Práctica DID

Econometría - Doctorado en Ciencias Financieras

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Contents

Practice 1: Canonical DID estimation - manually using Stata

- The simplest way of calculating the DID estimator is to **manually take the difference in outcomes between treatment and control between the surveys.**
- We are using a subset of information from the Bangladesh Household Survey 1991–1998, conducted jointly by the Bangladesh Institute of Development Studies and the World Bank.
- **We are testing the impact of a microcredit program for females in Bangladesh on household per capita expenditure.** This analysis compares household consumption in 1991 (initial) and 1998 (final) using a DID approach.
- The information was collected at individual, household, and community levels.
- For practices 1, 2 and 3 we will be using the database from Khandker et al. (2011)
- The panel data is called *hh_9198.dta* and can be obtained in the following **Link.**

Variables descriptives

```
clear all

use "hh_9198_a.dta"

describe dfmfd lexptot91 lexptot98 lexptot9891, short
```

```
Variable      Storage   Display    Value
    name         type    format    label      Variable label
------------------------------------------------------------------------------------------------
dfmfd           byte    %8.0g                 HH has female microcredit participant: 1=Y, 0=N
lexptot91       float   %9.0g                * 1991 log of per capita expenditure
lexptot98       float   %9.0g                * 1998 log of per capita expenditure
lexptot9891     float   %9.0g                * difference between 98-91 per capita expenditure
```

DID Estimation using the Stata command `ttest`

- The Stata command `ttest` estimates the outcome variable difference *lexptot9891* and compares it for microcredit program participants and nonparticipants.
- In essence, **the command `ttest` creates a second difference of *lexptot9891* for those with dfmfd=1 (participant) and those with dfmfd=0 (nonparticipant).**
- This second difference gives the estimate of the impact of females' microcredit program participation on per capita expenditure.

```
clear all

use "hh_9198_a.dta"

ttest lexptot9891, by(dfmfd) // dfmfd = HH has female microcredit participant: 1=Y, 0=N

display ".2586952 - .1473188"
display .2586952 - .1473188
```

```
Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. err.   Std. dev.   [95% conf. interval]
---------+--------------------------------------------------------------------
       0 |     391    .1473188    .0269923    .5337372    .0942502    .2003873
       1 |     435    .2586952     .024194    .5046057    .2111432    .3062472
---------+--------------------------------------------------------------------
Combined |     826    .2059734     .018137    .5212616    .1703733    .2415735
---------+--------------------------------------------------------------------
    diff |           -.1113764      .03614               -.1823136   -.0404392
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -3.0818
H0: diff = 0                                     Degrees of freedom =      824

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0011         Pr(|T| > |t|) = 0.0021          Pr(T > t) = 0.9989

.2586952 - .1473188

.1113764
```

- The result shows that microcredit **program participation by females increases percapita consumption by 11.13 percent**
- Notice that the impact is significant.

Practice 2: Canonical DID estimation - Regression using Stata

- Instead of manually taking the difference of the outcomes, DID can be implemented using regression analysis.
- The DID estimate can be calculated from the following regression:

$$Y_{it} = \alpha + DD.T_i + \beta T_i + \delta t_i + \epsilon_{it}$$

- Where:
  - Y is the outcome variable.
  - T is the treatment variable.
  - t is a time dummy.
  - DD is the coefficient of the interaction of T and t; and gives the estimate of the impact of treatment.

```
clear all

use "hh_9198_b.dta"

describe lexptot year dfmfd98 dfmfdyr, short

reg lexptot year dfmfd98 dfmfdyr

test (dfmfdyr)
```

```
Variable      Storage   Display    Value
    name         type    format    label      Variable label
------------------------------------------------------------------------------------------------
lexptot         float   %9.0g                 * log of per capita expenditure (outcome variable)
year            byte    %8.0g                   Year of observation: 0=1991, 1=1998
dfmfd98         float   %9.0g                 *
dfmfdyr         float   %9.0g                 * interaction variable of treatment and time dummy.
                                                  1991 =0; 1998 =1

      Source |       SS           df       MS      Number of obs   =     1,652
-------------+----------------------------------   F(3, 1648)      =     32.18
       Model |  20.2263902         3  6.74213005   Prob > F        =    0.0000
    Residual |  345.321048     1,648  .209539471   R-squared       =    0.0553
-------------+----------------------------------   Adj R-squared   =    0.0536
       Total |  365.547438     1,651  .221409714   Root MSE        =    .45775

------------------------------------------------------------------------------
     lexptot | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |   .1473188   .0327386     4.50   0.000     .0831052    .2115323
     dfmfd98 |  -.1145671   .0318999    -3.59   0.000    -.1771358   -.0519984
     dfmfdyr |   .1113764   .0451133     2.47   0.014     .0228909    .1998619
       _cons |   8.310481   .0231497   358.99   0.000     8.265075    8.355887
------------------------------------------------------------------------------
```

```
 ( 1)  dfmfdyr = 0

       F(  1,  1648) =    6.10
            Prob > F =    0.0137
```

- The results show **the same impact of female participation in microfinance programs on households' annual total per capita expenditures as obtained in the previous exercise.**
- A basic assumption behind the simple implementation of canonical DID is that **other covariates do not change across the years.**
- But **if those variables do vary, they should be controlled for in the regression** to get the net effect of program participation on the outcome.
- So the regression model is extended to include other covariates that may affect the outcomes of interest:

```
Variable      Storage   Display    Value
    name         type    format    label      Variable label
------------------------------------------------------------------------------------------------
sexhead         byte    %8.0g                Gender of HH head: 1=M, 0=F
educhead        byte    %8.0g                Education of HH head: years
vaccess         byte    %8.0g                Village is accessible by road all year: 1=Y, 0=N

(sum of wgt is 1,644.45936635137)

Linear regression                               Number of obs     =      1,652
                                                F(6, 1645)        =      37.19
                                                Prob > F          =     0.0000
                                                R-squared         =     0.1811
                                                Root MSE          =     .45581

------------------------------------------------------------------------------
             |               Robust
     lexptot | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |   .1591163    .044822     3.55   0.000     .0712021    .2470305
     dfmfd98 |  -.1121909   .0356595    -3.15   0.002    -.1821336   -.0422481
     dfmfdyr |   .0880952   .0551336     1.60   0.110    -.0200442    .1962347
     sexhead |  -.0493514   .0575182    -0.86   0.391     -.162168    .0634651
    educhead |   .0501469    .004821    10.40   0.000     .0406909     .059603
     vaccess |  -.0007248   .0528859    -0.01   0.989    -.1044557    .1030061
       _cons |   8.270437   .0822923   100.50   0.000     8.109028    8.431845
------------------------------------------------------------------------------
```

- By holding other factors constant, **the impact of the microfinance programs has changed from significant to insignificant** (dfmfdyr = .08809; t = 1.60).

Practice 3: Checking Robustness with Fixed-Effects Regression - Using Stata´s command `xtreg`

- Another way to measure the DID estimate is to use a fixed-effects regression instead of ordinary least squares (OLS).
- **Fixed-effects regression** controls for household's unobserved and time-invariant characteristics that may influence the outcome variable.
- The `Stata´s` command `xtreg` is used to run fixed-effects regression. In particular, with the `fe` option, it fits fixed-effect models.

```
Panel variable: nh (strongly balanced)
 Time variable: year, 0 to 1
         Delta: 1 unit

note: dfmfd98 omitted because of collinearity.

Fixed-effects (within) regression               Number of obs     =      1,652
Group variable: nh                              Number of groups  =        826

R-squared:                                      Obs per group:
     Within  = 0.1450                                         min =          2
     Between = 0.0061                                         avg =        2.0
     Overall = 0.0415                                         max =          2

                                                F(2,824)          =      69.90
corr(u_i, Xb) = -0.0379                         Prob > F          =     0.0000

------------------------------------------------------------------------------
     lexptot | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |   .1473188   .0262266     5.62   0.000     .0958399    .1987976
     dfmfd98 |          0  (omitted)
     dfmfdyr |   .1113764     .03614     3.08   0.002     .0404392    .1823136
       _cons |   8.250146   .0127593   646.60   0.000     8.225101     8.27519
-------------+----------------------------------------------------------------
     sigma_u |  .38132289
     sigma_e |  .36670395
         rho |  .51953588   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(825, 824) = 2.14                     Prob > F = 0.0000
```

