)
mcaid.data <- read_tsv("https://raw.githubusercontent.co
reg.dat <- as.data.table(mcaid.data) %>%
  filter(!is.na(expand_ever)) %>%
  mutate(perc_unins=uninsured/adult_pop,
         post = (year>=2014),
         treat=post*expand_ever,
         time_to_treat = ifelse(expand_ever==FALSE, 0, y
         time_to_treat = ifelse(time_to_treat < -3, -3,

mod.twfe <- feols(perc_unins~i(time_to_treat, expand_eve
                  cluster=~State,
                  data=reg.dat)
```

What are we estimating?

Problems with TWFE

- Recall goal of estimating ATE or ATT
- TWFE and 2x2 DD identical with homogeneoues effects and common treatment timing
- Otherwise...TWFE is biased and inconsistent for ATT

Inutition

- OLS is a weighted average of all 2x2 DD groups
- Weights are function of size of subsamples, size of treatment/control units, and timing of treatment
- Units treated in middle of sample receive larger weights
- Prior-treated units act as controls for late-treated units

Just the length of the panel will change the estimate!

Does it really matter?

- Definitely! But how much?
- Large treatment effects for early treated units could reverse the sign of final estimate
- Let's explore this nice Shiny app from Kyle Butts: Bacon-Decomposition Shiny App.