Regression II
Vanderbilt University
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October 29, 2024
41 total points

Problem Set 6 Solutions

Question 1. This problem will use the dataset described in the midterm. You are interested in the effects that eliminating school fees had on childrens' school enrollment in sub-Saharan Africa. You have annual country-level data on school enrollment rates from 1981 to 2015 for 15 countries and the year in which each country eliminated fees. (Note the enrollment measure is "gross enrollment" which can be greater than 100% since it is the ratio of total enrollment in a grade level divided by the population of the age group typically served by that grade, multiplied by 100). The countries eliminated fees in various years between 1994 and 2012. (**41 points**)

(a) In Stata, open the panel dataset called *WDI-FPE-data.dta* from Github:

For this problem, drop all observations from 2006 and later. All countries were eventually treated in this panel, and we would like to have some "never treated" cases for sake of this problem. After doing this, create a table and an accompanying bar graph that shows the years treatment occurred for countries in this panel. (You may decide on the format for these). How many "timing groups" are there? How many "never treated" countries are there? (**5 points**)

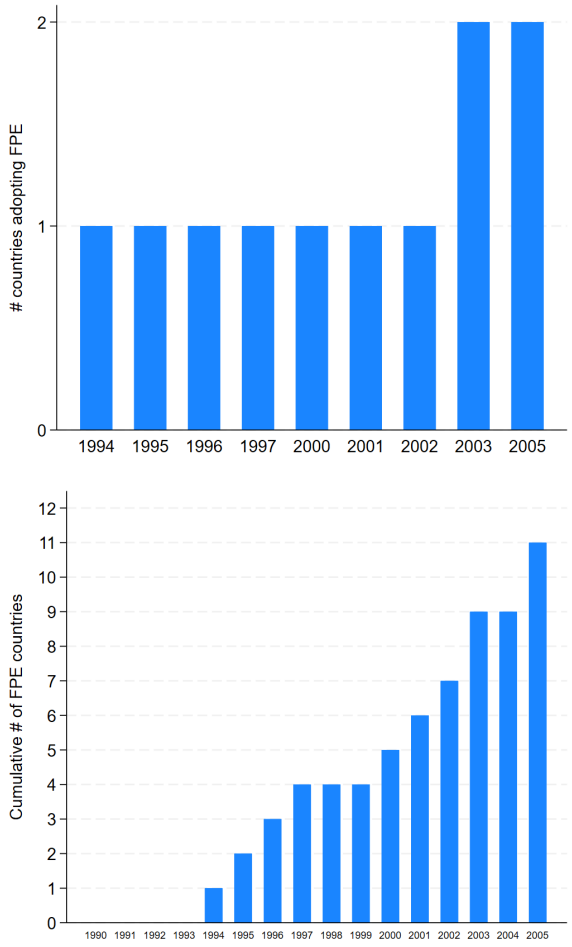
See attached log and figure below. By 2005, 11 countries had eliminated their primary school enrollment fees. Based on the top figure there are 9 different treatment timing groups. Since there are 15 countries in the dataset, there are 4 never-treated countries.

(b) Use `xtset` to declare the data as a panel. Is this a balanced panel? (**2 points**)

See attached log. This is a balanced panel, with 15 countries observed for 25 periods each. However—as noted below—some countries have missing data on the outcome variables in select years.

(c) Estimate the effect of eliminating fees on (i) primary school enrollment, and (ii) secondary school enrollment using "generalized difference-in-differences." For each, implement the two-way fixed effects regression model via `xtreg` and `xtdidregress`. When using `xtreg` be sure to cluster your standard errors appropriately. Briefly summarize your results. (**5 points**)

See attached log. Countries that eliminated primary school fees saw their gross enrollment rate increase 19.2 points, on average, relative to countries

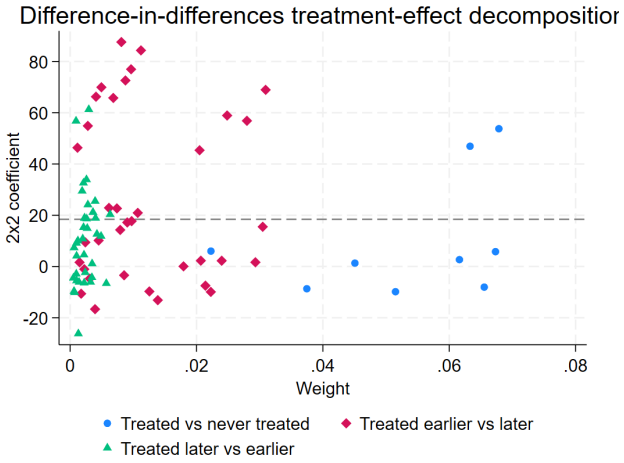


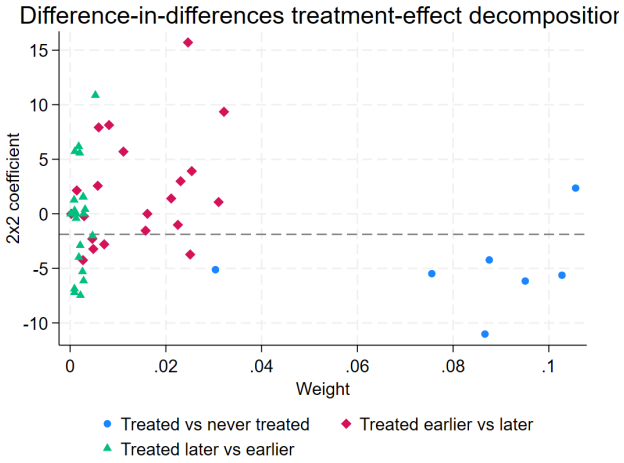
that did not. (Both `xtreg` and `xtdidreg` yield the same result). The estimate is statistically significant at the p=0.10 level. The point estimate for secondary enrollment is a statistically insignificant -1.46 points.

(d) (Quietly) re-run the `xtdidregress` command in part (c)—for both outcomes—and follow each by the post-estimation command `estat bdecomp` which provides the Bacon decomposition. Include the `graph` and `summaryonly` options. Explain in words what the results tell us. (**5 points**)

See attached log and figures below. This command decomposes the TWFE estimate into all possible 2x2 difference-in-differences based on timing groups. The decomposition summary shows the combined ATEs for three groups: treated vs. never treated, treated earlier vs. later, treated later vs. earlier. It also shows the applicable weight for each group. The problematic group is the treated later vs. earlier. If the ATEs for this group are quite different

and they receive a meaningfully large weight, the TWFE model may be misleading. Setting that aside, if the other two group averages are quite different from one another (and both receive significant weights), this may itself suggest a heterogeneous treatment effect model is appropriate. For the primary enrollment regression, the problematic group does not receive much weight (0.087), but the other two group estimates are quite different. For the secondary enrollment regression, all of the estimates are quite different, and are even of different sign. NOTE: it is not clear why the ATET reported in the `bdecomp` (18.4) differs from the one reported by `xtdidregress` (19.1). I think this may have to do with the small number of missing values on the outcome variable—the Stata manual says this command requires the panel be strongly balanced. When I replicated this with a dataset that was not missing values, the results were consistent with each other.