- Then, including other covariates in the regression, the fixed-effects model can be extended in the following way:

```
Panel variable: nh (strongly balanced)
 Time variable: year, 0 to 1
         Delta: 1 unit

note: dfmfd98 omitted because of collinearity.

Fixed-effects (within) regression               Number of obs     =      1,652
```

```
Group variable: nh                              Number of groups  =        826

R-squared:                                      Obs per group:
     Within  = 0.1501                                         min =          2
     Between = 0.0821                                         avg =        2.0
     Overall = 0.0945                                         max =          2

                                                F(5,821)          =      29.00
corr(u_i, Xb) = 0.0664                          Prob > F          =     0.0000

------------------------------------------------------------------------------
     lexptot | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |   .1383035   .0269954     5.12   0.000     .0853154    .1912916
     dfmfd98 |          0  (omitted)
     dfmfdyr |   .1125507   .0362163     3.11   0.002     .0414633    .1836381
     sexhead |  -.0465909   .0724287    -0.64   0.520    -.1887582    .0955764
    educhead |   .0126249    .008331     1.52   0.130    -.0037277    .0289775
     vaccess |  -.0817861   .0527423    -1.55   0.121    -.1853116    .0217395
       _cons |   8.341554   .0848214    98.34   0.000     8.175062    8.508046
-------------+----------------------------------------------------------------
     sigma_u |  .36665938
     sigma_e |  .36628457
         rho |  .50051138   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(825, 821) = 1.80                     Prob > F = 0.0000
```

- Results show that, after controlling for the effects of time-invariant unobserved factors, **female participation in microcredit has a 9.17 percent positive impact on household's per capita consumption**, and the impact is very significant (dfmfdyr t = 2.49).

Staggered DID estimation

- Remember that when treatment adoption is staggered (i.e., not everyone in the treatment group receives the treatment at the same time), the effects are heterogeneous (some people respond to the treatment more than others), and the effect is not constant over time, then the TWFE approach could introduce a bias, as it makes non-sense comparisons.
- Recently, new approaches have emerged to address the issues with TWFE estimators. Notable examples include the Goodman-Bacon decomposition by Goodman-Bacon (2021) and the Callaway & Sant'Anna (2021) approach.

The Callaway and Sant'Anna approach

- Callaway and Sant'Anna (CS) approach was the first to allow for covariate-specific trends across groups in DID setups with staggered treatment.
  - This is relevant when the differences in the observed characteristics among groups lead to the PTA violation.
- CS propose a two-step procedure that avoids the TWFE unsound comparisons.

1. The first step proposes **identifying all possible valid (2x2) comparisons** and estimating the corresponding ATTs.
   - Here, the CS ATTs estimation strategy relies on robust estimators, including:
     - The **outcome regressions (OR) estimator.** Requires the correct specification of the outcome evolution for the comparison group.
     - The **inverse-probability-weighted (IPW) estimator.** Must correctly model the conditional probability of unit i being in the group g given their covariates.
     - The **doubly robust (DR) estimator.** proposed by Sant'Anna & Zhao (2020). Combines both approaches (hence the name). It requires correctly specifying either (but not necessarily both).
       * Hence, the DR is the most robust to modeling misspecifications.
       * The DR allows using suitable covariates to increase the likelihood of identifying the units treated.
2. In the second step, **CS aggregates the ATTs into time groups (cohorts) to summarize the results.**

Why Choosing the CS approach

- Another advantage of CS approach is its **robustness, as instead of point-wise inference of average ATTs, CS proposes to use a simple multiplier bootstrap procedure to estimate simultaneous (group and time) confidence intervals.**
- The CS methodology offers three aggregation methods to summarize the potentially large number of group-time average treatment effects.
  - 1. The estimation of ATTs for specific treatment groups (cohorts)
  - 2. The cumulative ATTs over time.
  - 3. ATTs that change based on the length of treatment exposure, **similar to an event study.**
- The CS approach quickly gained popularity as they developed packages for both `Stata` (`csdid`) and `R` users (`did`).
  - In 2023, the latest version of `Stata` (18) integrated their solution natively with the built-in command `xthdidregress`.

- **Since the CS approach is likely to keep gaining traction, we will focus on their solution by providing an example using `Stata` and `R`.**

Practice 4: Staggered DID estimation using `Stata`

- For Practice 4 & 5 we will be using a subset of the data used in the article "Subnational Public Debt Sustainability in Mexico: Is the new fiscal rule working?" by del Castillo & Cabral (2024)
- *The study evaluates the impact of the fiscal rule alert system on the levels of debt accumulation across Mexican states.**
  - Using a quarterly panel data set comprising the period 2013–2020 and employing difference-in-differences techniques.

Dataset description using `Stata`

```
clear all

use "panel_mex.dta"

xtset id date // declare the panel data structure


describe // variables description

*
tabstat deuda_r_pc, statistics( min mean median max sd ) by(regions) labelwidth(30) columns(statistics)


* Check the structure of the staggered treatment
tab2 first_treat treated
```

```
Panel variable: id (strongly balanced)
 Time variable: date, 2013q4 to 2020q4
         Delta: 1 quarter


Contains data from panel_mex.dta
 Observations:           899
    Variables:            11                  13 Nov 2024 22:10
-------------------------------------------------------------------------------------------------
Variable      Storage   Display    Value
    name         type    format    label      Variable label
-------------------------------------------------------------------------------------------------
ent             str19   %19s                * Entidad Federativa
id              byte    %8.0g                 ID Entidad Federativa
date            float   %tq                   Quarterly date
quarter_id      byte    %8.0g      quarters
regions         long    %12.0g     reg_banxico
                                                regiones BANXICO
ied             float   %9.0g               * IED trimestral acumulada. En millones de dolares
deuda_r_pc      float   %9.0g               * Deuda Real per capita. En pesos constantes de 2018.
rating          float   %9.0g               * Rating crediticio maximo (0 min - 9 max)
first_treat     float   %9.0g               * Numero de Primer trimestre de tratamiento
```

```
treated         float   %9.0g                 Entidades que recibieron al menos una vez un
                                                semaforo amarillo
treatment       float   %9.0g                 Periodo en que recibe o no tratamiento
                                              * indicated variables have notes
------------------------------------------------------------------------------------------------
Sorted by: id  date
```

regions	Variable	Min	Mean	p50	Max	SD
Centro	deuda_r_pc	66	2511	1738	8971	2586
Centro Norte	deuda_r_pc	1181	3212	2857	6035	1281
Norte	deuda_r_pc	3143	8927	9900	14745	4105
Sur	deuda_r_pc	521	3863	2581	14765	3665
Total	deuda_r_pc	66	4328	3045	14765	3747

-> tabulation of first_treat by treated

Numero de Primer trimestre de tratamiento	Entidades que recibieron al menos una vez un semaforo amarillo		Total
	0	1	
0	551	0	551
46	0	232	232
47	0	29	29
50	0	29	29
54	0	29	29
58	0	29	29
Total	551	348	899

