Quant II

Lab 7: Synthetic control

Giacomo Lemoli

March 30, 2023

Today's plan

- DiD with staggered timing (continued): Sun & Abraham
- Synthetic control: `fect`

Sun & Abraham

- Similar results to other papers, but special focus on event-studies
- Event-study regression:

$$Y_{g,t} = \gamma_g + \lambda_t + \sum_{l=-K, l\neq -1}^{L} \hat{\beta}_l \mathbb{I}\{F_g = t - l\} + \varepsilon_{g,t}$$

- For $l \geq 2$: $\hat{\beta}_l$ is the cumulative effect of $l+1$ treatment periods
- For $l \leq -2$: $\hat{\beta}_l$ is a placebo coefficient (parallel trends test)

Sun & Abraham

- Main result: the regression coefficient $\hat{\beta}_l$ can be decomposed in two weighted averages
  - Weighted average of group TEs at l, with possibly negative weights if the TEs vary across groups at l
  - Weighted average of group and period TEs for the other periods $l' \neq l$, non-zero if TEs vary across groups at l'
- "New" implication: the second weighted average contaminates also pre-treatment placebo coefficients
- Under TE heterogeneity, placebo coefficients cannot reliably inform about PT

Sub & Abraham

- Solution: very close to Callaway & Sant'Anna
- Estimate the individual $ATT_{g,t}$ using "clean" controls (never-treated or last-treated)
  - With never-treated, S&A is equivalent to C&S
  - Estimator a bit less general than C&S
- Implemented in `fixest` through the `sunab` function

Sun & Abraham

- Back to Daniele & Geys (2015): the effect of local government dissolution on politicians' quality

```
library(tidyverse); library(haven); library(fixest)

dat <- read_dta("Organized Crime and Political Quality.dta")

dat <- mutate(dat, befcomgeneral_recode=(1-befcomgeneral)*mafiaben)

# Group variable
dat <- dat %>% group_by(desc_comune) %>%
  mutate(group = case_when(mafiaben==1 ~ min(year[befcomgeneral_recode==1]),
                           mafiaben==0 ~ 0)) %>%
  ungroup()
```

