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Trabajo Práctico N° 4:
Extensiones de Diferencias en Diferencias.

Ejercicio 1: Static Two-Way Fixed Effects.

Una forma de extender el framework de diferencias en diferencias cuando hay más períodos temporales disponibles es utilizar efectos fijos temporales adicionalmente a los efectos fijos por individuo. Es decir, si el resultado de interés es Y y el tratamiento está definido por D, entonces, se puede estimar la ecuación:

$$Y_{it} = \alpha_i + \phi_t + D_{it}\beta_{post} + \epsilon_{it} \qquad \textbf{(1)}$$

donde α_i son efectos fijos por individuo, ϕ_t son efectos fijos temporales.

(a) *¿Cómo debe definirse D_{it} para que esto sea la generalización de la ecuación de DiD 2x2?*

D_{it}= $\mathbb{1}$\{i tratado\}\{t $\geq$ fecha de otorgamiento del tratamiento\}.

(b) *Escribir cómo queda la variable si T= 3 y N= 3 con la unidad 1 sin tratar, la unidad 2 tratada en el período 1, la unidad 3 tratada en el período 2.*

id	t	Cuándo	D_i	D_{it}
1	1	0	0	0
1	2	0	0	0
1	3	0	0	0
2	1	1	1	1
2	2	1	1	1
2	3	1	1	1
3	1	2	1	0
3	2	2	1	1
3	3	2	1	1

(c) *¿Cuál es la expresión del estimador de β_{post}?*

La expresión del estimador de β_{post} es:

$$\hat{\beta}_{post} = \frac{\sum_{i,t}(D_{it} - \widehat{D}_{it})}{\sum_{i,t}(D_{it} - \widehat{D}_{it})^2}.$$

(d) *¿Cuándo podría este estimador ser bueno para recuperar el efecto promedio de tratamiento sobre los tratados? ¿Qué problemas podría tener esta especificación?*

Este estimador podría ser bueno para recuperar el efecto promedio de tratamiento sobre los tratados cuando todas las unidades tienen el mismo efecto de tratamiento y cuando éste es idéntico independientemente de cuánto tiempo haya pasado desde que comenzó el tratamiento. Entonces, los problemas que podría tener esta especificación es heterogeneidad en efecto de tratamiento en términos de unidades de corte transversal y tiempo transcurrido desde el tratamiento.

(e) *Utilizando la base de datos "organ_donations.dta" de Kessler & Roth (2014), estimar el coeficiente β_{post} de esta especificación.*

```
HDFE Linear regression                            Number of obs   =        162
Absorbing 2 HDFE groups                           F(   1,     26) =      13.42
Statistics robust to heteroskedasticity           Prob > F        =     0.0011
                                                  R-squared       =     0.9793
                                                  Adj R-squared   =     0.9742
                                                  Within R-sq.    =     0.0092
Number of clusters (state)   =         27         Root MSE        =     0.0246

                                 (Std. err. adjusted for 27 clusters in state)
------------------------------------------------------------------------------
             |               Robust
        rate | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
           D |   -.022459   .0061312    -3.66   0.001    -.0350619   -.0098561
       _cons |   .4454641   .0001135  3923.36   0.000     .4452307    .4456974
------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
       state |        27          27           0    *|
     quarter |         6           1           5     |
-----------------------------------------------------+
* = FE nested within cluster; treated as redundant for DoF computation
```

<u>Ejercicio 2:</u> Dynamic Two-Way Fixed Effects.

Con la especificación anterior, se estima un único efecto de tratamiento.Sin embargo, si se posee informacion de varios períodos, ésta podrá utilizarse para evaluar, por un lado, cómo cambian los efectos en el tiempo y, por otro, evaluar cómo se comportaba la variable de interés previo del otorgamiento del tratamiento. La especificación dinámica de TWFE es:

$$Y_{it} = \alpha_i + \phi_t + \sum_{\substack{r \neq 0 \\ -\underline{T} \leq r \leq \overline{T}}} 1[R_{it} = r]\beta_r + \epsilon_{it}.$$

(a) *Escribir cómo quedan las variables si T= 3 y N= 3 con la unidad 1 sin tratar, la unidad 2 tratada en el período 1, la unidad 3 tratada en el período 2.*

id	t	Cuándo	D_i	D_{it}	t(-1)	t(0)	t(+1)	t(+2)
1	1	0	0	0	0	0	0	0
1	2	0	0	0	0	0	0	0
1	3	0	0	0	0	0	0	0
2	1	1	1	1	0	1	0	0
2	2	1	1	1	0	0	1	0
2	3	1	1	1	0	0	0	1
3	1	2	1	0	1	0	0	0
3	2	2	1	1	0	1	0	0
3	3	2	1	1	0	0	1	0