CSDID estimation using `Stata`

```
clear all

use "panel_mex.dta"

xtset id date // declare the panel data structure

*** Use CSDID for Estimation

csdid deuda_r_pc rating ied, ivar(id) time(quarter_id) gvar(first_treat) method(dripw) cluster(regions)

estimates store csdid_deuda
global tr_eff = _b[ATT]
dis $tr_eff

estat all
csdid_estat event, window (-16 15)
csdid_plot
```

```
Panel variable: id (strongly balanced)
 Time variable: date, 2013q4 to 2020q4
         Delta: 1 quarter

Program DRDID is outdated, or not installed.
Please install ssc install drdid
.........................x.....................
..........x..........................xxxx...xxx
x...........xx.........xxxx...........
Difference-in-difference with Multiple Time Periods

                                                      Number of obs = 888
Outcome model  : least squares
Treatment model: inverse probability
(Std. err. adjusted for        4 clusters in regions)
------------------------------------------------------------------------
            | Coefficient  Std. err.      t      [95% conf. interval]
------------+-----------------------------------------------------------
        ATT |  -456.7465   246.2774    -1.85    -862.4488   -51.04421
------------------------------------------------------------------------
Control: Never Treated

See Callaway and Sant'Anna (2021) for details



-456.74648

Test will be based on asymptotic VCoV
If you want aggregations based on WB, use option saverif() ad csdid_stats
Pretrend Test. H0 All Pre-treatment are equal to 0
chi2(64) =     3.9152
```

p-value = 1.0000
Average Treatment Effect on Treated

	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
ATT	-456.7465	185.0866	-2.47	0.014	-819.5095	-93.98346

ATT by group

	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
GAverage	-393.6491	141.0126	-2.79	0.005	-670.0287	-117.2695
G46	-420.3611	199.4535	-2.11	0.035	-811.2827	-29.4394
G47	-1427.035	98.931	-14.42	0.000	-1620.937	-1233.134
G50	-485.6666	45.27065	-10.73	0.000	-574.3955	-396.9378
G54	449.677	39.07854	11.51	0.000	373.0844	526.2695
G58	102.1246	15.63975	6.53	0.000	71.47126	132.778

ATT by Calendar Period

	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
CAverage	-431.5859	183.3015	-2.35	0.019	-790.8501	-72.32157
T46	133.9772	133.1478	1.01	0.314	-126.9876	394.9421
T47	-89.6155	61.50906	-1.46	0.145	-210.171	30.94005
T48	-195.7333	69.95541	-2.80	0.005	-332.8434	-58.62322
T49	-267.1912	102.1459	-2.62	0.009	-467.3935	-66.98888
T50	-202.3536	107.9912	-1.87	0.061	-414.0125	9.305369
T51	-404.8876	235.4584	-1.72	0.086	-866.3776	56.60236
T52	-414.093	199.3535	-2.08	0.038	-804.8187	-23.36725
T53	-417.2771	200.0969	-2.09	0.037	-809.4599	-25.09429
T54	-460.2967	204.022	-2.26	0.024	-860.1724	-60.42093
T55	-561.596	212.7748	-2.64	0.008	-978.6271	-144.565
T56	-630.3452	252.862	-2.49	0.013	-1125.946	-134.7448
T57	-634.7229	235.234	-2.70	0.007	-1095.773	-173.6727
T58	-419.5721	185.8546	-2.26	0.024	-783.8405	-55.30367
T59	-733.0532	301.0587	-2.43	0.015	-1323.117	-142.989
T60	-660.1059	290.5897	-2.27	0.023	-1229.651	-90.56057
T61	-659.6129	324.4346	-2.03	0.042	-1295.493	-23.73284
T62	-720.4806	344.9218	-2.09	0.037	-1396.515	-44.44634

ATT by Periods Before and After treatment
Event Study:Dynamic effects

	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
Pre_avg	91.55434	12.02456	7.61	0.000	67.98663	115.122
Post_avg	-492.0043	177.8874	-2.77	0.006	-840.6573	-143.3514
Tm23	29.03587	20.8705	1.39	0.164	-11.86956	69.94131
Tm20	625.2228	.4849902	1289.15	0.000	624.2723	626.1734
Tm19	-15.88473	21.55676	-0.74	0.461	-58.13521	26.36575
Tm18	12.17268	14.26069	0.85	0.393	-15.77777	40.12312
Tm17	-87.19778	27.10681	-3.22	0.001	-140.3261	-34.06941
Tm16	549.7815	19.87973	27.66	0.000	510.8179	588.745

```
        Tm15 |  -88.51135   33.78222    -2.62   0.009    -154.7233   -22.29941
        Tm14 |   173.9194   133.6098     1.30   0.193    -87.95113    435.7899
        Tm13 |   107.7892   74.13104     1.45   0.146    -37.50496    253.0834
        Tm12 |   87.64972   13.86523     6.32   0.000     60.47436    114.8251
        Tm11 |  -193.2888   160.4352    -1.20   0.228     -507.736    121.1585
        Tm10 |   147.6931   132.2263     1.12   0.264    -111.4656    406.8518
         Tm9 |  -9.970321   79.61868    -0.13   0.900    -166.0201    146.0794
         Tm8 |   418.2144   179.5866     2.33   0.020     66.23112    770.1977
         Tm7 |  -37.28005   58.24016    -0.64   0.522    -151.4287    76.86857
         Tm6 |   4.791569    13.1727     0.36   0.716    -21.02645    30.60959
         Tm5 |   38.28093   32.40266     1.18   0.237    -25.22712     101.789
         Tm4 |   140.9712   80.39071     1.75   0.080    -16.59169    298.5341
         Tm3 |  -152.9136   21.51504    -7.11   0.000    -195.0823   -110.7449
         Tm2 |  -29.35274    59.1858    -0.50   0.620    -145.3548    86.64929
         Tm1 |    201.518   119.6772     1.68   0.092    -33.04509    436.0811
         Tp0 |   72.45666   52.42817     1.38   0.167    -30.30067     175.214
         Tp1 |  -72.00938   48.84799    -1.47   0.140    -167.7497    23.73092
         Tp2 |  -144.0809    78.9969    -1.82   0.068     -298.912    10.75014
         Tp3 |  -211.5156   144.8105    -1.46   0.144     -495.339    72.30784
         Tp4 |  -107.6476   153.7188    -0.70   0.484     -408.931    193.6358
         Tp5 |  -352.4878   277.6421    -1.27   0.204    -896.6563    191.6807
         Tp6 |  -389.7584   253.4529    -1.54   0.124    -886.5169         107
         Tp7 |  -418.0101   246.6722    -1.69   0.090    -901.4788    65.45864
         Tp8 |  -474.8009    232.007    -2.05   0.041    -929.5264   -20.07544
         Tp9 |  -660.0227   185.9643    -3.55   0.000    -1024.506   -295.5393
        Tp10 |  -715.7991   220.1706    -3.25   0.001    -1147.326   -284.2727
        Tp11 |    -690.27   191.2337    -3.61   0.000    -1065.081    -315.459
        Tp12 |  -603.4742   136.2395    -4.43   0.000    -870.4988   -336.4496
        Tp13 |  -978.5005   257.3088    -3.80   0.000    -1482.817   -474.1845
        Tp14 |  -909.4213    246.708    -3.69   0.000     -1392.96   -425.8825
        Tp15 |  -861.6213    262.366    -3.28   0.001    -1375.849   -347.3934
        Tp16 |  -847.1102   298.1354    -2.84   0.004    -1431.445   -262.7756
-------------------------------------------------------------------------------

Test will be based on asymptotic VCoV
If you want aggregations based on WB, use option saverif() ad csdid_stats
ATT by Periods Before and After treatment
Event Study:Dynamic effects
-------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+-----------------------------------------------------------------
     Pre_avg |   84.95576   15.91084     5.34   0.000     53.77109    116.1404
    Post_avg |  -469.8102   172.7529    -2.72   0.007    -808.3997   -131.2207
        Tm16 |   549.7815   19.87973    27.66   0.000     510.8179     588.745
        Tm15 |  -88.51135   33.78222    -2.62   0.009    -154.7233   -22.29941
        Tm14 |   173.9194   133.6098     1.30   0.193    -87.95113    435.7899
        Tm13 |   107.7892   74.13104     1.45   0.146    -37.50496    253.0834
        Tm12 |   87.64972   13.86523     6.32   0.000     60.47436    114.8251
        Tm11 |  -193.2888   160.4352    -1.20   0.228     -507.736    121.1585
        Tm10 |   147.6931   132.2263     1.12   0.264    -111.4656    406.8518
         Tm9 |  -9.970321   79.61868    -0.13   0.900    -166.0201    146.0794
         Tm8 |   418.2144   179.5866     2.33   0.020     66.23112    770.1977
         Tm7 |  -37.28005   58.24016    -0.64   0.522    -151.4287    76.86857
         Tm6 |   4.791569    13.1727     0.36   0.716    -21.02645    30.60959
```