Sun & Abraham

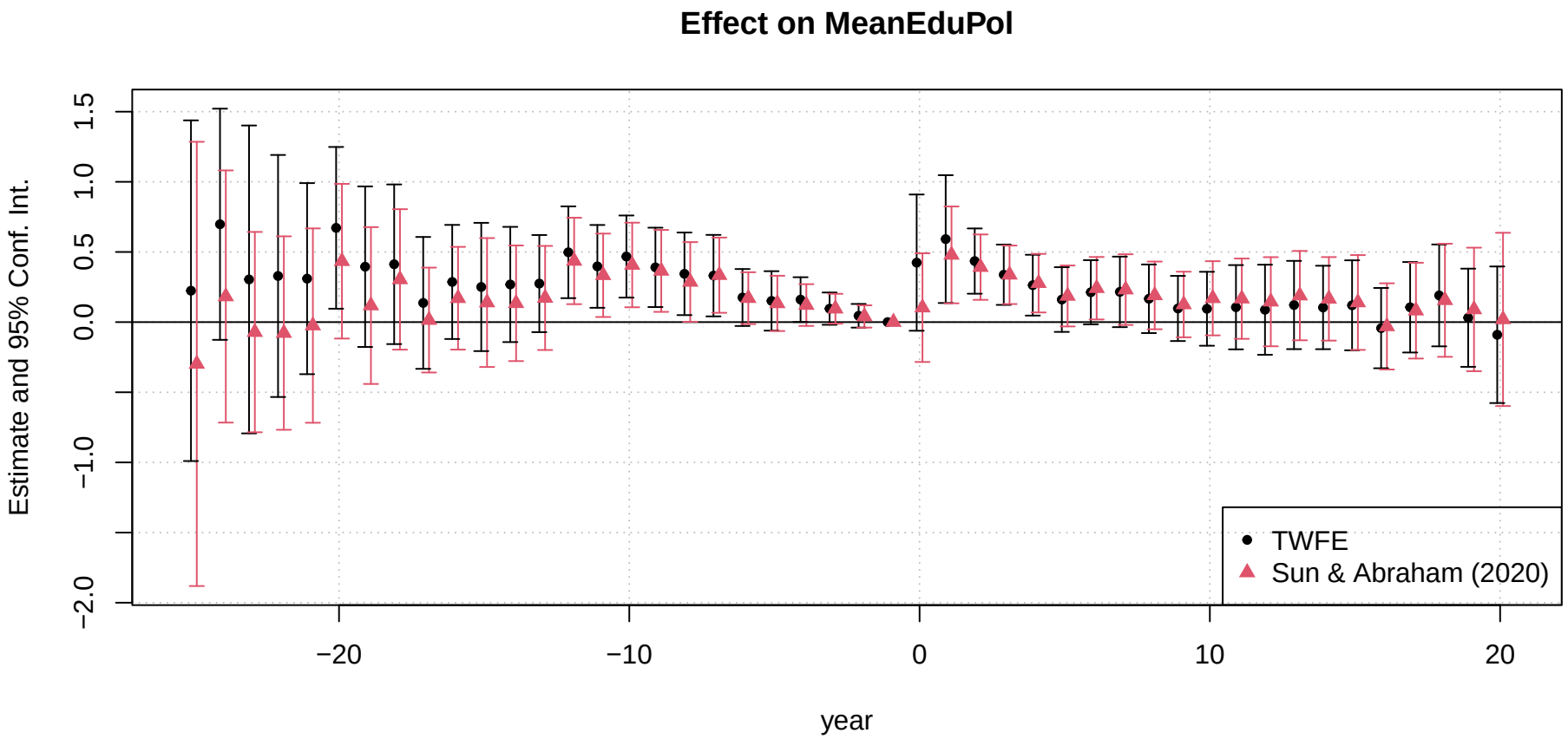
```
# Indicator for time to treatment
dat <- dat %>% mutate(time_to_treatment =
                        case_when(mafiaben==1 ~ (year-group),
                                  mafiaben==0 ~ -99))

# TWFE
fit_tw <- feols(MeanEduPol ~ i(time_to_treatment, ref=c(-1,-99)) | ID_municip + year, dat)

# Sun & Abraham
fit_sa <- feols(MeanEduPol ~ sunab(group, year) | ID_municip + year, dat)
```

Sun & Abraham

```
iplot(list(fit_tw, fit_sa)); legend("bottomright", col = c(1,2), pch = c(20, 17),
       legend = c("TWFE", "Sun & Abraham (2020)"))
```



Synthetic control

- Last lecture: SC for causal inference with one treated unit
- Next lecture: SC for causal inference with multiple treated units
    - Can be used in cases with staggered (or not) adoption
- Today: preview + packages

Synthetic control

- Discussion based on Liu, Wang & Xu (2022)
- Basic idea: use weighted averages of control observations to inpute the counterfactual trend among the treated
  - "Counterfactual estimators"
- Only use the control units at the modeling stage, so no "forbidden comparisons"
- Illustration with `fect` package (Liu, Wang & Xu)
  - Implements 3 counterfactual estimators
  - Implements placebo tests for pre-trends and other hypotheses

Synthetic control

Application: Hainmueller & Hangartner (2019)

Does Direct Democracy Hurt Immigrant Minorities? Evidence from Naturalization Decisions in Switzerland

Jens Hainmueller Stanford University
Dominik Hangartner ETH Zurich & London School of Economics

Abstract: *Do minorities fare worse under direct democracy than under representative democracy? We provide new evidence by studying naturalization requests of immigrants in Switzerland that were typically decided with referendums in each municipality. Using panel data from about 1,400 municipalities for the 1991–2009 period, we exploit Federal Court rulings that forced municipalities to transfer the decisions to their elected municipality councils. We find that naturalization rates surged by about 60% once politicians rather than citizens began deciding on naturalization applications. Whereas voters in referendums face no cost of arbitrarily rejecting qualified applicants based on discriminatory preferences, politicians in the council are constrained to formally justify rejections and may be held accountable by judicial review. Consistent with this mechanism, the increase in naturalization rates caused by switching from direct to representative democracy is much stronger for more marginalized immigrant groups and in areas where voters are more xenophobic or where judicial review is more salient.*