(e) The Stata command `xthdidregress` was created to implement a variety of estimators that allow for heterogeneous treatment effects and address the biases of traditional TWFE estimators when there is staggered treatment timing. Estimate the effect of eliminating fees on primary school enrollment using (i) the Wooldridge (2021) modified TWFE estimator, and (ii) the Callaway and Sant'Anna regression adjustment estimator. These are estimated using `xthdidregress twfe` and `ra`, respectively. (It may help to refer to the Stata help and documentation). Note the default is to use the never-treated as the comparison group. Explain in words how to interpret the regression output (in general, not each specific estimate). (**6 points**)

See attached log. Both approaches estimate separate treatment effects for each treatment timing group and post-treatment time period (Callaway-Sant'Anna also estimates treatment effects for the pre-treatment periods). The Wooldridge model does this using a modified TWFE with group and *post*-treatment period effects and interactions between each timing group and post-treatment period. The Callaway and Sant'Anna approach estimates separate treatment effects for each treatment timing group and year, using the never treated group as the comparison by default. The `ra` version of C-S regresses the change over time in Y on covariates X *in the never treated group* to get predicted changes for all units based on their X. It then calculates ATEs based on the actual change relative to predicted. (Note we have no covariates in this problem, so we are just calculating simple differences in mean changes in Y over time).

In the Wooldridge TWFE approach, treatment effect estimates are in reference to prevailing differences over the *full pre-treatment period*. For example, taking the 1997 cohort as an example, countries that eliminated fees in 1997 saw a comparatively larger increase in gross enrollment of 49.0 in 1997, relative to existing differences in the pre-treatment period. Likewise, they saw a comparatively larger increase in gross enrollment of 55.3 in 1998, relative to existing differences in the pre-treatment period, and so on.

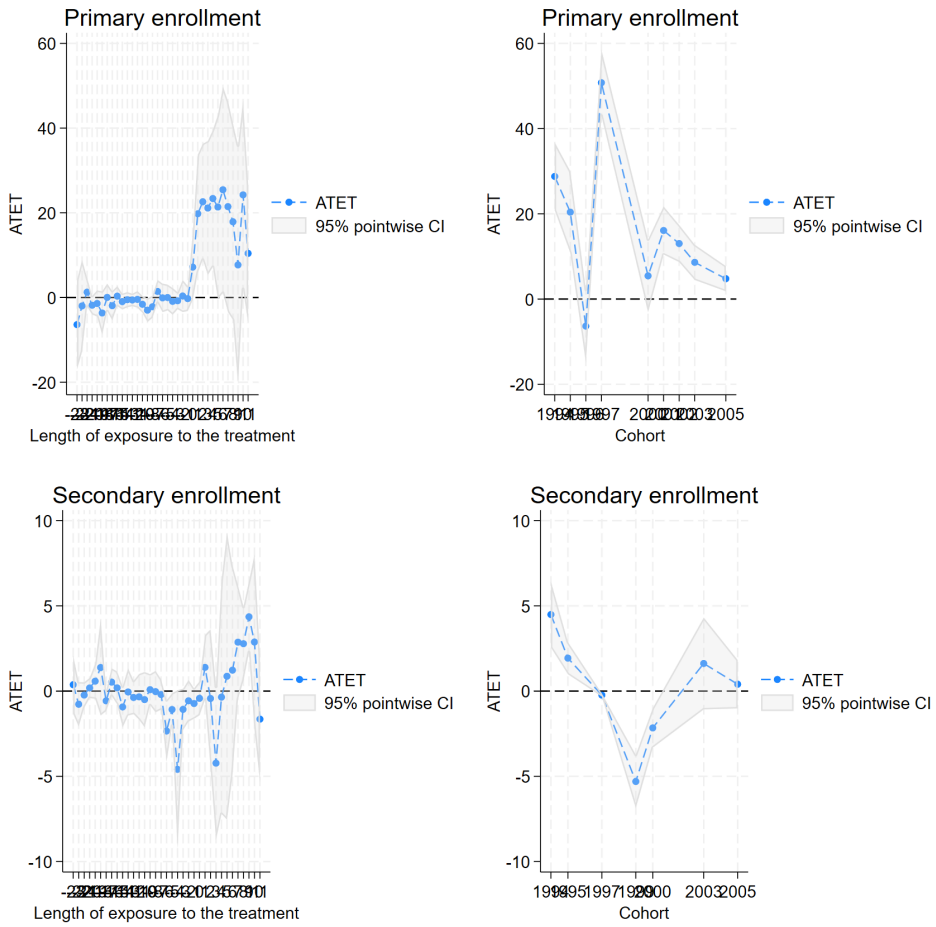
In the C-S approach, the pre-treatment effects contrast *year-to-year changes* for the cohort and the never-treated group. Note these are not comparisons with the time period before treatment. For example, take the 1994 treatment cohort. The 1993 TE estimate contrasts the 1992-to-1993 change for this cohort to the 1992-to-1993 change for the never treated. Similarly, the 1992 TE estimate contrasts the 1991-to-1992 changes, and so on. This is why an estimate for the period before treatment is possible and not an omitted gorup. In the post-treatment periods, the contrast is always with the year before treatment, as you would see in an event study. Note the original C-S Stata package `csdid` actually makes this more transparent through better labeling.