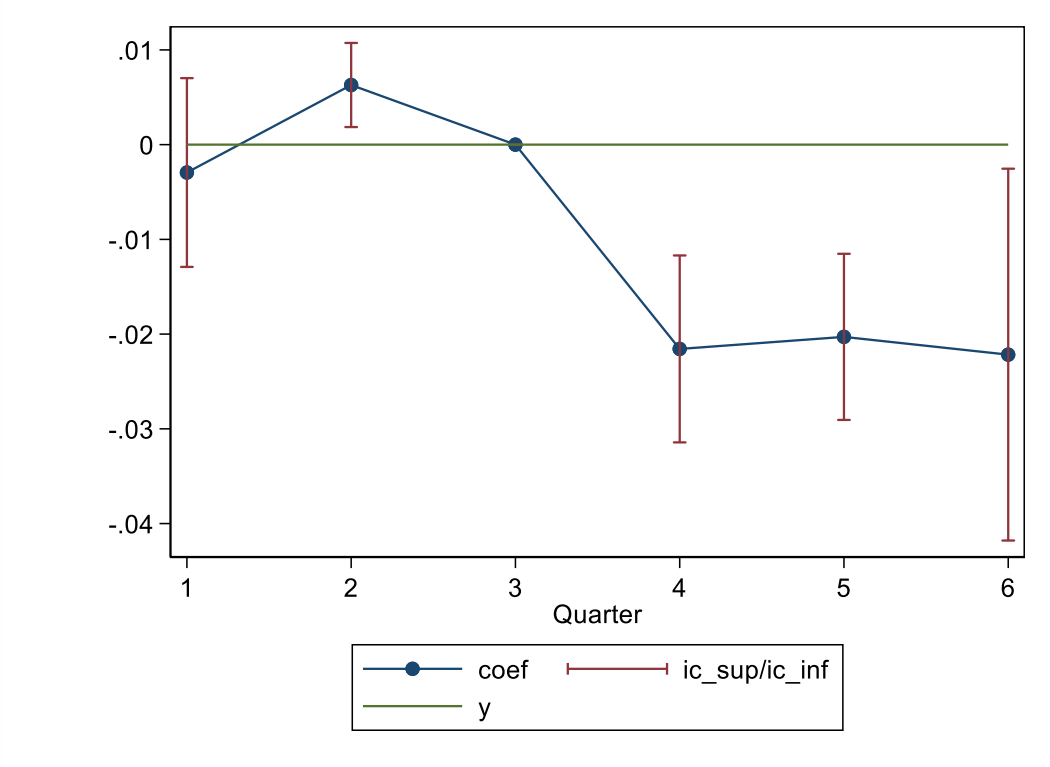
(b) *Computar los efectos de tratamiento dinámicos β_r. Notar que se normaliza β_0= 0. (¿Por qué?).*

```
HDFE Linear regression                            Number of obs   =        162
Absorbing 2 HDFE groups                           F(   5,     26) =       5.79
Statistics robust to heteroskedasticity           Prob > F        =     0.0010
                                                  R-squared       =     0.9793
                                                  Adj R-squared   =     0.9734
                                                  Within R-sq.    =     0.0098
Number of clusters (state)   =         27         Root MSE        =     0.0250

                                          (Std. err. adjusted for 27 clusters in state)
------------------------------------------------------------------------------------------
                       |               Robust
                  rate | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-----------------------+------------------------------------------------------------------
          1.California |          0  (omitted)
                       |
           quarter_num |
       Quarter 4 2010  |          0  (omitted)
       Quarter 1 2011  |          0  (omitted)
       Quarter 3 2011  |          0  (omitted)
       Quarter 4 2011  |          0  (omitted)
       Quarter 1 2012  |          0  (omitted)
                       |
California#quarter_num |
     1#Quarter 4 2010  |  -.0029423   .0050842    -0.58   0.568     -.013393    .0075084
     1#Quarter 1 2011  |   .0062961   .0022658     2.78   0.010     .0016388    .0109535
     1#Quarter 3 2011  |  -.0215654   .0050337    -4.28   0.000    -.0319124   -.0112184
     1#Quarter 4 2011  |  -.0202923   .0044733    -4.54   0.000    -.0294874   -.0110973
     1#Quarter 1 2012  |  -.0221654   .0100132    -2.21   0.036    -.0427479   -.0015829
                       |
                 _cons |   .4454226   .0001052  4232.23   0.000     .4452063     .445639
------------------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
       state |        27          27           0    *|
 quarter_num |         6           1           5     |
-----------------------------------------------------+
* = FE nested within cluster; treated as redundant for DoF computation
```

(c) *Graficar los efectos de tratamiento pre y post otorgamiento junto con sus intervalos de confianza.*



(d) *Utilizar los datos de los períodos anteriores al tratamiento para hacer un "test de placebo":*

- *Utilizar sólo los datos que llegaron antes de que el tratamiento entrara en vigor.*
- *Elegir un período de tratamiento falso.*
- *Calcular el mismo modelo de diferencias en diferencias que se planeaba usar (por ejemplo), pero crear la variable igual a 1 si está en el grupo tratado y después de la fecha de tratamiento falso que se eligió.*
- *Si se encuentra un "efecto" para esa fecha de tratamiento donde, realmente, no debería haberlo, eso es evidencia de que hay algo mal con el diseño, lo que puede implicar una violación de tendencias paralelas.*

```
HDFE Linear regression                            Number of obs   =         81
Absorbing 2 HDFE groups                           F(   1,     26) =       1.43
Statistics robust to heteroskedasticity           Prob > F        =     0.2421
                                                  R-squared       =     0.9938
                                                  Adj R-squared   =     0.9902
                                                  Within R-sq.    =     0.0019
Number of clusters (state)   =         27         Root MSE        =     0.0156

                                 (Std. err. adjusted for 27 clusters in state)
------------------------------------------------------------------------------
             |               Robust
        rate | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
  FakeTreat1 |   .0060904   .0050881     1.20   0.242    -.0043684    .0165492
       _cons |   .4383509   .0001256  3489.15   0.000     .4380926    .4386091
------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
       state |        27          27           0    *|
     quarter |         3           1           2     |
-----------------------------------------------------+
* = FE nested within cluster; treated as redundant for DoF computation

HDFE Linear regression                            Number of obs   =         81
Absorbing 2 HDFE groups                           F(   1,     26) =       0.36
Statistics robust to heteroskedasticity           Prob > F        =     0.5540
                                                  R-squared       =     0.9938
                                                  Adj R-squared   =     0.9902
                                                  Within R-sq.    =     0.0001
Number of clusters (state)   =         27         Root MSE        =     0.0156

                                 (Std. err. adjusted for 27 clusters in state)
------------------------------------------------------------------------------
             |               Robust
        rate | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
  FakeTreat2 |  -.0016769   .0027968    -0.60   0.554    -.0074259     .004072
       _cons |   .4385219   .0000345  1.3e+04   0.000      .438451    .4385929
------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
       state |        27          27           0    *|
     quarter |         3           1           2     |
-----------------------------------------------------+
* = FE nested within cluster; treated as redundant for DoF computation
```

Por lo tanto, no se encuentra un efecto estadísticamente significativo para estas fechas de tratamiento falsas, por lo que es evidencia de que el diseño está bien hecho.