Synthetic control

```r
# Data preparation
o.data <- read_dta("hh2015.dta")
dim <- nrow(o.data)
# Outcome variable
Y <- "nat_rate_ord"
# Treatment variable
D <- "indirect"
# Unit indicator
unit <- "bfs"
# Period indicator
period <- "year"
# Fixed effects level
FE <- c(unit, period)
# Cluster
cl <- unit
# Seed
seed <- 1453
# Clean from NAs
d <- o.data[complete.cases(o.data[,c(Y,D,FE)]), c(Y,D,FE)]
# Some more preparation
FEct.formula <- as.formula(paste0(Y, "~", D))
ylimit <- c(-3, 6)
elimit <- c(-0.4, 0.4)
nboots <- 1000
```

Synthetic control

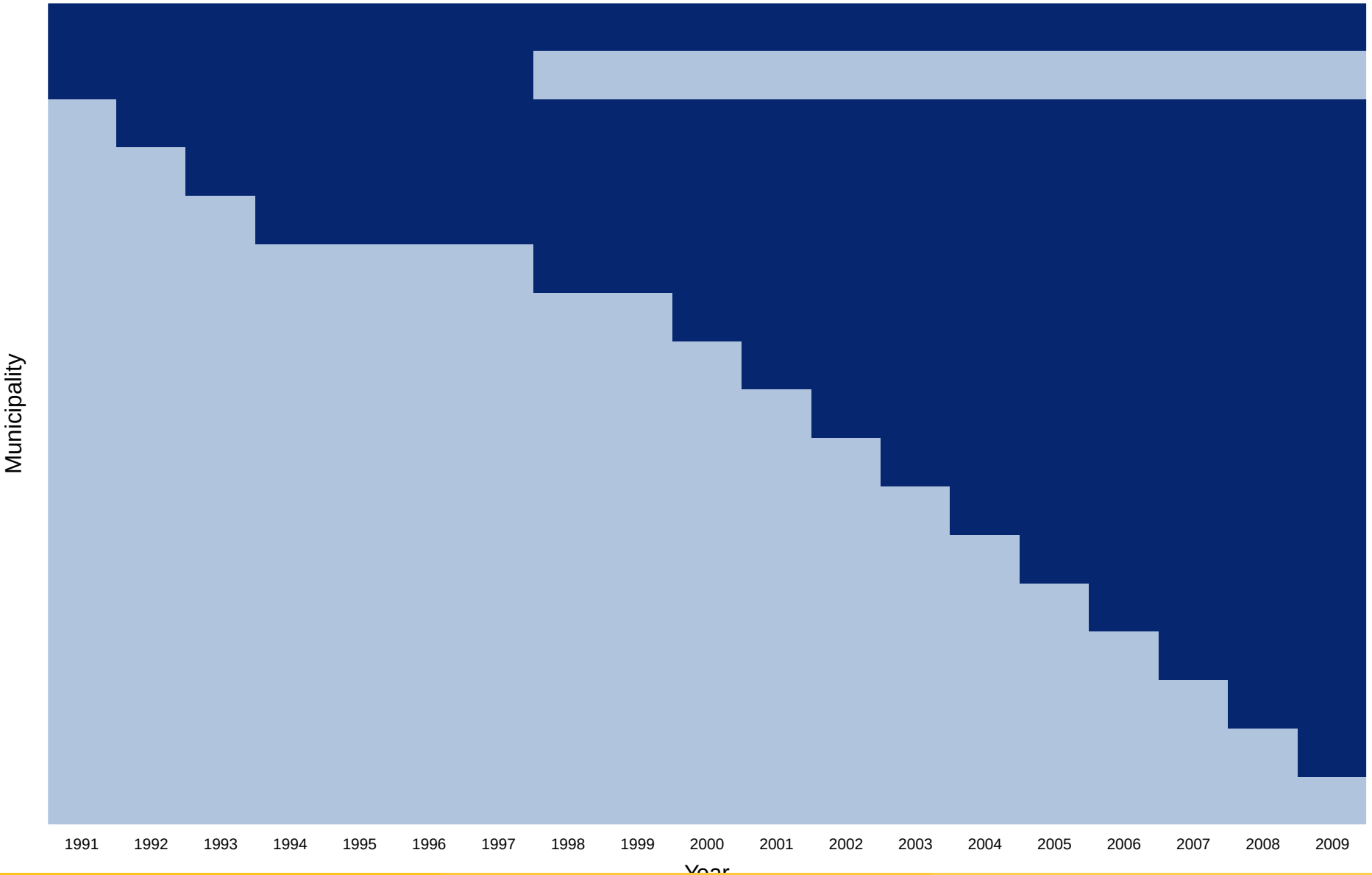
- Plot the treatment sequence with `panelView`

```
library(panelView)

pv <- panelview(FEct.formula,
                data = d,
                index = c("bfs","year"), by.timing = TRUE,
                axis.lab = "time", xlab = "Year", ylab = "Municipality", main = "", gridOff = TRUE,
                background= "white", legend.labs = c("Direct Democracy", "Indirect Democracy"))
```