(f) (Quietly) re-run the `xthdidregress ra` command in part (e) and follow it by the post-estimation commands below. Briefly explain what each does. Is there evidence of heterogeneous treatment effects by timing group? By event time? How do these results compare to the traditional TWFE estimates in part (c)? Based on the *dynamic* plot, in what post-treatment years is the treatment effect statistically significant? Finally, explain why the standard errors get larger in this plot over time. (**8 points**)

```
estat aggregation
estat atetplot
estat aggregation, dynamic graph
estat aggregation, cohort graph
```

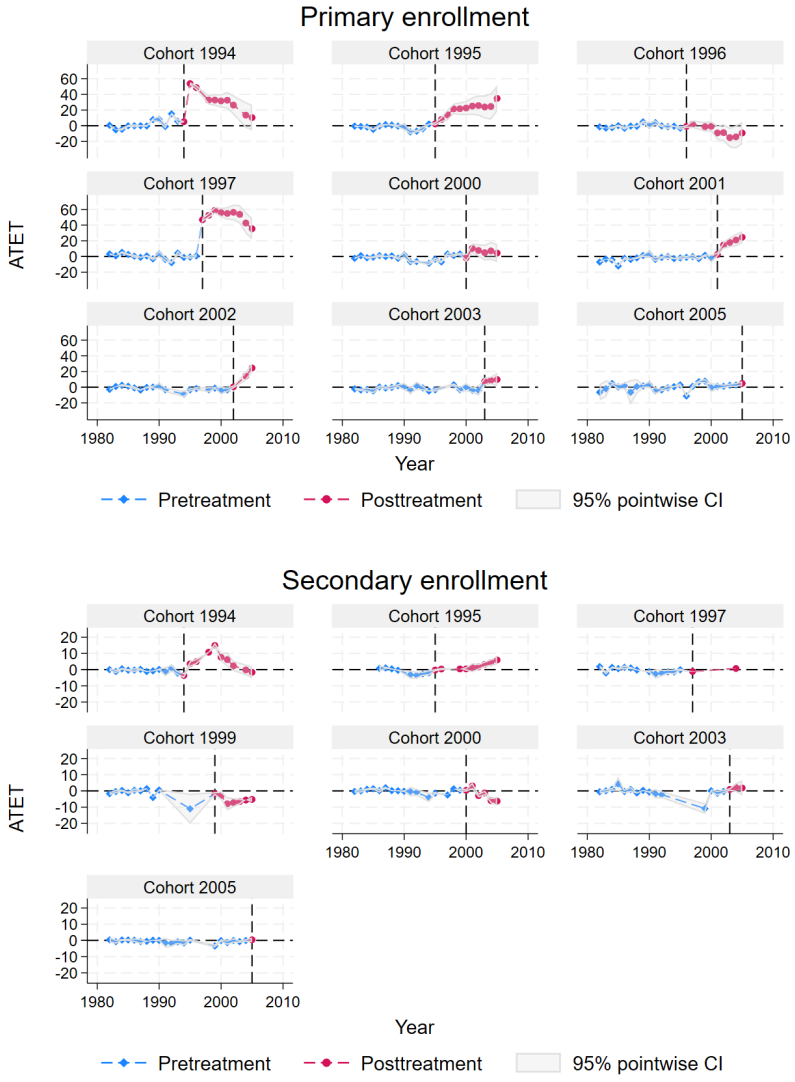
See attached log. The aggregation commands combine the many point estimates from part (e) in meaningful ways. `estat aggregation` **by itself provides an overall ATE estimate for the post-treatment period. In our case, this is 18.4—not all that far off from the original TWFE estimate. The** `dynamic` **option provides an aggregate ATE estimate for each pre and post-treatment period—i.e., combining across treatment timing groups. The** `cohort` **option provides an aggregate post-treatment period effect for each treatment timing group. The figure below shows the time period and cohort specific aggregates. In the dynamic plot, estimates are statistically significant at the 0.05 level in leads 1, 2, 3, 4, 6, and 10, corresponding to year 2-5, 7, and 11 of treatment. The standard errors get larger over time in part because there are fewer observations with data this many periods after treatment.**

`atetplot` **provides a separate event study for each treatment timing group. This plot is shown below.**



(g) As an alternative approach, use the command `eventdd` to estimate an event study model for primary school enrollment. Create your *event time* variable carefully, and use the option `method(fe)` to include country fixed effects. Be sure to also include calendar year effects. In words, interpret the *lead4* and *lag4* coefficients. Does the event study plot support the parallel trends assumption? Briefly explain. (**6 points**)

See attached log and figure below. The *lead4* coefficient of -1.49 tells us that gross enrollment in treated countries was -1.49 points lower than untreated countries in period *t-4* as compared to their prevailing difference in period *t-1* (one year before treatment). This difference is not statistically significant, however. The *lag4* coefficient of 20.7 tells us that gross enrollment in treated countries was 20.7 points higher than untreated countries in period *t+4* as compared to their prevailing difference one year before treatment. The pattern of pre-treatment differences suggest a convergence between the treated and untreated countries prior to treatment. However,



few of these point estimates are statistically different from zero.

(h) Modify your `eventdd` syntax in part (g) to include the `accum` option and to consolidate "8 or more" time periods before and "8 or more" time periods after into one parameter (each). (See the `eventdd` help menu). (**4 points**)