<u>Ejercicio 3:</u> Callaway & Sant'Anna y csdid.

Una solución a los problemas de TWFE es la que proponen Callaway & Sant'Anna (2020). Ellos proponen computar todos los ATT válidos y ponderarlos adecuadamente. En Stata, esto se puede hacer con el comando csdid. Utilizando la base de datos "mpdta.dta", se busca estimar el impacto de una suba del salario mínimo en el empleo joven.

(a) *Estimar todos los ATT (g, t) sin variables explicativas.*

<u>Estimación (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):</u>

```
Difference-in-difference with Multiple Time Periods

                                                   Number of obs = 2,500
Outcome model  : least squares
Treatment model: inverse probability
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
g2004        |
 t_2003_2004 |  -.0105032    .023251    -0.45   0.651    -.0560744    .0350679
 t_2003_2005 |  -.0704232   .0309848    -2.27   0.023    -.1311522   -.0096941
 t_2003_2006 |  -.1372587   .0364357    -3.77   0.000    -.2086713   -.0658461
 t_2003_2007 |  -.1008114   .0343592    -2.93   0.003    -.1681542   -.0334685
-------------+----------------------------------------------------------------
g2006        |
 t_2003_2004 |   .0065201   .0233268     0.28   0.780    -.0391996    .0522398
 t_2004_2005 |  -.0027508   .0195586    -0.14   0.888    -.0410849    .0355833
 t_2005_2006 |  -.0045946   .0177552    -0.26   0.796    -.0393942    .0302049
 t_2005_2007 |  -.0412245   .0202292    -2.04   0.042    -.0808729    -.001576
-------------+----------------------------------------------------------------
g2007        |
 t_2003_2004 |   .0305067   .0150336     2.03   0.042     .0010414    .0599719
 t_2004_2005 |  -.0027259   .0163958    -0.17   0.868    -.0348611    .0294093
 t_2005_2006 |  -.0310871   .0178775    -1.74   0.082    -.0661264    .0039522
 t_2006_2007 |  -.0260544   .0166554    -1.56   0.118    -.0586985    .0065896
------------------------------------------------------------------------------
Control: Never Treated

See Callaway and Sant'Anna (2021) for details
```

(b) *Evaluar si es plausible el efecto de tendencias paralelas en base a las tendencias previas al otorgamiento del tratamiento. ¿Puede haber habido factores que hayan afectado la evolución del empleo en todos los estados tratados que no se deba al otorgamiento del tratamiento? Reflexionar acerca del rol de la forma funcional de las variables (por ejemplo, en niveles vs. en logaritmos).*

<u>Test para tendencias paralelas (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):</u>

```
Pretrend Test. H0 All Pre-treatment are equal to 0
chi2(5) =     7.7912
p-value =     0.1681
```

(c) *Computar el efecto agregado simple, el efecto agregado por grupos, el efecto agregado por período y el efecto agregado por períodos tras el otorgamiento del tratamiento.*

Efecto agregado simple (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
Average Treatment Effect on Treated
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         ATT |  -.0399513    .012034    -3.32   0.001    -.0635375    -.016365
------------------------------------------------------------------------------
```

Efecto agregado por grupos (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
ATT by group
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    GAverage |  -.0310183   .0123872    -2.50   0.012    -.0552967   -.0067399
       G2004 |  -.0797491   .0263678    -3.02   0.002    -.1314291   -.0280692
       G2006 |  -.0229095   .0167033    -1.37   0.170    -.0556475    .0098284
       G2007 |  -.0260544   .0166554    -1.56   0.118    -.0586985    .0065896
------------------------------------------------------------------------------
```

Efecto agregado por período (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
ATT by Calendar Period
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    CAverage |  -.0417004   .0159719    -2.61   0.009    -.0730047   -.0103962
       T2004 |  -.0105032    .023251    -0.45   0.651    -.0560744    .0350679
       T2005 |  -.0704232   .0309848    -2.27   0.023    -.1311522   -.0096941
       T2006 |   -.048816   .0201259    -2.43   0.015    -.0882619     -.00937
       T2007 |  -.0370593   .0137471    -2.70   0.007    -.0640031   -.0101156
------------------------------------------------------------------------------
```

Efecto agregado por períodos tras el otorgamiento del tratamiento (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
ATT by Periods Before and After treatment
Event Study:Dynamic effects
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
     Pre_avg |   .0018283    .007657     0.24   0.811    -.0131791    .0168357
    Post_avg |  -.0772398    .019965    -3.87   0.000    -.1163705   -.0381092
         Tm3 |   .0305067   .0150336     2.03   0.042     .0010414    .0599719
         Tm2 |  -.0005631   .0132916    -0.04   0.966    -.0266142    .0254881
         Tm1 |  -.0244587   .0142364    -1.72   0.086    -.0523616    .0034441
         Tp0 |  -.0199318   .0118264    -1.69   0.092    -.0431111    .0032474
         Tp1 |  -.0509574   .0168935    -3.02   0.003     -.084068   -.0178468
         Tp2 |  -.1372587   .0364357    -3.77   0.000    -.2086713   -.0658461
         Tp3 |  -.1008114   .0343592    -2.93   0.003    -.1681542   -.0334685
------------------------------------------------------------------------------
```