Tm5	38.28093	32.40266	1.18	0.237	-25.22712	101.789
Tm4	140.9712	80.39071	1.75	0.080	-16.59169	298.5341
Tm3	-152.9136	21.51504	-7.11	0.000	-195.0823	-110.7449
Tm2	-29.35274	59.1858	-0.50	0.620	-145.3548	86.64929
Tm1	201.518	119.6772	1.68	0.092	-33.04509	436.0811
Tp0	72.45666	52.42817	1.38	0.167	-30.30067	175.214
Tp1	-72.00938	48.84799	-1.47	0.140	-167.7497	23.73092
Tp2	-144.0809	78.9969	-1.82	0.068	-298.912	10.75014
Tp3	-211.5156	144.8105	-1.46	0.144	-495.339	72.30784
Tp4	-107.6476	153.7188	-0.70	0.484	-408.931	193.6358
Tp5	-352.4878	277.6421	-1.27	0.204	-896.6563	191.6807
Tp6	-389.7584	253.4529	-1.54	0.124	-886.5169	107
Tp7	-418.0101	246.6722	-1.69	0.090	-901.4788	65.45864
Tp8	-474.8009	232.007	-2.05	0.041	-929.5264	-20.07544
Tp9	-660.0227	185.9643	-3.55	0.000	-1024.506	-295.5393
Tp10	-715.7991	220.1706	-3.25	0.001	-1147.326	-284.2727
Tp11	-690.27	191.2337	-3.61	0.000	-1065.081	-315.459
Tp12	-603.4742	136.2395	-4.43	0.000	-870.4988	-336.4496
Tp13	-978.5005	257.3088	-3.80	0.000	-1482.817	-474.1845
Tp14	-909.4213	246.708	-3.69	0.000	-1392.96	-425.8825
Tp15	-861.6213	262.366	-3.28	0.001	-1375.849	-347.3934

Practice 5: Staggered DID estimation using R

- Here we will be reproducing the same analysis of Practice 4, but using R.

CSDID estimation using R (without covariates)

```
[1] TRUE
```

```
[1] TRUE
```

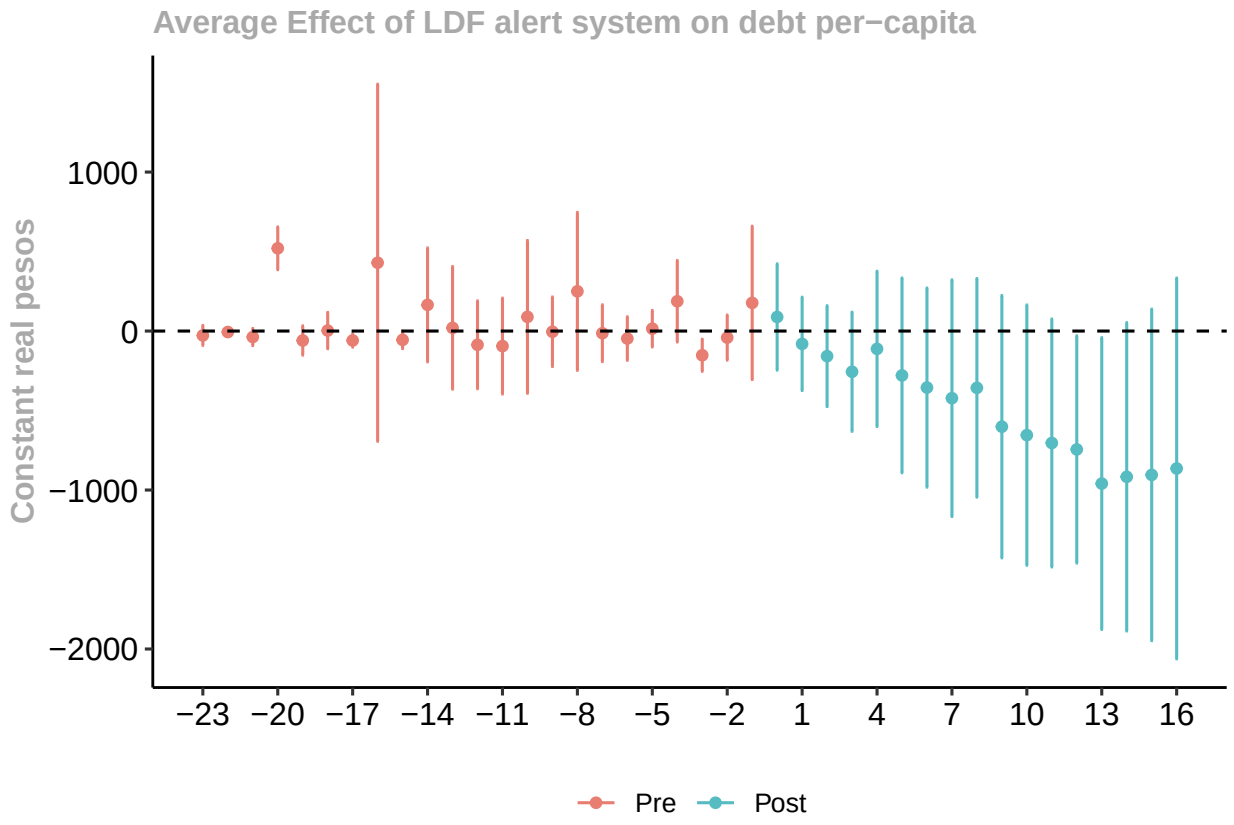
```
Call:
att_gt(yname = "deuda_r_pc", tname = "quarter_id", idname = "id",
    gname = "first_treat", xformla = NULL, data = data, panel = TRUE,
    control_group = "nevertreated", alp = 0.05, bstrap = TRUE,
    biters = 1000, clustervars = NULL, est_method = "dr")

Reference: Callaway, Brantly and Pedro H.C. Sant'Anna.  "Difference-in-Differences with Multiple Time P

Group-Time Average Treatment Effects:
 Group Time   ATT(g,t) Std. Error [95% Simult.  Conf. Band]
    46   35   -94.6418   176.0718     -563.0046    373.7209
    46   36   192.9183   263.5706     -508.1970    894.0336
    46   37    -8.1162   128.0086     -348.6275    332.3951
    46   38   319.2546   276.6827     -416.7397   1055.2490
    46   39    34.8140    96.8029     -222.6880    292.3160
    46   40     0.0568    47.4366     -126.1276    126.2413
    46   41    -6.2382    67.8882     -186.8253    174.3489
    46   42   144.2091   108.9636     -145.6413    434.0595
    46   43  -152.6374    57.0306     -304.3425     -0.9323 *
    46   44   -50.5383    59.3411     -208.3895    107.3128
    46   45   316.4526   260.4642     -376.3994   1009.3047
    46   46   150.9261   176.6129     -318.8759    620.7280
    46   47   -76.2716   165.7452     -517.1648    364.6216
    46   48  -174.9020   168.3927     -622.8378    273.0338
    46   49  -274.3269   185.4568     -767.6543    219.0005
    46   50  -107.3826   260.8352     -801.2215    586.4564
    46   51  -299.3780   295.0450    -1084.2172    485.4612
    46   52  -316.0347   324.8062    -1180.0409    547.9715
    46   53  -326.7587   361.9937    -1289.6861    636.1687
    46   54  -256.6821   387.5339    -1287.5482    774.1839
    46   55  -466.2757   399.2684    -1528.3563    595.8048
    46   56  -523.4897   408.7006    -1610.6605    563.6810
    46   57  -558.6551   405.1261    -1636.3176    519.0074
    46   58  -594.4534   357.4735    -1545.3568    356.4499
    46   59  -827.4198   386.0853    -1854.4325    199.5929
    46   60  -747.1819   403.6924    -1821.0305    326.6666
    46   61  -742.5901   473.8852    -2003.1563    517.9761
    46   62  -864.4101   501.6562    -2198.8489    470.0287
    47   35  -379.6016    25.5646     -447.6051   -311.5981 *
    47   36   -85.1644     9.0756     -109.3062    -61.0226 *
    47   37  -163.6142    24.3509     -228.3893    -98.8392 *
```