See figure above. This is a good example of how the use of endcaps improves precision and results a cleaner event study diagram, while potentially concealing the trend visible in the top graph.

```
.
. // ************************************************************************
. // LPO-8852 Problem set 6 solutions
. // Last updated: October 28, 2024
. // ************************************************************************
.
. // ****
. // (a)
. // ****
. // Get data
. // These data include 15 sub-saharan African countries observed for 35 years
. // (1981-2015). The "treatment" is the elimination of fees for primary
. // education. Treatment timing is staggered, and by 2013 all countries had
. // eliminated fees.
.
.         use https://github.com/spcorcor18/LPO-8852/raw/main/data/WDI-FPE-data.
> dta, clear

.
.         // Drop observations 2006 and later--just so that we have some never-
.         // treated cases
.
.         keep if year<=2005
(150 observations deleted)

.
.         // Table and bar chart showing count of countries that eliminated fees
> ,
.         // by first year of elimination.
.
.         preserve

.         duplicates drop country, force

Duplicates in terms of country

(360 observations deleted)

.         table fpe_year if fpe_year<=2005

---------------------------------
                     |  Frequency
---------------------+-----------
Year FPE implemented |
  1994               |          1
  1995               |          1
  1996               |          1
  1997               |          1
  2000               |          1
  2001               |          1
  2002               |          1
  2003               |          2
  2005               |          2
  Total              |         11
---------------------------------

.         graph bar (count) if fpe_year<=2005, over(fpe_year) ///
>                 ytitle("# countries adopting FPE") ///
>                 ylabel(0(1)2) name(treat1, replace)
```

```
.         restore

.
.         // Also, a cumulative bar graph
.
.         preserve

.         collapse (sum) treatment, by(year)

.         graph bar (asis) treatment if year>=1990, over(year, label(labsize(vsm
> all))) ///
>                 ytitle("Cumulative # of FPE countries") ylabel(0(1)12) ///
>                 name(treat2, replace)

.
.         graph combine treat1 treat2, altshrink col(1) ysize(8) xsize(5)

.         graph export treattime.png, as(png) replace
file treattime.png saved as PNG format

.         restore

.
.
. // ****
. // (b)
. // ****
. // Declare panel
.
.         encode country, gen(country2)

.         xtset country2 year

Panel variable: country2 (strongly balanced)
 Time variable: year, 1981 to 2005
         Delta: 1 unit

.         xtdescribe

country2:  1, 2, ..., 15                                       n =         15
    year:  1981, 1982, ..., 2005                               T =         25
           Delta(year) = 1 unit
           Span(year)  = 25 periods
           (country2*year uniquely identifies each observation)

Distribution of T_i:   min      5%     25%       50%       75%     95%     max
                        25      25      25        25        25      25      25

     Freq.  Percent    Cum. |  Pattern
 ---------------------------+---------------------------
       15    100.00  100.00 |  111111111111111111111111
 ---------------------------+---------------------------
       15    100.00         |  XXXXXXXXXXXXXXXXXXXXXXXX

.
.
. // ****
. // (c)
. // ****
. // Generalized DD models for primary and secondary gross enrollment rates
```

```
.
.         xtreg primary treatment i.year, fe cluster(country2)

Fixed-effects (within) regression               Number of obs     =         351
Group variable: country2                        Number of groups  =          15

R-squared:                                      Obs per group:
     Within  = 0.3947                                         min =          20
     Between = 0.0002                                         avg =        23.4
     Overall = 0.1304                                         max =          25

                                                F(14, 14)         =           .
corr(u_i, Xb) = -0.0406                         Prob > F          =           .

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
     primary | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
   treatment |   19.18157   10.76345     1.78   0.096    -3.903722    42.26687
             |
        year |
        1982 |   1.259226   1.167683     1.08   0.299    -1.245205    3.763658
        1983 |   1.235221   2.015239     0.61   0.550    -3.087036    5.557478
        1984 |   .7391054   2.369233     0.31   0.760    -4.342394    5.820604
        1985 |   .8244025   3.210361     0.26   0.801    -6.061136    7.709941
        1986 |   .7474387   3.605706     0.21   0.839    -6.986032    8.480909
        1987 |   .7926339   4.558856     0.17   0.864     -8.98514    10.57041
        1988 |   .6215708   5.215499     0.12   0.907    -10.56456     11.8077
        1989 |   .3690333   5.204604     0.07   0.944    -10.79373     11.5318
        1990 |  -.4892878   5.312129    -0.09   0.928    -11.88267     10.9041
        1991 |   .9591381   5.629854     0.17   0.867     -11.1157    13.03397
        1992 |   .2774358    6.09542     0.05   0.964    -12.79594    13.35081
        1993 |   .7158023   6.702409     0.11   0.916    -13.65943    15.09104
        1994 |  -.6675706   5.559854    -0.12   0.906    -12.59227    11.25713
        1995 |   1.760913   7.180693     0.25   0.810    -13.64014    17.16197
        1996 |  -.0607276   6.648265    -0.01   0.993    -14.31984    14.19838
        1997 |   1.558775   6.744974     0.23   0.821    -12.90776    16.02531
        1998 |    5.53646   7.290101     0.76   0.460    -10.09925    21.17217
        1999 |   5.316527   6.945771     0.77   0.457     -9.58067    20.21372
        2000 |   7.396517   7.110302     1.04   0.316    -7.853563     22.6466
        2001 |   9.472849   7.327793     1.29   0.217    -6.243704     25.1894
        2002 |   10.82246   7.692731     1.41   0.181     -5.67681    27.32173
        2003 |   12.01836   8.656464     1.39   0.187    -6.547906    30.58463
        2004 |   14.36221    8.17183     1.76   0.101    -3.164626    31.88904
        2005 |   14.47297   9.205851     1.57   0.138    -5.271618    34.21756
             |
       _cons |   74.30724   5.223551    14.23   0.000     63.10384    85.51065
-------------+----------------------------------------------------------------
     sigma_u |  22.823526
     sigma_e |  13.591824
         rho |  .73820249   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.         xtdidregress (primary) (treatment), group(country2) time(year)

Treatment and time information

Time variable: year
Control:       treatment = 0
Treatment:     treatment = 1
-------------------------------------
             |   Control  Treatment
-------------+-----------------------
Group        |
    country2 |         4         11
-------------+-----------------------
Time         |
     Minimum |      1981       1994
     Maximum |      1986       2005
-------------------------------------
```

```
Difference-in-differences regression                        Number of obs = 351
Data type: Longitudinal

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
     primary | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
ATET         |
   treatment |
   (1 vs 0)  |   19.18157   10.76345     1.78   0.096    -3.903722    42.26687
------------------------------------------------------------------------------
Note: ATET estimate adjusted for panel effects and time effects.
Note: Treatment occurs at different times.

.
.         xtreg secondary treatment i.year, fe cluster(country2)