(d) *Repetir los incisos anteriores condicionando en la variable de población.*

Estimación (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
Difference-in-difference with Multiple Time Periods

                                                      Number of obs = 2,500
Outcome model  : least squares
Treatment model: inverse probability
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
g2004        |
 t_2003_2004 |  -.0145297   .0221292    -0.66   0.511     -.057902    .0288427
 t_2003_2005 |  -.0764219   .0286713    -2.67   0.008    -.1326166   -.0202271
 t_2003_2006 |  -.1404483   .0353782    -3.97   0.000    -.2097882   -.0711084
 t_2003_2007 |  -.1069039   .0328865    -3.25   0.001    -.1713602   -.0424476
-------------+----------------------------------------------------------------
g2006        |
 t_2003_2004 |  -.0004721   .0222234    -0.02   0.983    -.0440293     .043085
 t_2004_2005 |  -.0062025   .0184957    -0.34   0.737    -.0424534    .0300484
 t_2005_2006 |   .0009606   .0194002     0.05   0.961    -.0370631    .0389843
 t_2005_2007 |  -.0412939   .0197211    -2.09   0.036    -.0799466   -.0026411
-------------+----------------------------------------------------------------
g2007        |
 t_2003_2004 |   .0267278   .0140657     1.90   0.057    -.0008404     .054296
 t_2004_2005 |  -.0045766   .0157178    -0.29   0.771    -.0353828    .0262297
 t_2005_2006 |  -.0284475   .0181809    -1.56   0.118    -.0640814    .0071864
 t_2006_2007 |  -.0287814    .016239    -1.77   0.076    -.0606091    .0030464
------------------------------------------------------------------------------
Control: Never Treated

See Callaway and Sant'Anna (2021) for details
```

Test para tendencias paralelas (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
Pretrend Test. H0 All Pre-treatment are equal to 0
chi2(5) =     6.8418
p-value =     0.2327
```

Efecto agregado simple (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
Average Treatment Effect on Treated
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         ATT |  -.0417518   .0115028    -3.63   0.000    -.0642969   -.0192066
------------------------------------------------------------------------------
```

Efecto agregado por grupos (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
ATT by group
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    GAverage |  -.0310183   .0123872    -2.50   0.012    -.0552967   -.0067399
       G2004 |  -.0797491   .0263678    -3.02   0.002    -.1314291   -.0280692
       G2006 |  -.0229095   .0167033    -1.37   0.170    -.0556475    .0098284
       G2007 |  -.0260544   .0166554    -1.56   0.118    -.0586985    .0065896
------------------------------------------------------------------------------
```

Efecto agregado por período (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
ATT by Calendar Period
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    CAverage |  -.0441774   .0150382    -2.94   0.003    -.0736516   -.0147031
       T2004 |  -.0145297   .0221292    -0.66   0.511     -.057902    .0288427
       T2005 |  -.0764219   .0286713    -2.67   0.008    -.1326166   -.0202271
       T2006 |  -.0461757   .0212107    -2.18   0.029     -.087748   -.0046035
       T2007 |  -.0395822   .0129299    -3.06   0.002    -.0649242   -.0142401
------------------------------------------------------------------------------
```

Efecto agregado por períodos tras el otorgamiento del tratamiento (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
ATT by Periods Before and After treatment
Event Study:Dynamic effects
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
     Pre_avg |  -.0000442   .0075204    -0.01   0.995     -.014784    .0146955
    Post_avg |  -.0803539   .0189576    -4.24   0.000    -.1175101   -.0431978
         Tm3 |   .0267278   .0140657     1.90   0.057    -.0008404     .054296
         Tm2 |  -.0036165   .0129283    -0.28   0.780    -.0289555    .0217226
         Tm1 |   -.023244   .0144851    -1.60   0.109    -.0516343    .0051463
         Tp0 |  -.0210604   .0114942    -1.83   0.067    -.0435886    .0014679
         Tp1 |  -.0530032   .0163465    -3.24   0.001    -.0850417   -.0209647
         Tp2 |  -.1404483   .0353782    -3.97   0.000    -.2097882   -.0711084
         Tp3 |  -.1069039   .0328865    -3.25   0.001    -.1713602   -.0424476
------------------------------------------------------------------------------
```

(e) *Hasta ahora, se utilizaron los nunca tratados como grupo de control. Repetir los incisos anteriores utilizando el grupo de los no tratados todavía. ¿Se observan cambios?*

Estimación (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
Difference-in-difference with Multiple Time Periods