Synthetic control

```
## Specified labels in the order of: Under Control, Under Treatment.
```



Synthetic control

- FEct

$$Y_{it}(0) = \mathbf{X}'_{it}\beta + \alpha_i + \xi_t + \varepsilon_{it}$$

```
library(fect)
out.fect.p <- fect(formula = as.formula(FEct.formula),
                   data = d, method = "fe",
                   index=FE, tol = 1e-5, se = 1, nboots = nboots, r = 0,
                   CV = FALSE, force = "two-way", parallel = 1,
                   placeboTest = 1, placebo.period = c(-2, 0))
```

Synthetic control

- IFEct

$$Y_{it}(0) = \mathbf{X}'_{it}\beta + \alpha_i + \xi_t + \lambda'_i f_t + \varepsilon_{it}$$

```
out.fect <- fect(formula = as.formula(FEct.formula),
                 data = d, method = "ife",
                 index=FE, tol = 1e-5, se = 1, nboots = nboots, loo = 1,
                 r = 0, CV = FALSE, force = "two-way", parallel = 1)
```

Synthetic control

- Matrix completion

$$\mathbf{Y(0)} = \mathbf{X}\beta + \mathbf{L} + \varepsilon$$

```
out.mc <- fect(as.formula(FEct.formula),
               data = d, method = "mc",
               index=FE, tol = 1e-3, se = TRUE, nboots = nboots,
               cv.prop = 0.1, cv.nobs = 3, cv.treat = 1, loo = 0,
               CV = TRUE, force = "two-way", parallel = 1)
```