Fixed-effects (within) regression               Number of obs     =        270
Group variable: country2                        Number of groups  =         15

R-squared:                                      Obs per group:
     Within  = 0.4792                                         min =          8
     Between = 0.2632                                         avg =       18.0
     Overall = 0.1288                                         max =         25

                                                F(14, 14)         =          .
corr(u_i, Xb) = 0.1286                          Prob > F          =          .

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
   secondary | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
   treatment |  -1.464931   2.854691    -0.51   0.616    -7.587635    4.657773
             |
        year |
        1982 |   .7962491   .3308181     2.41   0.030     .0867149    1.505783
        1983 |   1.624021   .4942474     3.29   0.005     .5639657    2.684076
        1984 |   1.764989   .4874427     3.62   0.003     .7195281    2.810449
        1985 |   2.682103   .7832058     3.42   0.004     1.002294    4.361913
        1986 |   1.957971    1.19386     1.64   0.123    -.6026048    4.518546
        1987 |   2.297373   1.375334     1.67   0.117    -.6524247    5.247171
        1988 |   3.066853   1.463417     2.10   0.055    -.0718652    6.205571
        1989 |   2.290612   1.616455     1.42   0.178    -1.176338    5.757563
        1990 |     2.6571   1.410123     1.88   0.080     -.367313    5.681513
        1991 |    3.34971   1.060216     3.16   0.007     1.075773    5.623648
        1992 |   4.064627   .8917332     4.56   0.000     2.152049    5.977204
        1993 |   3.800913   .9111843     4.17   0.001     1.846617    5.755209
        1994 |   4.511493   1.332001     3.39   0.004     1.654636    7.368351
        1995 |    5.57954   1.386862     4.02   0.001     2.605016    8.554063
        1996 |   6.481263   1.926202     3.36   0.005      2.34997    10.61256
        1997 |   6.206332   1.882953     3.30   0.005       2.1678    10.24486
        1998 |     9.6283   2.363148     4.07   0.001     4.559852    14.69675
        1999 |   6.874548   2.128417     3.23   0.006     2.309547    11.43955
        2000 |   7.340093   2.007296     3.66   0.003     3.034872    11.64531
        2001 |   8.854785   2.253882     3.93   0.002     4.020688    13.68888
        2002 |   9.359532   2.223488     4.21   0.001     4.590625    14.12844
        2003 |   10.50029   2.443569     4.30   0.001     5.259357    15.74122
        2004 |   11.80188   2.340546     5.04   0.000     6.781904    16.82185
        2005 |   13.07087    2.86688     4.56   0.000     6.922022    19.21972
             |
       _cons |   15.98785   .7928777    20.16   0.000     14.28729     17.6884
-------------+----------------------------------------------------------------
     sigma_u |  12.949929
     sigma_e |  3.6939926
         rho |  .92475399   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
.         xtdidregress (secondary) (treatment), group(country2) time(year)

Treatment and time information

Time variable: year
Control:       treatment = 0
Treatment:     treatment = 1
-------------------------------------
             |   Control  Treatment
-------------+-----------------------
Group        |
    country2 |         4         11
-------------+-----------------------
Time         |
     Minimum |      1981       1994
     Maximum |      1986       2005
-------------------------------------

Difference-in-differences regression                        Number of obs = 270
Data type: Longitudinal

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
   secondary | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
ATET         |
   treatment |
   (1 vs 0)  |  -1.464931   2.854691    -0.51   0.616    -7.587635    4.657773
------------------------------------------------------------------------------
Note: ATET estimate adjusted for panel effects and time effects.
Note: Treatment occurs at different times.

.
.
. // ****
. // (d)
. // ****
. // Bacon decomposition for primary and secondary enrollment TWFE models
.
.         quietly: xtdidregress (primary) (treatment), group(country2) time(year
> )

.         estat bdecomp, graph summaryonly name(bdecomp1, replace)

DID treatment-effect decomposition

ATET = 18.41153                                         Number of obs     = 351
                                                        Number of groups  =  15
                                                        Number of cohorts =  10

ATET decomposition summary               ATET component                Weight
------------------------------------------------------------------------------
Treated vs never treated                       12.467926             0.481939
Treated earlier vs later                       26.034949             0.433221
Treated later vs earlier                       12.849885             0.087462
------------------------------------------------------------------------------
Note: Number of cohorts includes never treated.
Note: The ATET reported by xtdidregress is a weighted average of the ATET
      components. If any component is substantially different from the ATET
      reported by xtdidregress and the weight is large, consider accounting
      for treatment-effect heterogeneity by using xthdidregress.
```

```
.
.         quietly: xtdidregress (secondary) (treatment), group(country2) time(ye
> ar)

.         estat bdecomp, graph summaryonly name(bdecomp2, replace)

DID treatment-effect decomposition

ATET = -1.882997                                        Number of obs     = 270
                                                        Number of groups  =  15
                                                        Number of cohorts =   8

ATET decomposition summary               ATET component                Weight
------------------------------------------------------------------------------
Treated vs never treated                     -4.8168067             0.583529
Treated earlier vs later                      3.1361367             0.291621
Treated later vs earlier                       .30114105            0.043783
------------------------------------------------------------------------------
Note: Number of cohorts includes never treated.
Note: The ATET reported by xtdidregress is a weighted average of the ATET
      components. If any component is substantially different from the ATET
      reported by xtdidregress and the weight is large, consider accounting
      for treatment-effect heterogeneity by using xthdidregress.

.
.         graph combine bdecomp1 bdecomp2, altshrink col(1) ysize(8) xsize(5)

.         graph export bacon.png, as(png) replace
file bacon.png saved as PNG format

.
.
. // ****
. // (e)
. // ****
. // Heterogeneous treatment effect models
.
.         // Wooldridge (2021) TWFE
.         xthdidregress twfe (primary) (treatment), group(country2)
note: variable _did_cohort, containing cohort indicators formed by treatment
      variable treatment and group variable country2, was added to the
      dataset.

Treatment and time information

Time variable: year
Time interval: 1981 to 2005
Control:       _did_cohort = 0
Treatment:     _did_cohort > 0
------------------------------------
                   | _did_cohort
-------------------+----------------
Number of cohorts |          10
-------------------+----------------
Number of obs      |
    Never treated |          94
             1994 |          23
             1995 |          25
             1996 |          24
             1997 |          25
             2000 |          24
             2001 |          25
             2002 |          21
             2003 |          44
             2005 |          46
--------------------------------
```