                                                      Number of obs = 2,500
Outcome model  : least squares
Treatment model: inverse probability
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
g2004        |
 t_2003_2004 |  -.0193724   .0223101    -0.87   0.385    -.0630994    .0243547
 t_2003_2005 |  -.0783191   .0303902    -2.58   0.010    -.1378829   -.0187553
 t_2003_2006 |  -.1362743   .0354034    -3.85   0.000    -.2056637    -.066885
 t_2003_2007 |  -.1008114   .0343592    -2.93   0.003    -.1681542   -.0334685
-------------+----------------------------------------------------------------
g2006        |
 t_2003_2004 |  -.0025626   .0225302    -0.11   0.909     -.046721    .0415959
 t_2004_2005 |  -.0019392   .0190422    -0.10   0.919    -.0392612    .0353827
 t_2005_2006 |   .0046609   .0163356     0.29   0.775    -.0273563     .036678
 t_2005_2007 |  -.0412245   .0202292    -2.04   0.042    -.0808729    -.001576
-------------+----------------------------------------------------------------
g2007        |
 t_2003_2004 |   .0305067   .0150336     2.03   0.042     .0010414    .0599719
 t_2004_2005 |  -.0027259   .0163958    -0.17   0.868    -.0348611    .0294093
 t_2005_2006 |  -.0310871   .0178775    -1.74   0.082    -.0661264    .0039522
 t_2006_2007 |  -.0260544   .0166554    -1.56   0.118    -.0586985    .0065896
------------------------------------------------------------------------------
Control: Not yet Treated

See Callaway and Sant'Anna (2021) for details
```

Test para tendencias paralelas (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
Pretrend Test. H0 All Pre-treatment are equal to 0
chi2(5) =     7.7912
p-value =     0.1681
```

Efecto agregado simple (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
Average Treatment Effect on Treated
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         ATT |  -.0397636   .0120524    -3.30   0.001    -.0633859   -.0161413
------------------------------------------------------------------------------
```

Efecto agregado por grupos (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
ATT by group
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    GAverage |  -.0304622   .0125031    -2.44   0.015    -.0549678   -.0059566
       G2004 |  -.0836943   .0257016    -3.26   0.001    -.1340685   -.0333201
       G2006 |  -.0182818   .0159222    -1.15   0.251    -.0494888    .0129252
       G2007 |  -.0260544   .0166554    -1.56   0.118    -.0586985    .0065896
------------------------------------------------------------------------------
```

Efecto agregado por período (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
ATT by Calendar Period
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    CAverage |  -.0442671   .0155709    -2.84   0.004    -.0747855   -.0137487
       T2004 |  -.0193724   .0223101    -0.87   0.385    -.0630994    .0243547
       T2005 |  -.0783191   .0303902    -2.58   0.010    -.1378829   -.0187553
       T2006 |  -.0423175   .0190563    -2.22   0.026    -.0796671    -.004968
       T2007 |  -.0370593   .0137471    -2.70   0.007    -.0640031   -.0101156
------------------------------------------------------------------------------
```

Efecto agregado por períodos tras el otorgamiento del tratamiento (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
ATT by Periods Before and After treatment
Event Study:Dynamic effects
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
     Pre_avg |   .0011834   .0073393     0.16   0.872    -.0132015    .0155682
    Post_avg |  -.0773993   .0195602    -3.96   0.000    -.1157366   -.0390621
         Tm3 |   .0305067   .0150336     2.03   0.042     .0010414    .0599719
         Tm2 |  -.0026877   .0134388    -0.20   0.841    -.0290273    .0236519
         Tm1 |  -.0242689   .0144637    -1.68   0.093    -.0526172    .0040794
         Tp0 |  -.0189222   .0120446    -1.57   0.116    -.0425291    .0046847
         Tp1 |  -.0535893   .0169464    -3.16   0.002    -.0868037    -.020375
         Tp2 |  -.1362743   .0354034    -3.85   0.000    -.2056637    -.066885
         Tp3 |  -.1008114   .0343592    -2.93   0.003    -.1681542   -.0334685
------------------------------------------------------------------------------
```

Estimación (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
Difference-in-difference with Multiple Time Periods

                                                      Number of obs = 2,500
Outcome model  : least squares
Treatment model: inverse probability
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
g2004        |
 t_2003_2004 |  -.0211831   .0216482    -0.98   0.328    -.0636128    .0212467
 t_2003_2005 |  -.0816032   .0283415    -2.88   0.004    -.1371516   -.0260548
 t_2003_2006 |  -.1381918    .034228    -4.04   0.000    -.2052775   -.0711061
 t_2003_2007 |  -.1069039   .0328865    -3.25   0.001    -.1713602   -.0424476
-------------+----------------------------------------------------------------
g2006        |
 t_2003_2004 |  -.0074552   .0218357    -0.34   0.733    -.0502525     .035342
 t_2004_2005 |  -.0045634   .0182914    -0.25   0.803    -.0404138    .0312871
 t_2005_2006 |   .0086607   .0168391     0.51   0.607    -.0243433    .0416647
 t_2005_2007 |  -.0412939   .0197211    -2.09   0.036    -.0799466   -.0026411
-------------+----------------------------------------------------------------
g2007        |
 t_2003_2004 |   .0267278   .0140657     1.90   0.057    -.0008404     .054296
 t_2004_2005 |  -.0045766   .0157178    -0.29   0.771    -.0353828    .0262297
 t_2005_2006 |  -.0284475   .0181809    -1.56   0.118    -.0640814    .0071864
 t_2006_2007 |  -.0287814    .016239    -1.77   0.076    -.0606091    .0030464
------------------------------------------------------------------------------
Control: Not yet Treated

See Callaway and Sant'Anna (2021) for details
```

Test para tendencias paralelas (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
Pretrend Test. H0 All Pre-treatment are equal to 0
chi2(5) =     6.8655
p-value =     0.2308
```

Efecto agregado simple (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
Average Treatment Effect on Treated
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         ATT |  -.0413516   .0114278    -3.62   0.000    -.0637498   -.0189535
------------------------------------------------------------------------------
```

Efecto agregado por grupos (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
ATT by group
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    GAverage |   -.032264   .0119004    -2.71   0.007    -.0555884   -.0089397
       G2004 |  -.0869705    .024062    -3.61   0.000    -.1341312   -.0398097
       G2006 |  -.0163166   .0161883    -1.01   0.313    -.0480451     .015412
       G2007 |  -.0287814    .016239    -1.77   0.076    -.0606091    .0030464
------------------------------------------------------------------------------
```