47	38	-340.0762	51.2569	-476.4228	-203.7295	*
47	39	762.0726	18.5052	712.8476	811.2975	*
47	40	-146.0327	35.1538	-239.5442	-52.5211	*
47	41	34.4580	28.2386	-40.6586	109.5746	
47	42	49.7929	68.2141	-131.6611	231.2468	
47	43	-274.0397	28.0428	-348.6354	-199.4441	*
47	44	-102.5357	15.5749	-143.9660	-61.1054	*
47	45	-143.8115	12.3294	-176.6086	-111.0144	*
47	46	-514.4181	49.0480	-644.8891	-383.9470	*
47	47	-398.6271	61.3614	-561.8524	-235.4018	*
47	48	-539.7201	62.8882	-707.0069	-372.4333	*
47	49	-646.4412	69.6151	-831.6219	-461.2606	*
47	50	-938.7505	80.5040	-1152.8966	-724.6044	*
47	51	-960.5145	92.7864	-1207.3326	-713.6965	*
47	52	-1106.6114	85.7150	-1334.6189	-878.6039	*
47	53	-1338.5761	114.0566	-1641.9743	-1035.1779	*
47	54	-1403.9320	124.4708	-1735.0327	-1072.8313	*
47	55	-1539.7928	120.4806	-1860.2792	-1219.3063	*
47	56	-1630.4450	124.7251	-1962.2220	-1298.6680	*
47	57	-1712.4333	121.4588	-2035.5218	-1389.3448	*
47	58	-1696.6397	121.0886	-2018.7434	-1374.5359	*
47	59	-1991.6421	115.9643	-2300.1149	-1683.1693	*
47	60	-2014.4821	133.2495	-2368.9345	-1660.0297	*
47	61	-2274.7268	133.1175	-2628.8282	-1920.6254	*
47	62	-2202.9543	186.8738	-2700.0510	-1705.8577	*
50	35	-57.7149	25.5646	-125.7184	10.2886	
50	36	460.4276	9.0756	436.2859	484.5694	*
50	37	219.3191	24.3509	154.5441	284.0941	*
50	38	89.1045	51.2569	-47.2422	225.4512	
50	39	-69.2329	18.5052	-118.4578	-20.0079	*
50	40	-62.9467	35.1538	-156.4583	30.5648	
50	41	421.9192	28.2386	346.8026	497.0358	*
50	42	188.7065	68.2141	7.2525	370.1604	*
50	43	-215.1638	28.0428	-289.7594	-140.5681	*
50	44	-100.2872	15.5749	-141.7175	-58.8569	*
50	45	159.5483	12.3294	126.7512	192.3454	*
50	46	577.4970	49.0480	447.0259	707.9680	*
50	47	-92.1759	61.3614	-255.4012	71.0494	
50	48	-154.6946	28.0192	-229.2275	-80.1618	*
50	49	111.0919	18.1226	62.8845	159.2992	*
50	50	-74.6735	59.5270	-233.0192	83.6721	
50	51	122.7314	65.0691	-50.3567	295.8195	
50	52	-25.9646	71.3215	-215.6845	163.7553	
50	53	-159.2569	103.5476	-434.7005	116.1866	
50	54	-208.1236	118.3658	-522.9844	106.7372	
50	55	-380.7583	109.0407	-670.8137	-90.7028	*
50	56	-732.8888	114.5934	-1037.7149	-428.0627	*
50	57	-1154.4833	113.0557	-1455.2190	-853.7476	*
50	58	-582.3630	97.4837	-841.6762	-323.0498	*
50	59	-655.6488	96.5893	-912.5828	-398.7149	*
50	60	-645.9730	108.0375	-933.3599	-358.5861	*
50	61	-875.9760	112.0042	-1173.9145	-578.0374	*
50	62	-699.8056	143.5108	-1081.5540	-318.0572	*
54	35	-96.6534	25.5646	-164.6569	-28.6499	*