Heterogeneous-treatment-effects regression Number of obs = 351
Number of panels = 15

Estimator: Two-way fixed effects
Panel variable: country2
Treatment level: country2
Control group: Never treated
Heterogeneity: Cohort and time

(Std. err. adjusted for 15 clusters in country2)

Cohort	ATET	Robust std. err.	t	P>|t|	[95% conf.	interval]
1994						
year						
1994	38.24273	3.030973	12.62	0.000	31.74194	44.74352
1995	87.35979	3.235131	27.00	0.000	80.42112	94.29845
1996	84.16837	4.58625	18.35	0.000	74.33184	94.0049
1997	0	(omitted)				
1998	66.54247	6.297995	10.57	0.000	53.03461	80.05033
1999	65.41308	5.69054	11.50	0.000	53.20809	77.61807
2000	63.96411	6.008948	10.64	0.000	51.0762	76.85202
2001	64.71435	6.286947	10.29	0.000	51.23019	78.19851
2002	57.02825	7.012181	8.13	0.000	41.98862	72.06788
2003	0	(omitted)				
2004	41.72954	6.678689	6.25	0.000	27.40518	56.0539
2005	39.08245	9.200352	4.25	0.001	19.34966	58.81525
1995						
year						
1995	-4.517479	3.035481	-1.49	0.159	-11.02794	1.992981
1996	2.805326	4.422651	0.63	0.536	-6.680316	12.29097
1997	5.463151	7.386776	0.74	0.472	-10.37991	21.30621
1998	14.71739	6.132741	2.40	0.031	1.563971	27.87081
1999	13.74882	5.531821	2.49	0.026	1.88425	25.6134
2000	14.34482	5.874642	2.44	0.028	1.744966	26.94468
2001	16.63937	6.170702	2.70	0.017	3.404526	29.8742
2002	15.7559	6.90402	2.28	0.039	.9482496	30.56355
2003	11.83389	6.564182	1.80	0.093	-2.244877	25.91266
2004	12.13764	6.646499	1.83	0.089	-2.117684	26.39296
2005	22.95468	9.177604	2.50	0.025	3.270675	42.63868
1996						
year						
1996	6.600945	4.247129	1.55	0.142	-2.508241	15.71013
1997	6.413013	7.240145	0.89	0.391	-9.115554	21.94158
1998	0	(omitted)				
1999	3.464628	5.361466	0.65	0.529	-8.034572	14.96383
2000	3.521539	5.724198	0.62	0.548	-8.755645	15.79872
2001	-5.007784	6.030896	-0.83	0.420	-17.94277	7.9272
2002	-6.009695	6.774522	-0.89	0.390	-20.5396	8.52021
2003	-14.61497	6.500601	-2.25	0.041	-28.55737	-.672563
2004	-13.99099	6.584216	-2.12	0.052	-28.11273	.1307484
2005	-8.52813	9.120451	-0.94	0.366	-28.08955	11.03329
1997						
year						
1997	49.01396	7.051269	6.95	0.000	33.89049	64.13743
1998	55.30455	5.774002	9.58	0.000	42.92055	67.68855
1999	60.70169	5.187521	11.70	0.000	49.57557	71.82782
2000	57.48449	5.584613	10.29	0.000	45.50668	69.46229
2001	56.15491	5.899108	9.52	0.000	43.50258	68.80724
2002	56.07834	6.669646	8.41	0.000	41.77337	70.3833
2003	51.39538	6.434922	7.99	0.000	37.59384	65.19691
2004	40.00326	6.527155	6.13	0.000	26.00391	54.00261
2005	33.20404	9.054908	3.67	0.003	13.78319	52.62488
2000						
year						
2000	-12.69945	4.826488	-2.63	0.020	-23.05124	-2.347665
2001	-.6614623	5.207826	-0.13	0.901	-11.83114	10.50821
2002	-4.764997	6.044067	-0.79	0.444	-17.72823	8.198237

```
       2003  |  -9.860013   6.123126    -1.61   0.130    -22.99281    3.272785
       2004  |   -7.89486   6.243276    -1.26   0.227    -21.28536    5.495636
       2005  |  -10.17886   8.783817    -1.16   0.266    -29.01828    8.660551
-------------+------------------------------------------------------------------
2001         |
        year |
       2001  |  -8.435587   4.970285    -1.70   0.112    -19.09579    2.224613
       2002  |   2.081385    5.83053     0.36   0.726    -10.42386    14.58663
       2003  |    3.29249   6.018203     0.55   0.593    -9.615271    16.20025
       2004  |   6.092567   6.127499     0.99   0.337    -7.049612    19.23474
       2005  |   10.06715   8.682388     1.16   0.266    -8.554716    28.68902
-------------+------------------------------------------------------------------
2002         |
        year |
       2002  |  -18.75903   5.772551    -3.25   0.006    -31.13992   -6.378143
       2003  |           0  (omitted)
       2004  |  -7.565227   5.986136    -1.26   0.227    -20.40421    5.273758
       2005  |   3.237646   8.522009     0.38   0.710    -15.04024    21.51554
-------------+------------------------------------------------------------------
2003         |
        year |
       2003  |   2.172772   15.16899     0.14   0.888    -30.36147    34.70702
       2004  |   3.129415   19.15839     0.16   0.873    -37.96125    44.22008
       2005  |   4.732264   22.41103     0.21   0.836    -43.33461    52.79914
-------------+------------------------------------------------------------------
2005         |
        year |
       2005  |   6.341593   8.085062     0.78   0.446    -10.99914    23.68233
------------------------------------------------------------------------------

.
.         // Callaway and Sant'Anna (2021)
.         xthdidregress ra (primary) (treatment), group(country2)
note: variable _did_cohort, containing cohort indicators formed by treatment
      variable treatment and group variable country2, was added to the
      dataset.

Computing ATET for each cohort and time:
Cohort 1994 (24): ..........10.....x....20.x.. done
Cohort 1995 (24): ..........10..........20.... done
Cohort 1996 (24): ..........10......x...20.... done
Cohort 1997 (24): ..........10..........20.... done
Cohort 2000 (24): ..........10.x........20.... done
Cohort 2001 (24): ..........10..........20.... done
Cohort 2002 (24): ..........10xx...x....20.x.. done
Cohort 2003 (24): ..........10....xx....20.... done
Cohort 2005 (24): ..........10..........20.... done

Treatment and time information

Time variable: year
Time interval: 1981 to 2005
Control:       _did_cohort = 0
Treatment:     _did_cohort > 0
--------------------------------
                  | _did_cohort
------------------+-------------
Number of cohorts |          10
------------------+-------------
Number of obs     |
    Never treated |          94
             1994 |          23
             1995 |          25
             1996 |          24
             1997 |          25
             2000 |          24
             2001 |          25
             2002 |          21
             2003 |          44
             2005 |          46
--------------------------------
```

Heterogeneous-treatment-effects regression Number of obs = 351
Number of panels = 15

Estimator: Regression adjustment
Panel variable: country2
Treatment level: country2
Control group: Never treated

(Std. err. adjusted for 15 clusters in country2)