Efecto agregado por período (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
ATT by Calendar Period
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
    CAverage |  -.0456646   .0146983    -3.11   0.002    -.0744727   -.0168566
       T2004 |  -.0211831   .0216482    -0.98   0.328    -.0636128    .0212467
       T2005 |  -.0816032   .0283415    -2.88   0.004    -.1371516   -.0260548
       T2006 |  -.0402901   .0192635    -2.09   0.036    -.0780459   -.0025344
       T2007 |  -.0395822   .0129299    -3.06   0.002    -.0649242   -.0142401
------------------------------------------------------------------------------
```

Efecto agregado por períodos tras el otorgamiento del tratamiento (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
ATT by Periods Before and After treatment
Event Study:Dynamic effects
------------------------------------------------------------------------------
             | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
     Pre_avg |  -.0004609   .0072816    -0.06   0.950    -.0147326    .0138108
    Post_avg |  -.0799926    .018494    -4.33   0.000    -.1162402    -.043745
         Tm3 |   .0267278   .0140657     1.90   0.057    -.0008404     .054296
         Tm2 |  -.0052499   .0130015    -0.40   0.686    -.0307325    .0202326
         Tm1 |  -.0228606   .0146118    -1.56   0.118    -.0514991     .005778
         Tp0 |  -.0201445   .0116323    -1.73   0.083    -.0429433    .0026544
         Tp1 |  -.0547303      .0164    -3.34   0.001    -.0868738   -.0225869
         Tp2 |  -.1381918    .034228    -4.04   0.000    -.2052775   -.0711061
         Tp3 |  -.1069039   .0328865    -3.25   0.001    -.1713602   -.0424476
------------------------------------------------------------------------------
```

(f) *Comparar con los resultados que surgen de hacer TWFE estático y dinámico.*

TWFE estático:

```
HDFE Linear regression                            Number of obs   =      2,500
Absorbing 2 HDFE groups                           F(   1,    499) =       7.59
Statistics robust to heteroskedasticity           Prob > F        =     0.0061
                                                  R-squared       =     0.9932
                                                  Adj R-squared   =     0.9915
                                                  Within R-sq.    =     0.0042
Number of clusters (countyreal) =        500      Root MSE        =     0.1391

                           (Std. err. adjusted for 500 clusters in countyreal)
------------------------------------------------------------------------------
             |               Robust
        lemp | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
           D |  -.0365489   .0132652    -2.76   0.006    -.0626114   -.0104865
       _cons |   5.776771   .0015441  3741.28   0.000     5.773737    5.779804
------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
  countyreal |       500         500           0    *|
        year |         5           1           4     |
-----------------------------------------------------+
* = FE nested within cluster; treated as redundant for DoF computation
```

TWFE dinámico:

```
HDFE Linear regression                            Number of obs   =      2,500
Absorbing 2 HDFE groups                           F(   7,    499) =       3.60
Statistics robust to heteroskedasticity           Prob > F        =     0.0009
                                                  R-squared       =     0.9933
                                                  Adj R-squared   =     0.9915
                                                  Within R-sq.    =     0.0103
Number of clusters (countyreal) =        500      Root MSE        =     0.1388

                           (Std. err. adjusted for 500 clusters in countyreal)
------------------------------------------------------------------------------
             |               Robust
        lemp | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         Tm4 |   .0216933   .0253871     0.85   0.393    -.0281855     .071572
         Tm3 |   .0427674   .0199126     2.15   0.032     .0036446    .0818902
         Tm2 |   .0414987   .0162692     2.55   0.011     .0095342    .0734633
         Tm1 |   .0181439   .0109822     1.65   0.099    -.0034332     .039721
         Tp1 |  -.0253284   .0160191    -1.58   0.114    -.0568016    .0061447
         Tp2 |  -.1136509   .0270505    -4.20   0.000    -.1667978    -.060504
         Tp3 |  -.0741029    .031016    -2.39   0.017    -.1350409   -.0131648
       _cons |    5.76634   .0040209  1434.09   0.000      5.75844     5.77424
------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
  countyreal |       500         500           0    *|
        year |         5           1           4     |
-----------------------------------------------------+
* = FE nested within cluster; treated as redundant for DoF computation
```

<u>Ejercicio 4:</u> Enfoque de Wooldridge y jwdid.

Frente a las críticas de la literatura a la presunta incapacidad de la especificación de TWFE para estimar los efectos promedio de tratamiento sobre los tratados, Wooldridge (2021) propone que el problema no es intrínseco a que la ecuación de estimación sea lineal con efectos fijos ni a que se estime con los métodos tradicionales de datos de panel.1 En particular, con T períodos temporales y el tratamiento otorgado en cada período desde el período q hasta el último, se propone estimar la siguiente ecuación:

$$Y_{it} = \alpha + \lambda_q d_{iq} + \ldots + \lambda_T d_{iT} + \sum_{r=q}^{T} \sum_{s=r}^{T} \tau_{rs}(d_{ir} 1\{t = s\}) + \theta_t + \epsilon_{it},$$

donde τ_{rs} representa el ATT en el período s para el grupo r, α es una constante, d_{ir} es una dummy que vale 1 para el grupo tratado en r, con r= q, … , T. Replicar el ejercicio anterior con el comando jwdid.