54	36	57.4782	9.0756	33.3364	81.6200	*
54	37	-66.0820	24.3509	-130.8570	-1.3070	*
54	38	-171.6177	51.2569	-307.9643	-35.2710	*
54	39	-60.9133	18.5052	-110.1382	-11.6883	*
54	40	54.8238	35.1538	-38.6878	148.3353	
54	41	-151.9321	28.2386	-227.0487	-76.8155	*
54	42	-145.3634	68.2141	-326.8173	36.0906	
54	43	-46.0407	28.0428	-120.6364	28.5550	
54	44	-25.9840	15.5749	-67.4143	15.4464	
54	45	-53.4302	12.3294	-86.2273	-20.6331	*
54	46	-377.3834	49.0480	-507.8545	-246.9124	*
54	47	-274.0685	61.3614	-437.2938	-110.8432	*
54	48	-482.9104	28.0192	-557.4433	-408.3776	*
54	49	-25.4511	18.1226	-73.6585	22.7563	
54	50	619.4031	59.5270	461.0574	777.7488	*
54	51	-268.8856	54.3634	-413.4958	-124.2754	*
54	52	-75.7575	29.0160	-152.9420	1.4270	
54	53	0.0724	39.6197	-105.3186	105.4635	
54	54	295.4136	54.8273	149.5693	441.2579	*
54	55	242.1041	39.9700	135.7813	348.4269	*
54	56	294.7717	58.4677	139.2437	450.2997	*
54	57	241.9557	63.0200	74.3182	409.5933	*
54	58	106.7269	71.9933	-84.7801	298.2339	
54	59	812.2314	66.5780	635.1293	989.3334	*
54	60	687.6726	71.6612	497.0491	878.2960	*
54	61	527.5031	80.9571	312.1518	742.8544	*
54	62	245.5719	134.9797	-113.4831	604.6270	
58	35	-27.6568	25.5646	-95.6603	40.3467	
58	36	-6.2403	9.0756	-30.3821	17.9014	
58	37	-37.5722	24.3509	-102.3473	27.2028	
58	38	520.4807	51.2569	384.1341	656.8274	*
58	39	-22.0988	18.5052	-71.3238	27.1261	
58	40	-51.2758	35.1538	-144.7874	42.2357	
58	41	-52.3975	28.2386	-127.5141	22.7191	
58	42	1030.9108	68.2141	849.4568	1212.3648	*
58	43	-47.6926	28.0428	-122.2882	26.9031	
58	44	-21.3985	15.5749	-62.8288	20.0318	
58	45	-7.6841	12.3294	-40.4812	25.1130	
58	46	89.9833	49.0480	-40.4878	220.4543	
58	47	-178.3043	61.3614	-341.5296	-15.0790	*
58	48	-221.0921	28.0192	-295.6249	-146.5592	*
58	49	-16.7568	18.1226	-64.9641	31.4506	
58	50	-129.6777	59.5270	-288.0234	28.6680	
58	51	192.7685	54.3634	48.1583	337.3786	*
58	52	-18.5422	29.0160	-95.7266	58.6423	
58	53	44.5802	39.6197	-60.8108	149.9713	
58	54	172.2554	54.8273	26.4111	318.0997	*
58	55	-141.7472	47.7641	-268.8030	-14.6915	*
58	56	282.4810	32.5861	195.7999	369.1621	*
58	57	-1.7134	24.4612	-66.7818	63.3550	
58	58	32.3430	72.9899	-161.8149	226.5009	
58	59	-184.5232	45.0213	-304.2829	-64.7634	*
58	60	-118.2636	40.0627	-224.8330	-11.6942	*
58	61	-22.8718	54.5014	-167.8491	122.1054	

```
    58   62   575.6243   121.3309      252.8760    898.3725 *
---
Signif. codes: ‘*’ confidence band does not cover 0

Control Group:  Never Treated,  Anticipation Periods:  0
Estimation Method:  Doubly Robust


Call:
aggte(MP = model1, type = "group")

Reference: Callaway, Brantly and Pedro H.C. Sant’Anna.  "Difference-in-Differences with Multiple Time Pe


Overall summary of ATT’s based on group/cohort aggregation:
      ATT    Std. Error     [ 95%  Conf. Int.]
 -393.609      182.1538  -750.6238    -36.5941 *


Group Effects:
 Group   Estimate Std. Error [95% Simult.  Conf. Band]
    46  -412.0757   291.6898    -1041.7767    217.6253
    47 -1399.7681    87.6653    -1589.0203  -1210.5159 *
    50  -467.1680    84.0595     -648.6359   -285.7001 *
    54   383.7723    56.0885      262.6882    504.8565 *
    58    56.4617    49.1949      -49.7404    162.6639
---
Signif. codes: ‘*’ confidence band does not cover 0

Control Group:  Never Treated,  Anticipation Periods:  0
Estimation Method:  Doubly Robust


Call:
aggte(MP = model1, type = "dynamic")

Reference: Callaway, Brantly and Pedro H.C. Sant’Anna.  "Difference-in-Differences with Multiple Time Pe


Overall summary of ATT’s based on event-study/dynamic aggregation:
       ATT    Std. Error     [ 95%  Conf. Int.]
 -487.2597      251.3098  -979.8179      5.2985


Dynamic Effects:
 Event time  Estimate Std. Error [95% Simult.  Conf. Band]
        -23  -27.6568    24.5737      -89.6709     34.3573
        -22   -6.2403     8.3522      -27.3180     14.8373
        -21  -37.5722    21.0817      -90.7739     15.6295
        -20  520.4807    53.0821      386.5231    654.4384 *
        -19  -59.3761    36.3115     -151.0115     32.2593
        -18    3.1012    45.0324     -110.5424    116.7448
        -17  -59.2397    16.4358     -100.7169    -17.7625 *
        -16  429.6466   444.8107     -692.8754   1552.1685
```

```
        -15  -55.4403    21.6537     -110.0853     -0.7952 *
        -14  164.6176   141.7545     -193.1134    522.3486
        -13   19.9010   152.5925     -365.1806    404.9825
        -12  -86.4693   109.2881     -362.2682    189.3296
        -11  -94.6564   119.3207     -395.7736    206.4608
        -10   89.1425   190.2162     -390.8861    569.1710
         -9   -4.4394    86.4059     -222.4930    213.6142
         -8  249.8129   196.6109     -246.3533    745.9791
         -7  -13.6654    70.4671     -191.4958    164.1651
         -6  -47.2356    54.0296     -183.5843     89.1131
         -5   14.8804    45.2760      -99.3780    129.1388
         -4  187.3990   101.2698      -68.1648    442.9629
         -3 -152.2036    39.7085     -252.4118    -51.9955 *
         -2  -41.3408    55.9187     -182.4570     99.7755
         -1  177.2212   190.7876     -304.2494    658.6918
          0   88.4887   132.2062     -245.1461    422.1235
          1  -80.7984   116.1552     -373.9270    212.3302
          2 -157.9261   125.4440     -474.4960    158.6437
          3 -256.1282   148.2624     -630.2825    118.0261
          4 -112.1123   193.2689     -599.8447    375.6200
          5 -279.1057   242.6237     -891.3895    333.1782
          6 -355.6427   247.9640     -981.4034    270.1180
          7 -422.2711   294.7592    -1166.1238    321.5817
          8 -357.2765   272.1674    -1044.1167    329.5638
          9 -601.6300   326.7813    -1426.2937    223.0338
         10 -654.6324   324.1039    -1472.5395    163.2746
         11 -704.1856   308.7538    -1483.3552     74.9839
         12 -744.7075   283.0617    -1459.0405    -30.3745 *
         13 -959.3156   363.3485    -1876.2600    -42.3712 *
         14 -916.9091   384.0296    -1886.0444     52.2262
         15 -904.8528   412.9891    -1947.0701    137.3644
         16 -864.4101   474.3933    -2061.5866    332.7664
---
Signif. codes: ‘*’ confidence band does not cover 0

Control Group:  Never Treated,  Anticipation Periods:  0
Estimation Method:  Doubly Robust
```


Average Effect of LDF alert system on debt per−capita
Constant real pesos
1000
0
−1000
−2000
−23
−20
−17
−14
−11
−8
−5
−2
1
4
7
10
13
16
Pre
Post