Cohort	ATET	Robust std. err.	z	P>|z|	[95% conf.	interval]
1994						
year						
1982	.6621984	.6764209	0.98	0.328	-.6635623	1.987959
1983	-5.149809	.2026309	-25.41	0.000	-5.546958	-4.75266
1984	-4.510092	.8382131	-5.38	0.000	-6.152959	-2.867224
1985	-.0319087	.6528358	-0.05	0.961	-1.311443	1.247626
1986	-.0023772	1.038666	-0.00	0.998	-2.038125	2.033371
1987	.0524139	.4380256	0.12	0.905	-.8061004	.9109283
1988	-.2710547	.6169261	-0.44	0.660	-1.480208	.9380982
1989	7.864911	.9758074	8.06	0.000	5.952364	9.777458
1990	8.32047	2.160627	3.85	0.000	4.085718	12.55522
1991	-.9473333	1.524939	-0.62	0.534	-3.936159	2.041493
1992	15.21814	.8258958	18.43	0.000	13.59942	16.83687
1993	5.705656	1.635081	3.49	0.000	2.500957	8.910355
1994	5.173844	.3941876	13.13	0.000	4.401251	5.946438
1995	53.66702	.9662202	55.54	0.000	51.77326	55.56077
1996	48.69049	1.568461	31.04	0.000	45.61637	51.76462
1997	0	(omitted)				
1998	32.807	3.104471	10.57	0.000	26.72235	38.89165
1999	32.80986	3.788042	8.66	0.000	25.38544	40.23429
2000	31.6389	4.401357	7.19	0.000	23.0124	40.2654
2001	32.56647	5.524376	5.90	0.000	21.73889	43.39404
2002	26.36173	6.394008	4.12	0.000	13.82971	38.89376
2003	0	(omitted)				
2004	13.58479	8.424669	1.61	0.107	-2.927254	30.09684
2005	10.41767	8.333884	1.25	0.211	-5.916445	26.75178
1995						
year						
1982	-.4053141	.6764209	-0.60	0.549	-1.731075	.9204465
1983	-.8489933	.2026309	-4.19	0.000	-1.246142	-.4518441
1984	-1.684668	.8382131	-2.01	0.044	-3.327535	-.0418001
1985	-4.598147	.6528358	-7.04	0.000	-5.877682	-3.318612
1986	-.2697798	1.038666	-0.26	0.795	-2.305528	1.765968
1987	1.528835	.4380256	3.49	0.000	.6703209	2.38735
1988	1.025397	.6169261	1.66	0.096	-.1837561	2.23455
1989	-.4445791	.9758074	-0.46	0.649	-2.357127	1.467968
1990	-1.351584	2.160627	-0.63	0.532	-5.586336	2.883167
1991	-7.764215	1.524939	-5.09	0.000	-10.75304	-4.775389
1992	-6.885764	.8258958	-8.34	0.000	-8.50449	-5.267038
1993	-3.812	1.635081	-2.33	0.020	-7.016699	-.6073011
1994	2.255872	.3941876	5.72	0.000	1.483278	3.028465
1995	2.393218	1.149148	2.08	0.037	.1409297	4.645506
1996	7.930919	1.884665	4.21	0.000	4.237044	11.62479
1997	13.89147	3.527336	3.94	0.000	6.978017	20.80492
1998	21.58539	3.479677	6.20	0.000	14.76535	28.40543
1999	21.74908	4.14953	5.24	0.000	13.61615	29.88201
2000	22.62308	4.628644	4.89	0.000	13.5511	31.69505
2001	25.09495	5.783551	4.34	0.000	13.7594	36.4305
2002	25.69285	6.649245	3.86	0.000	12.66057	38.72513
2003	23.94109	7.524148	3.18	0.001	9.194032	38.68815
2004	24.59636	8.658749	2.84	0.005	7.625522	41.56719
2005	34.89336	8.54403	4.08	0.000	18.14737	51.63935
1996						
year						
1982	-1.406909	.6764209	-2.08	0.038	-2.732669	-.081148
1983	-2.904531	.2026309	-14.33	0.000	-3.301681	-2.507382
1984	-2.363466	.8382131	-2.82	0.005	-4.006334	-.7205987
1985	.1729291	.6528358	0.26	0.791	-1.106605	1.452464

1986	-3.057168	1.038666	-2.94	0.003	-5.092916	-1.02142
1987	-.3161354	.4380256	-0.72	0.470	-1.17465	.542379
1988	-.6555037	.6169261	-1.06	0.288	-1.864657	.5536492
1989	4.947038	.9758074	5.07	0.000	3.03449	6.859585
1990	.5808306	2.160627	0.27	0.788	-3.653921	4.815582
1991	4.033929	1.524939	2.65	0.008	1.045103	7.022755
1992	-.1555967	.8258958	-0.19	0.851	-1.774323	1.463129
1993	-1.177309	1.635081	-0.72	0.472	-4.382008	2.02739
1994	-.4652014	.3941876	-1.18	0.238	-1.237795	.3073922
1995	-2.986068	1.149148	-2.60	0.009	-5.238356	-.7337794
1996	-.8766766	.9582545	-0.91	0.360	-2.754821	1.001468
1997	1.985374	2.496496	0.80	0.426	-2.907668	6.878417
1998	0	(omitted)				
1999	-1.138334	3.252514	-0.35	0.726	-7.513144	5.236476
2000	-.8034172	3.485562	-0.23	0.818	-7.634993	6.028159
2001	-9.155415	4.679052	-1.96	0.050	-18.32619	.0153588
2002	-8.67596	5.574208	-1.56	0.120	-19.60121	2.249286
2003	-15.11098	6.441275	-2.35	0.019	-27.73565	-2.486314
2004	-14.13548	7.541761	-1.87	0.061	-28.91706	.6460948
2005	-9.192663	7.402082	-1.24	0.214	-23.70048	5.315152
1997						
year						
1982	3.221666	.6764209	4.76	0.000	1.895905	4.547426
1983	.8282375	.2026309	4.09	0.000	.4310883	1.225387
1984	5.363592	.8382131	6.40	0.000	3.720725	7.00646
1985	2.552141	.6528358	3.91	0.000	1.272606	3.831675
1986	.3685067	1.038666	0.35	0.723	-1.667241	2.404255
1987	-1.058018	.4380256	-2.42	0.016	-1.916532	-.1995034
1988	.6814713	.6169261	1.10	0.269	-.5276816	1.890624
1989	-2.959075	.9758074	-3.03	0.002	-4.871622	-1.046528
1990	3.098935	2.160627	1.43	0.151	-1.135816	7.333687
1991	-3.789985	1.524939	-2.49	0.013	-6.778811	-.8011588
1992	-7.906802	.8258958	-9.57	0.000	-9.525528	-6.288076
1993	4.306257	1.635081	2.63	0.008	1.101558	7.510956
1994	-1.213195	.3941876	-3.08	0.002	-1.985788	-.4406013
1995	-.7068853	1.149148	-0.62	0.538	-2.959174	1.545403
1996	.7678699	.9582545	0.80	0.423	-1.110274	2.646014
1997	46.82146	1.423863	32.88	0.000	44.03075	49.61218
1998	52.39636	1.750435	29.93	0.000	48.96557	55.82715
1999	58.92576	2.323449	25.36	0.000	54.37188	63.47964
2000	55.98656	3.053183	18.34	0.000	50.00243	61.97069
2001	54.83431	4.196919	13.07	0.000	46.6085	63.06012
2002	56.2391	5.13303	10.96	0.000	46.17855	66.29966
2003	53.72639	6.074739	8.84	0.000	41.82012	65.63266
2004	42.68579	7.097532	6.01	0.000	28.77489	56.5967
2005	35.36653	6.96363	5.08	0.000	21.71807	49.015
2000						
year						
1982	-2.256312	.6764209	-3.34	0.001	-3.582073	-.9305514
1983	1.072702	.2026309	5.29	0.000	.6755532	1.469852
1984	-1.534777	.8382131	-1.83	0.067	-3.177644	.1080908
1985	-.8099353	.6528358	-1.24	0.215	-2.08947	.4695994
1986	1.134048	1.038666	1.09	0.275	-.9017002	3.169796
1987	-.1060066	.4380256	-0.24	0.809	-.964521	.7525077
1988	.6960511	.6169261	1.13	0.259	-.5131018	1.905204
1989	-2.315719	.9758074	-2.37	0.018	-4.228266	-.4031713
1990	2.075688	2.160627	0.96	0.337	-2.159063	6.31044
1991	-6.680655	1.524939	-4.38	0.000	-9.669481	-3.69183
1992	-6.461078	.8258958	-7.82	0.000	-8.079804	-4.842352
1993	0	(omitted)				
1994	-8.729867	1.251289	-6.98	0.000	-11.18235	-6.277386
1995	-3.502776	1.149148	-3.05	0.002	-5.755065	-1.250488
1996	-6.964338	.9582545	-7.27	0.000	-8.842483	-5.086194
1997	3.222733	1.423863	2.26	0.024	.4320132	6.013452
1998	1.322441	.9202045	1.44	0.151	-.4811266	3.126009
1999	3.211077	.7838569	4.10	0.000	1.674745	4.747408
2000	-1.831175	2.643178	-0.69	0.488	-7.011708	3.349358
2001	10.38414	3.211806	3.23	0.001	4.089118	16.67917
2002	7.761973	4.08622	1.90	0.057	-.2468715	15.77082
2003	4.837206	5.136832	0.94	0.346	-5.2308	14.90521