<u>Estimación (sin variables explicativas y sin utilizar el grupo de los no tratados todavía):</u>

```
HDFE Linear regression                            Number of obs   =      2,500
Absorbing 2 HDFE groups                           F(  12,    499) =       2.87
Statistics robust to heteroskedasticity           Prob > F        =     0.0008
                                                  R-squared       =     0.0288
                                                  Adj R-squared   =     0.0213
                                                  Within R-sq.    =     0.0001
Number of clusters (countyreal) =        500      Root MSE        =     1.4926

                                       (Std. err. adjusted for 500 clusters in countyreal)
------------------------------------------------------------------------------------------
                          |               Robust
                     lemp | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
--------------------------+---------------------------------------------------------------
first_treat#year#c.__tr__ |
              2004 2004   |  -.0105032   .0233633    -0.45   0.653    -.0564058    .0353993
              2004 2005   |  -.0704232   .0311344    -2.26   0.024    -.1315938   -.0092525
              2004 2006   |  -.1372587   .0366116    -3.75   0.000    -.2091906   -.0653269
              2004 2007   |  -.1008114   .0345251    -2.92   0.004    -.1686439   -.0329788
              2006 2003   |  -.0037693   .0314934    -0.12   0.905    -.0656452    .0581067
              2006 2004   |   .0027508    .019653     0.14   0.889     -.035862    .0413637
              2006 2006   |  -.0045946   .0178409    -0.26   0.797    -.0396472     .030458
              2006 2007   |  -.0412245   .0203269    -2.03   0.043    -.0811613   -.0012877
              2007 2003   |   .0033064   .0245699     0.13   0.893    -.0449669    .0515796
              2007 2004   |    .033813   .0212312     1.59   0.112    -.0079006    .0755266
              2007 2005   |   .0310871   .0179638     1.73   0.084     -.004207    .0663812
              2007 2007   |  -.0260544   .0167359    -1.56   0.120    -.0589358     .006827
                          |
                    _cons |   5.773609   .0666494    86.63   0.000     5.642661    5.904557
------------------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
 first_treat |         4           0           4     |
        year |         5           1           4     |
-----------------------------------------------------+
```

Estimación (con variables explicativas y sin utilizar el grupo de los no tratados todavía):

```
HDFE Linear regression                            Number of obs   =      2,500
Absorbing 2 HDFE groups                           F(  32,    499) =     260.29
Statistics robust to heteroskedasticity           Prob > F        =     0.0000
                                                  R-squared       =     0.8732
                                                  Adj R-squared   =     0.8712
                                                  Within R-sq.    =     0.8695
Number of clusters (countyreal) =        500      Root MSE        =     0.5414

                                                  (Std. err. adjusted for 500 clusters in countyreal)
------------------------------------------------------------------------------------------------------
                                    |               Robust
                               lemp | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-----------------------------------+------------------------------------------------------------------
          first_treat#year#c.__tr__ |
                        2004 2004  |  -.0149112   .0222514    -0.67   0.503    -.0586293    .0288068
                        2004 2005  |  -.0769963   .0278076    -2.77   0.006    -.1316307    -.022362
                        2004 2006  |  -.1410801   .0322892    -4.37   0.000    -.2045196   -.0776406
                        2004 2007  |  -.1075443   .0329232    -3.27   0.001    -.1722294   -.0428592
                        2006 2003  |   .0090343   .0302653     0.30   0.765    -.0504289    .0684976
                        2006 2004  |   .0069683   .0182179     0.38   0.702     -.028825    .0427616
                        2006 2006  |   .0007655   .0186594     0.04   0.967    -.0358952    .0374263
                        2006 2007  |  -.0415356   .0192255    -2.16   0.031    -.0793085   -.0037627
                        2007 2003  |   .0068961   .0246894     0.28   0.780    -.0416118     .055404
                        2007 2004  |   .0332619    .021331     1.56   0.120    -.0086478    .0751717
                        2007 2005  |   .0285021   .0182913     1.56   0.120    -.0074353    .0644395
                        2007 2007  |  -.0287895   .0161542    -1.78   0.075    -.0605281    .0029491
                                   |
first_treat#year#c.__tr__#c._x_lpop |
                        2004 2004  |   .0005953   .0183817     0.03   0.974    -.0355198    .0367104
                        2004 2005  |   .0234096    .018401     1.27   0.204    -.0127434    .0595626
                        2004 2006  |   .0482261   .0224513     2.15   0.032     .0041154    .0923369
                        2004 2007  |   .0091886   .0271808     0.34   0.735    -.0442144    .0625916
                        2006 2003  |  -.0126074   .0243681    -0.52   0.605    -.0604842    .0352693
                        2006 2004  |  -.0177865   .0162122    -1.10   0.273    -.0496391    .0140661
                        2006 2006  |   .0282074   .0141414     1.99   0.047     .0004234    .0559915
                        2006 2007  |   .0277793   .0181101     1.53   0.126    -.0078021    .0633607
                        2007 2003  |   .0083787   .0254399     0.33   0.742    -.0416037    .0583611
                        2007 2004  |  -.0079105   .0188942    -0.42   0.676    -.0450324    .0292114
                        2007 2005  |  -.0025825   .0178553    -0.14   0.885    -.0376633    .0324982
                        2007 2007  |  -.0203637   .0162347    -1.25   0.210    -.0522606    .0115331
                                   |
                              lpop |     1.0634   .0212754    49.98   0.000       1.0216      1.1052
                                   |
                  first_treat#c.lpop |
                              2004 |   .0530435   .0374929     1.41   0.158      -.02062     .126707
                              2006 |   -.030815   .0461109    -0.67   0.504    -.1214104    .0597803
                              2007 |    .056047   .0439926     1.27   0.203    -.0303866    .1424806
                                   |
                        year#c.lpop |
                              2004 |   .0150462   .0092116     1.63   0.103    -.0030521    .0331445
                              2005 |   .0224368   .0091008     2.47   0.014     .0045562    .0403173
                              2006 |   .0130438   .0132642     0.98   0.326    -.0130168    .0391044
                              2007 |   .0229821   .0129513     1.77   0.077    -.0024638    .0484279
                                   |
                             _cons |   2.152986   .0722075    29.82   0.000     2.011117    2.294854
------------------------------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
 first_treat |         4           0           4     |
        year |         5           1           4     |
-----------------------------------------------------+
```