CSDID estimation using R (with covariates)

```
Call:
att_gt(yname = "deuda_r_pc", tname = "quarter_id", idname = "id",
    gname = "first_treat", xformla = ~rating, data = data, panel = TRUE,
    control_group = "nevertreated", alp = 0.05, bstrap = TRUE,
    cband = FALSE, biters = 1000, clustervars = "regions", est_method = "dr",
    base_period = "varying", print_details = FALSE, pl = FALSE)

Reference: Callaway, Brantly and Pedro H.C. Sant'Anna.  "Difference-in-Differences with Multiple Time Pe

Group-Time Average Treatment Effects:
 Group Time   ATT(g,t) Std. Error [95% Pointwise  Conf. Band]
    46   35 -125.3855   229.0311       -574.2783    323.5072
    46   36  184.9001   272.4696       -349.1306    718.9307
    46   37  -24.4210   127.5650       -274.4437    225.6018
    46   38  373.9973   264.5791       -144.5682    892.5627
    46   39   32.6027    60.7252        -86.4165    151.6218
    46   40   19.6630    35.5784        -50.0693     89.3954
    46   41    4.3894    18.6596        -32.1827     40.9616
    46   42  149.6956   126.3791        -98.0029    397.3942
    46   43 -186.2624    61.5288       -306.8565    -65.6682 *
    46   44  -36.2533    32.5698       -100.0890     27.5824
    46   45  328.3922   364.2699       -385.5637   1042.3480
    46   46  132.2474   228.0636       -314.7490    579.2439
    46   47  -47.1546   111.0674       -264.8427    170.5335
    46   48 -148.0520    86.9135       -318.3993     22.2952
    46   49 -216.8220   101.5743       -415.9040    -17.7400 *
    46   50 -121.0031   192.5536       -498.4013    256.3950
    46   51 -397.9728   335.3376      -1055.2225    259.2768
    46   52 -371.8418   294.2878       -948.6353    204.9516
    46   53 -328.2668   323.2799       -961.8836    305.3501
    46   54 -431.5303   352.6975      -1122.8047    259.7440
    46   55 -528.1187   240.1239       -998.7529    -57.4845 *
    46   56 -597.7310   266.2989      -1119.6673    -75.7948 *
    46   57 -546.0007   242.6533      -1021.5924    -70.4090 *
    46   58 -415.5155   165.2040       -739.3095    -91.7216 *
    46   59 -848.4227   325.7372      -1486.8558   -209.9895 *
    46   60 -738.9122   296.7754      -1320.5813   -157.2432 *
    46   61 -692.4726   288.3492      -1257.6267   -127.3185 *
    46   62 -847.6398   334.6521      -1503.5459   -191.7336 *
    47   35 -462.9310    83.4986       -626.5852   -299.2768 *
    47   36 -113.3198    18.6046       -149.7842    -76.8555 *
    47   37 -175.4185    18.1818       -211.0542   -139.7828 *
    47   38 -299.9301     7.4180       -314.4691   -285.3912 *
    47   39  760.6291     1.2523        758.1746    763.0836 *
    47   40 -131.2812    16.1001       -162.8368    -99.7257 *
    47   41   41.2819     6.7488         28.0545     54.5093 *
    47   42   47.5674    39.8947        -30.6248    125.7595
    47   43 -295.1858    26.4847       -347.0948   -243.2769 *
    47   44  -98.1265     6.3095       -110.4929    -85.7601 *
    47   45 -141.3200     5.8453       -152.7765   -129.8635 *
    47   46 -511.5341    16.6390       -544.1460   -478.9222 *
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47	47	-406.4790	69.9879	-543.6527	-269.3053	*
47	48	-548.5076	73.2123	-692.0010	-405.0142	*
47	49	-623.3424	84.7235	-789.3975	-457.2873	*
47	50	-982.2414	65.1680	-1109.9683	-854.5146	*
47	51	-1016.3402	106.2278	-1224.5429	-808.1376	*
47	52	-1151.6976	76.1537	-1300.9560	-1002.4391	*
47	53	-1366.4929	56.2446	-1476.7303	-1256.2554	*
47	54	-1522.1863	139.7716	-1796.1335	-1248.2390	*
47	55	-1636.7629	94.3090	-1821.6052	-1451.9205	*
47	56	-1673.7303	47.9775	-1767.7644	-1579.6961	*
47	57	-1715.4911	121.3868	-1953.4048	-1477.5773	*
47	58	-1635.8571	63.9577	-1761.2120	-1510.5023	*
47	59	-2005.8873	72.3707	-2147.7312	-1864.0434	*
47	60	-2012.7001	45.0826	-2101.0604	-1924.3398	*
47	61	-2234.8536	109.9209	-2450.2946	-2019.4127	*
47	62	-2177.2209	116.7250	-2405.9977	-1948.4440	*
50	35	-52.0824	30.5789	-112.0160	7.8512	
50	36	461.6946	5.8250	450.2778	473.1113	*
50	37	224.1213	22.4592	180.1022	268.1405	*
50	38	73.2363	38.9143	-3.0342	149.5069	
50	39	-64.7352	62.3858	-187.0091	57.5386	
50	40	5.3501	7.5733	-9.4933	20.1935	
50	41	416.9092	23.4127	371.0211	462.7972	*
50	42	182.7714	27.7700	128.3431	237.1996	*
50	43	-204.3380	28.1692	-259.5486	-149.1274	*
50	44	-99.6076	12.1633	-123.4472	-75.7680	*
50	45	160.0717	5.1253	150.0264	170.1170	*
50	46	570.8970	24.7066	522.4730	619.3210	*
50	47	-87.5092	51.4395	-188.3289	13.3104	
50	48	-155.2671	7.9720	-170.8920	-139.6422	*
50	49	98.2015	6.4324	85.5943	110.8086	*
50	50	-132.3494	79.8383	-288.8295	24.1308	
50	51	49.8684	107.4688	-160.7666	260.5034	
50	52	-86.7289	89.4955	-262.1368	88.6789	
50	53	-200.3598	66.3218	-330.3482	-70.3715	*
50	54	-325.5734	145.0189	-609.8052	-41.3415	*
50	55	-479.0460	47.7333	-572.6015	-385.4905	*
50	56	-782.2420	73.3939	-926.0915	-638.3926	*
50	57	-1168.3809	58.9108	-1283.8441	-1052.9178	*
50	58	-569.4156	114.3326	-793.5034	-345.3278	*
50	59	-696.7204	101.1088	-894.8900	-498.5509	*
50	60	-660.6119	65.2848	-788.5677	-532.6562	*
50	61	-846.5904	53.3419	-951.1387	-742.0421	*
50	62	-689.2571	120.6352	-925.6978	-452.8164	*
54	35	-119.6416	21.3258	-161.4394	-77.8439	*
54	36	51.5393	3.5663	44.5494	58.5292	*
54	37	-77.8863	18.1818	-113.5220	-42.2506	*
54	38	-131.4716	7.5995	-146.3665	-116.5768	*
54	39	-62.3567	1.2523	-64.8112	-59.9023	*
54	40	69.5752	20.0113	30.3539	108.7966	*
54	41	-145.1082	7.5164	-159.8401	-130.3764	*
54	42	-147.5889	39.8947	-225.7810	-69.3967	*
54	43	-67.1868	26.4847	-119.0958	-15.2778	*
54	44	-21.5748	6.3095	-33.9411	-9.2084	*

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    54   45   -50.9386     4.4740       -59.7075    -42.1697 *
    54   46  -374.4994    18.1586      -410.0896   -338.9092 *
    54   47  -281.9204    69.6966      -418.5232   -145.3175 *
    54   48  -483.8460     8.3087      -500.1306   -467.5613 *
    54   49    -4.7838    11.9063       -28.1196     18.5521
    54   50   561.7273    79.8383       405.2471    718.2075 *
    54   51  -299.9027    43.7716      -385.6936   -214.1119 *
    54   52   -63.2475    16.8078       -96.1902    -30.3049 *
    54   53    23.3612    18.0213       -11.9599     58.6823
    54   54   236.8500    41.1994       156.1008    317.5992 *
    54   55   233.5762    45.0613       145.2577    321.8947 *
    54   56   333.1932    53.1368       229.0470    437.3394 *
    54   57   286.5126    56.5585       175.6600    397.3652 *
    54   58    90.8335    47.7248        -2.7055    184.3724
    54   59   839.0996    59.1529       723.1622    955.0371 *
    54   60   742.1370    55.0065       634.3262    849.9477 *
    54   61   587.9861    54.1430       481.8678    694.1044 *
    54   62   317.3077    72.3640       175.4769    459.1385 *
    58   35   -50.6451    21.3258       -92.4428     -8.8473 *
    58   36   -34.3958    18.6046       -70.8601      2.0686
    58   37   -77.1473    49.2561      -173.6875     19.3928
    58   38   560.6268     7.5995       545.7319    575.5216 *
    58   39   -23.5423     1.2523       -25.9968    -21.0878 *
    58   40   -36.5244    20.0113       -75.7458      2.6970
    58   41   -45.5736     7.5164       -60.3054    -30.8417 *
    58   42  1028.6853    39.8947       950.4931   1106.8774 *
    58   43   -68.8387    26.4847      -120.7477    -16.9297 *
    58   44   -16.9893     6.3095       -29.3557     -4.6229 *
    58   45    -5.1925     4.4740       -13.9615      3.5764
    58   46    92.8673    18.1586        57.2771    128.4575 *
    58   47  -186.1562    69.6966      -322.7591    -49.5534 *
    58   48  -222.0276     8.3087      -238.3123   -205.7429 *
    58   49     3.9105    11.9063       -19.4253     27.2464
    58   50  -187.3535    79.8383      -343.8337    -30.8733 *
    58   51   161.7513    43.7716        75.9605    247.5422 *
    58   52    -6.0322    16.8078       -38.9749     26.9105
    58   53    67.8690    18.0213        32.5479    103.1901 *
    58   54   113.6918    41.1994        32.9426    194.4410 *
    58   55   -91.7116    86.2607      -260.7793     77.3562
    58   56   329.4305    45.8060       239.6524    419.2085 *
    58   57     4.4220    18.7318       -32.2916     41.1356
    58   58   -55.8553    39.8400      -133.9402     22.2296
    58   59  -215.3523    40.1946      -294.1322   -136.5724 *
    58   60  -109.5111    35.7131      -179.5076    -39.5147 *
    58   61   -10.1356    23.3850       -55.9695     35.6982
    58   62   597.1247    82.3954       435.6326    758.6168 *
---
Signif. codes: '*' confidence band does not cover 0

Control Group:  Never Treated,  Anticipation Periods:  0
Estimation Method:  Doubly Robust


Call:
```
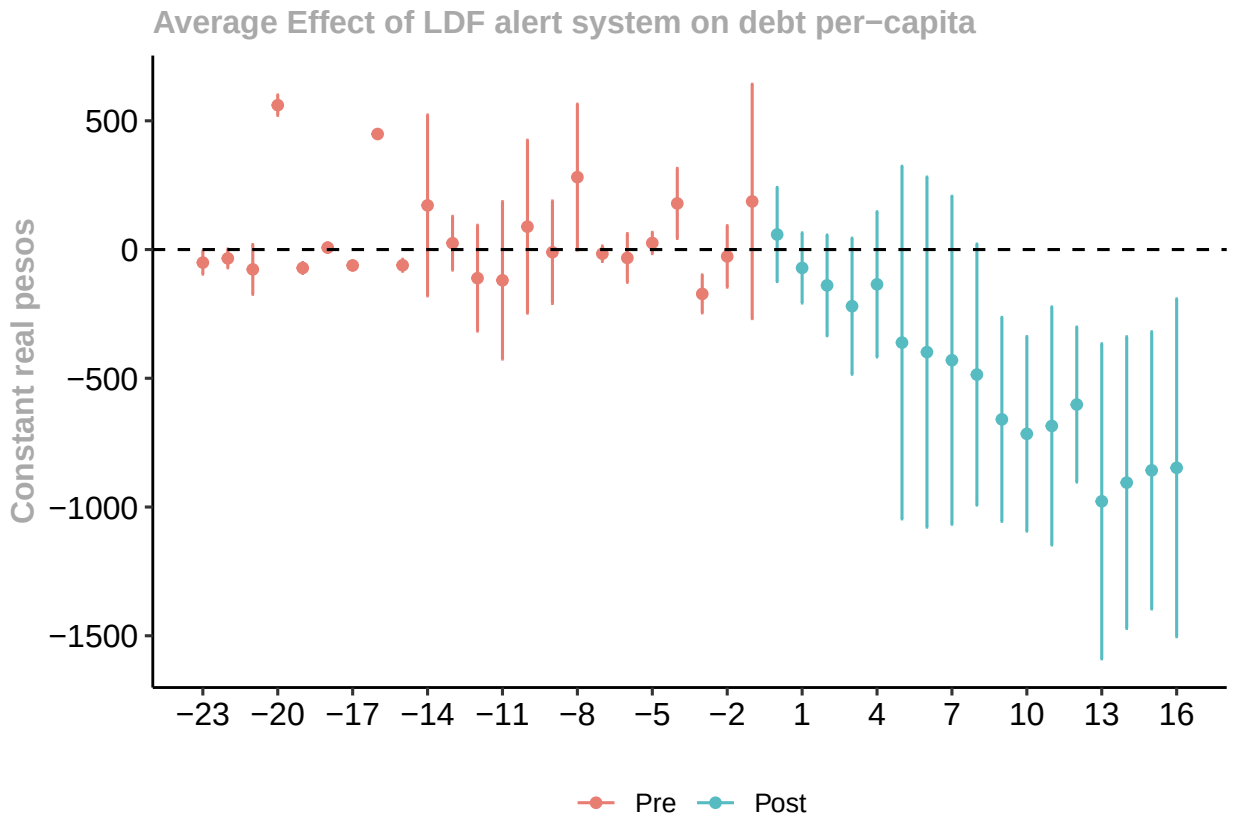

```
aggte(MP = model2, type = "group")

Reference: Callaway, Brantly and Pedro H.C. Sant'Anna.  "Difference-in-Differences with Multiple Time Pe


Overall summary of ATT's based on group/cohort aggregation:
       ATT    Std. Error     [ 95%  Conf. Int.]
 -403.3153      145.0641  -687.6357   -118.9949 *


Group Effects:
 Group   Estimate Std. Error [95% Pointwise  Conf. Band]
    46  -420.3064   227.6311       -866.4552     25.8424
    47 -1419.3619   102.8774      -1620.9979  -1217.7259 *
    50  -506.7237    72.8534       -649.5137   -363.9336 *
    54   407.4995    44.3315        320.6114    494.3877 *
    58    41.2541    40.1345        -37.4081    119.9163
---
Signif. codes: '*' confidence band does not cover 0

Control Group:  Never Treated,  Anticipation Periods:  0
Estimation Method:  Doubly Robust


Call:
aggte(MP = model2, type = "dynamic")

Reference: Callaway, Brantly and Pedro H.C. Sant'Anna.  "Difference-in-Differences with Multiple Time Pe


Overall summary of ATT's based on event-study/dynamic aggregation:
       ATT    Std. Error     [ 95%  Conf. Int.]
 -496.0613      182.9903  -854.7157   -137.4069 *


Dynamic Effects:
 Event time  Estimate Std. Error [95% Pointwise  Conf. Band]
        -23  -50.6451    22.7888        -95.3103     -5.9798 *
        -22  -34.3958    18.6046        -70.8601      2.0686
        -21  -77.1473    49.2561       -173.6875     19.3928
        -20  560.6268    20.1873        521.0605    600.1930 *
        -19  -71.5920    10.7683        -92.6974    -50.4866 *
        -18    7.5074     9.2325        -10.5879     25.6028
        -17  -61.7299     8.9221        -79.2170    -44.2429 *
        -16  448.6068     5.3441        438.1327    459.0810 *
        -15  -61.0926    11.9118        -84.4392    -37.7460 *
        -14  171.4268   179.1995       -179.7978    522.6514
        -13   24.6069    53.1679        -79.6003    128.8140
        -12 -111.1041   104.8108       -316.5295     94.3213
        -11 -119.5402   155.9728       -425.2412    186.1608
        -10   88.7941   171.3054       -246.9583    424.5465
         -9  -10.4514   101.5505       -209.4868    188.5840
         -8  281.1271   144.4985         -2.0847    564.3390
         -7  -16.2472    15.3020        -46.2386     13.7441
```

```
          -6  -32.5750    48.1992       -127.0437     61.8937
          -5   25.4867    21.0189        -15.7096     66.6829
          -4  179.0579    69.4108         43.0152    315.1007 *
          -3 -172.2791    37.5721       -245.9191    -98.6391 *
          -2  -26.7025    60.8556       -145.9774     92.5723
          -1  186.7990   232.1478       -268.2024    641.8004
           0   58.3455    93.2778       -124.4757    241.1666
           1  -71.4710    69.4211       -207.5340     64.5919
           2 -139.2338    99.6886       -334.6198     56.1522
           3 -220.0667   134.7675       -484.2062     44.0729
           4 -135.1651   143.7648       -416.9388    146.6087
           5 -361.4024   349.2656      -1045.9504    323.1455
           6 -398.3030   346.8095      -1078.0371    281.4312
           7 -429.8832   324.9579      -1066.7890    207.0226
           8 -485.5557   258.5625       -992.3290     21.2175
           9 -659.5400   202.0024      -1055.4575   -263.6226 *
          10 -715.7951   192.6164      -1093.3163   -338.2740 *
          11 -685.0453   235.8015      -1147.2077   -222.8829 *
          12 -601.9269   153.4921       -902.7659   -301.0878 *
          13 -977.7868   312.0417      -1589.3774   -366.1963 *
          14 -905.1280   288.9310      -1471.4222   -338.8337 *
          15 -857.4446   274.5347      -1395.5227   -319.3665 *
          16 -847.6398   334.6521      -1503.5459   -191.7336 *
---
Signif. codes: '*' confidence band does not cover 0

Control Group:  Never Treated,  Anticipation Periods:  0
Estimation Method:  Doubly Robust
```