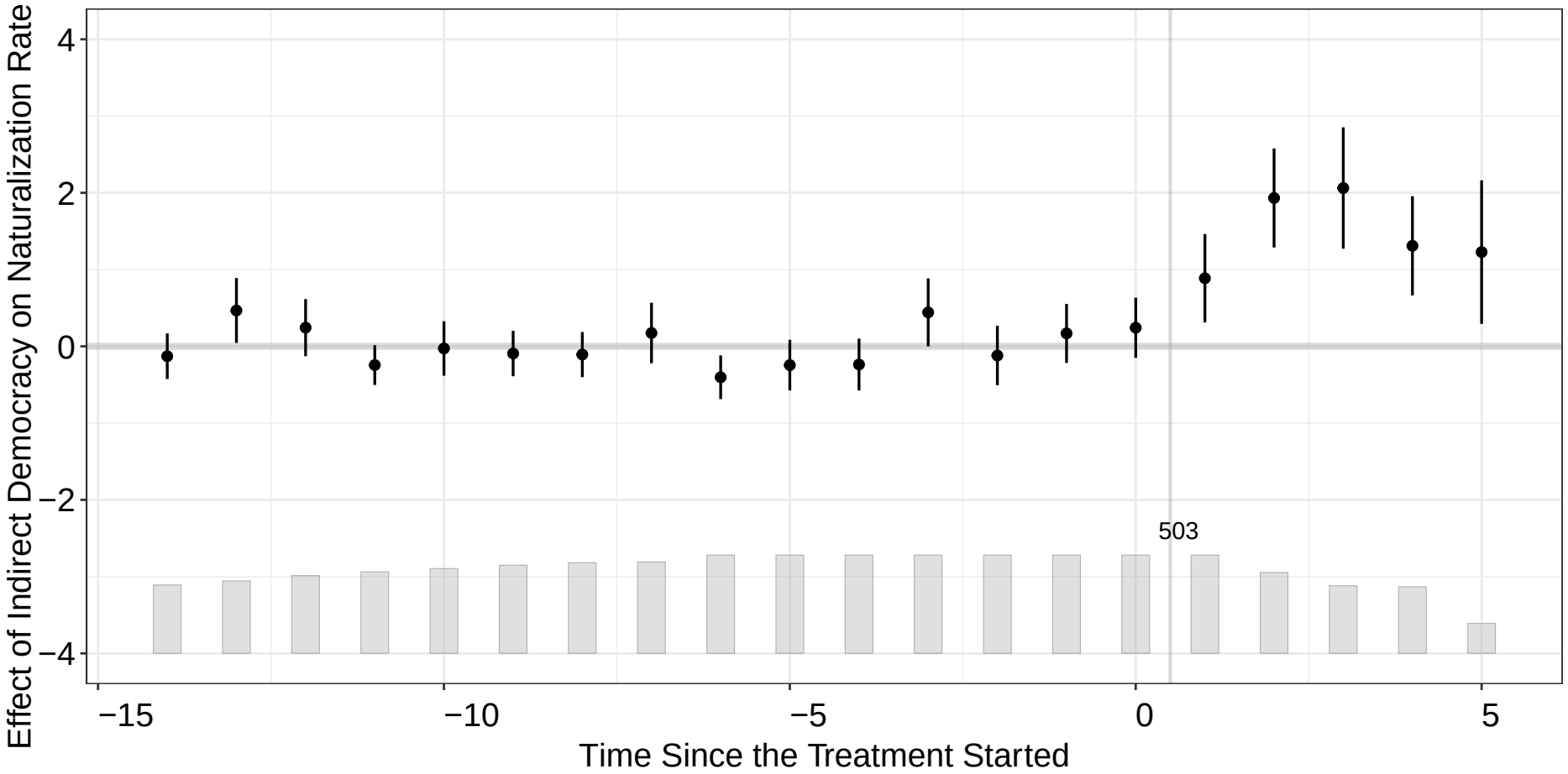
Synthetic control

- Plot the estimated effects

```
xlab <- "Time Since the Treatment Started"
d_ylim <- c(-4, 4)

p.gap <- plot(out.fect, type = "gap",
              ylab = "Effect of Indirect Democracy on Naturalization Rate (%)", ylim = d_ylim,
              xlim = c(-14,5), main = "", theme.bw = TRUE, xlab = xlab,
              p.value = TRUE, text.pos = c(-14.5,3))
```