Estimación (sin variables explicativas y utilizando el grupo de los no tratados todavía):

```
HDFE Linear regression                            Number of obs   =      2,500
Absorbing 2 HDFE groups                           F(   7,    499) =       3.81
Statistics robust to heteroskedasticity           Prob > F        =     0.0005
                                                  R-squared       =     0.0288
                                                  Adj R-squared   =     0.0233
                                                  Within R-sq.    =     0.0001
Number of clusters (countyreal) =        500      Root MSE        =     1.4911

                                        (Std. err. adjusted for 500 clusters in countyreal)
------------------------------------------------------------------------------------------
                         |               Robust
                    lemp | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------------------+----------------------------------------------------------------
first_treat#year#c.__tr__ |
               2004 2004  |  -.0193724   .0223953    -0.87   0.387     -.063373    .0246283
               2004 2005  |  -.0783191   .0305062    -2.57   0.011    -.1382556   -.0183826
               2004 2006  |  -.1360781   .0354769    -3.84   0.000    -.2057806   -.0663756
               2004 2007  |  -.1047075   .0338947    -3.09   0.002    -.1713015   -.0381135
               2006 2006  |   .0025139   .0199448     0.13   0.900    -.0366724    .0417001
               2006 2007  |  -.0391927   .0240232    -1.63   0.103    -.0863919    .0080064
               2007 2007  |   -.043106   .0184423    -2.34   0.020    -.0793401    -.006872
                          |
                     _cons |    5.77807   .0665051    86.88   0.000     5.647405    5.908734
------------------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
 first_treat |         4           0           4     |
        year |         5           1           4     |
-----------------------------------------------------+
```

Estimación (con variables explicativas y utilizando el grupo de los no tratados todavía):

```
HDFE Linear regression                            Number of obs   =      2,500
Absorbing 2 HDFE groups                           F(  22,    499) =     364.06
Statistics robust to heteroskedasticity           Prob > F        =     0.0000
                                                  R-squared       =     0.8732
                                                  Adj R-squared   =     0.8717
                                                  Within R-sq.    =     0.8695
Number of clusters (countyreal) =        500      Root MSE        =     0.5404

                                                  (Std. err. adjusted for 500 clusters in countyreal)
------------------------------------------------------------------------------------------------------
                                    |               Robust
                               lemp | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-----------------------------------+------------------------------------------------------------------
          first_treat#year#c.__tr__ |
                        2004 2004  |   -.021248    .021724    -0.98   0.329    -.0639298    .0214338
                        2004 2005  |    -.08185   .0273694    -2.99   0.003    -.1356234   -.0280766
                        2004 2006  |  -.1378704   .0307884    -4.48   0.000    -.1983612   -.0773796
                        2004 2007  |  -.1095395   .0323153    -3.39   0.001    -.1730302   -.0460487
                        2006 2006  |   .0025368    .018879     0.13   0.893    -.0345554     .039629
                        2006 2007  |  -.0450935   .0219826    -2.05   0.041    -.0882834   -.0019035
                        2007 2007  |  -.0459545   .0179714    -2.56   0.011    -.0812636   -.0106455
                                   |
first_treat#year#c.__tr__#c._x_lpop |
                        2004 2004  |   .0046278   .0175804     0.26   0.792    -.0299129    .0391685
                        2004 2005  |   .0251131   .0179003     1.40   0.161    -.0100561    .0602822
                        2004 2006  |   .0507346   .0210659     2.41   0.016     .0093457    .0921234
                        2004 2007  |   .0112497   .0266118     0.42   0.673    -.0410353    .0635346
                        2006 2006  |   .0389352   .0164686     2.36   0.018     .0065789    .0712915
                        2006 2007  |   .0380597   .0224724     1.69   0.091    -.0060925     .082212
                        2007 2007  |  -.0198351   .0161949    -1.22   0.221    -.0516538    .0119835
                                   |
                              lpop |   1.065461   .0218238    48.82   0.000     1.022583    1.108339
                                   |
                 first_treat#c.lpop |
                              2004 |   .0509824   .0377558     1.35   0.178    -.0231975    .1251622
                              2006 |  -.0410954   .0473896    -0.87   0.386    -.1342031    .0520122
                              2007 |   .0555184   .0392124     1.42   0.157    -.0215233    .1325601
                                   |
                       year#c.lpop |
                              2004 |   .0110137   .0075537     1.46   0.145    -.0038274    .0258548
                              2005 |   .0207333   .0081044     2.56   0.011     .0048103    .0366564
                              2006 |   .0105354   .0108157     0.97   0.330    -.0107145    .0317853
                              2007 |    .020921   .0118084     1.77   0.077    -.0022793    .0441212
                                   |
                             _cons |     2.1617   .0699859    30.89   0.000     2.024197    2.299204
------------------------------------------------------------------------------------------------------

Absorbed degrees of freedom:
-----------------------------------------------------+
 Absorbed FE | Categories  - Redundant  = Num. Coefs |
-------------+---------------------------------------|
 first_treat |         4           0           4     |
        year |         5           1           4     |
-----------------------------------------------------+
```