Average Effect of LDF alert system on debt per−capita
Constant real pesos
500
0
−500
−1000
−1500
−23
−20
−17
−14
−11
−8
−5
−2
1
4
7
10
13
16
Pre
Post

References

Callaway, B., & Sant'Anna, P. H. C. (2021). Difference-in-differences with multiple time periods. *Journal of Econometrics*, *225*(2), 200–230. https://www.sciencedirect.com/science/article/pii/S0304407620303948

del Castillo, E., & Cabral, R. (2024). Subnational public debt sustainability in mexico: Is the new fiscal rule working? *European Journal of Political Economy*, *82*, 102512. https://doi.org/https://doi.org/10.1016/j.ejpoleco.2024.102512

Goodman-Bacon, A. (2021). Difference-in-differences with variation in treatment timing. *Journal of Econometrics*, *225*(2), 254–277.

Khandker, S., Koolwal, G., & Samad, H. (2011). *Handbook on impact evaluation: Quantitative methods and practices - exercises 2009*. World Bank, Development Data Group. https://doi.org/10.48529/YSS8-M484

Sant'Anna, P. H. C., & Zhao, J. (2020). Doubly robust difference-in-differences estimators. *Journal of Econometrics*, *219*(1), 101–122. https://doi.org/https://doi.org/10.1016/j.jeconom.2020.06.003