Synthetic control

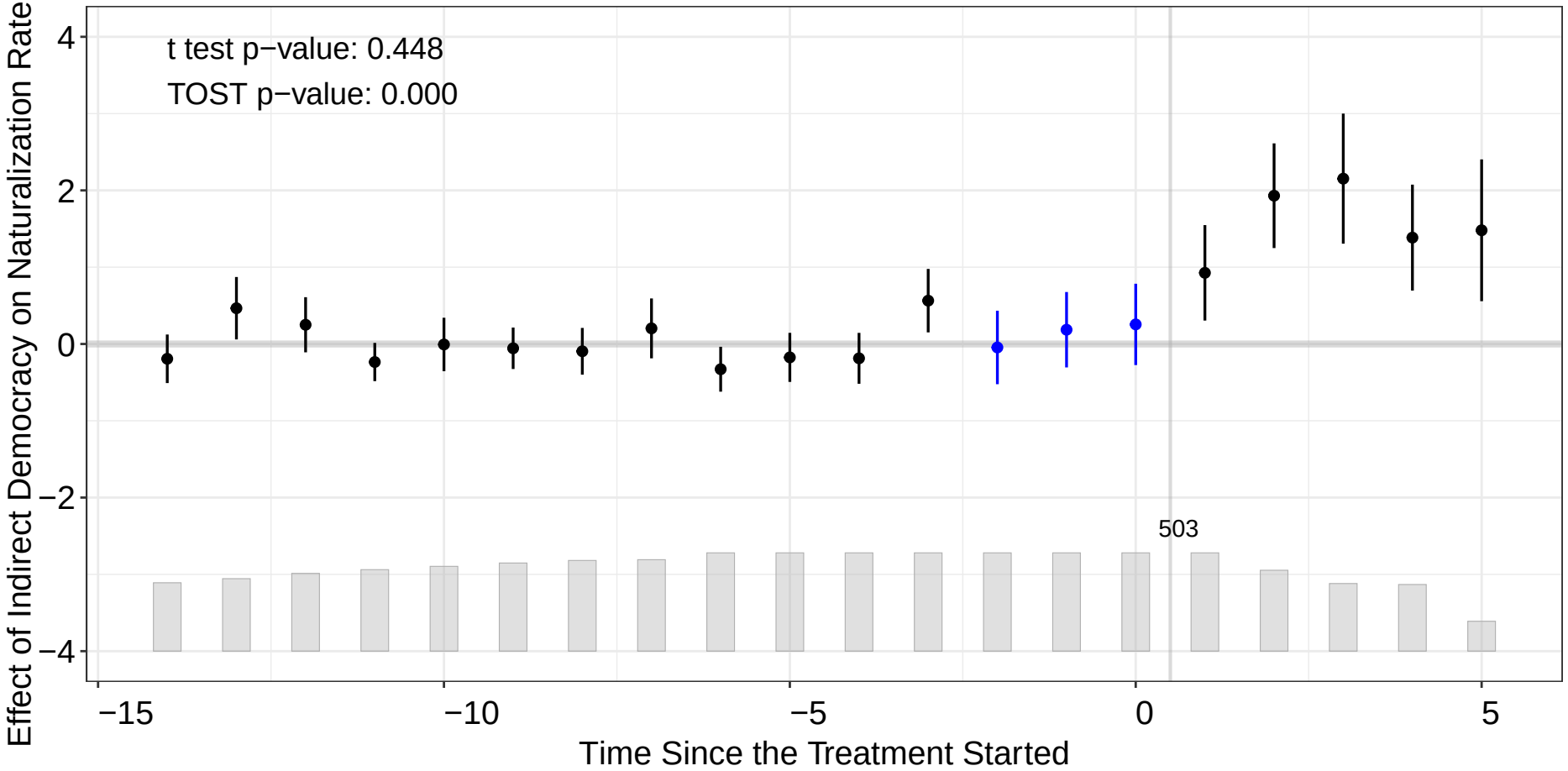


Synthetic controls

- Plot placebo test

```
p.placebo <- plot(out.fect.p, type = "gap",
                  ylab = "Effect of Indirect Democracy on Naturalization Rate (%)",
                  placeboTest = 1, placebo.period = c(-1, 0), xlab = xlab,
                  stats.labs = c("t test p-value","TOST p-value"), xlim = c(-14,5), ylim = d_ylim,
                  label.pos = c(-12.5, 3.8),
                  main = "", theme.bw = TRUE, show.stats = TRUE,
                  stats = c("placebo.p","equiv.p"))
```

Synthetic control



Synthetic control

- Plot equivalence test for pre-trends

```
p.equiv <- plot(out.fect, type = "equiv",
                ylab = "Average Prediction Error", ylim = d_ylim, xlim = c(-14,0),
                main = "", theme.bw = TRUE, xlab = xlab,
                stats.labs = c("F test p-value","TOST max p-value"), legendOff = TRUE, loo = 1)
```

Synthetic control