2004	7.153881	5.900317	1.21	0.225	-4.410527	18.71829
2005	4.349838	5.866496	0.74	0.458	-7.148282	15.84796
2001						
year						
1982	-7.038844	.6764209	-10.41	0.000	-8.364604	-5.713083
1983	-3.229261	.2026309	-15.94	0.000	-3.626411	-2.832112
1984	-4.338114	.8382131	-5.18	0.000	-5.980981	-2.695246
1985	-12.13562	.6528358	-18.59	0.000	-13.41515	-10.85608
1986	-2.341286	1.038666	-2.25	0.024	-4.377034	-.3055383
1987	-3.785709	.4380256	-8.64	0.000	-4.644224	-2.927195
1988	-1.823312	.6169261	-2.96	0.003	-3.032465	-.6141593
1989	1.246919	.9758074	1.28	0.201	-.6656287	3.159466
1990	3.069127	2.160627	1.42	0.155	-1.165624	7.303878
1991	-3.592864	1.524939	-2.36	0.018	-6.58169	-.6040382
1992	-1.154719	.8258958	-1.40	0.162	-2.773445	.4640067
1993	-.0249424	1.635081	-0.02	0.988	-3.229642	3.179757
1994	-2.663253	.3941876	-6.76	0.000	-3.435846	-1.890659
1995	-1.821082	1.149148	-1.58	0.113	-4.07337	.4312063
1996	-1.081038	.9582545	-1.13	0.259	-2.959182	.7971067
1997	-.1192093	1.423863	-0.08	0.933	-2.909929	2.67151
1998	-2.786972	.9202045	-3.03	0.002	-4.59054	-.9834043
1999	1.496881	.7838569	1.91	0.056	-.0394499	3.033213
2000	-2.69956	2.643178	-1.02	0.307	-7.880093	2.480973
2001	2.514069	1.455631	1.73	0.084	-.3389157	5.367053
2002	14.51241	2.431126	5.97	0.000	9.747487	19.27733
2003	17.89376	3.186081	5.62	0.000	11.64916	24.13836
2004	21.04536	4.115556	5.11	0.000	12.97902	29.1117
2005	24.49991	3.938739	6.22	0.000	16.78012	32.21969
2002						
year						
1982	-2.73762	.6764209	-4.05	0.000	-4.063381	-1.411859
1983	.9073734	.2026309	4.48	0.000	.5102242	1.304523
1984	2.413832	.8382131	2.88	0.004	.7709642	4.056699
1985	1.245775	.6528358	1.91	0.056	-.03376	2.525309
1986	-.8756034	1.038666	-0.84	0.399	-2.911351	1.160145
1987	-3.650837	.4380256	-8.33	0.000	-4.509351	-2.792323
1988	-.2556777	.6169261	-0.41	0.679	-1.464831	.9534752
1989	.1446619	.9758074	0.15	0.882	-1.767885	2.057209
1990	1.347173	2.160627	0.62	0.533	-2.887579	5.581924
1991	-3.214721	1.524939	-2.11	0.035	-6.203547	-.2258949
1992	0	(omitted)				
1993	0	(omitted)				
1994	-8.806889	2.073828	-4.25	0.000	-12.87152	-4.742261
1995	-3.262259	1.149148	-2.84	0.005	-5.514548	-1.009971
1996	-1.709379	.9582545	-1.78	0.074	-3.587523	.168765
1997	0	(omitted)				
1998	-3.21821	1.750435	-1.84	0.066	-6.649	.2125798
1999	-1.19277	.7838569	-1.52	0.128	-2.729101	.3435613
2000	-4.147055	2.643178	-1.57	0.117	-9.327588	1.033478
2001	-3.461967	1.455631	-2.38	0.017	-6.314952	-.6089832
2002	.4563837	1.015102	0.45	0.653	-1.533179	2.445947
2003	0	(omitted)				
2004	14.17196	2.945972	4.81	0.000	8.397962	19.94596
2005	24.45479	3.170675	7.71	0.000	18.24039	30.6692
2003						
year						
1982	-2.140868	.7087252	-3.02	0.003	-3.529944	-.7517921
1983	-3.542921	.839066	-4.22	0.000	-5.18746	-1.898382
1984	-2.89942	1.35818	-2.13	0.033	-5.561405	-.237435
1985	-4.725672	1.61046	-2.93	0.003	-7.882116	-1.569229
1986	.2663034	1.103041	0.24	0.809	-1.895618	2.428225
1987	-1.039444	.9661281	-1.08	0.282	-2.93302	.8541324
1988	-.2369056	1.247283	-0.19	0.849	-2.681535	2.207723
1989	1.967347	.9812707	2.00	0.045	.044092	3.890602
1990	.6573038	2.425425	0.27	0.786	-4.096441	5.411049
1991	-4.065112	2.147332	-1.89	0.058	-8.273806	.1435818
1992	1.830152	2.802738	0.65	0.514	-3.663114	7.323417
1993	-.9583683	1.635081	-0.59	0.558	-4.163067	2.246331
1994	-4.879073	.3941876	-12.38	0.000	-5.651667	-4.10648

```
       1995  |  -3.372611   1.149148    -2.93   0.003    -5.624899   -1.120323
       1996  |           0  (omitted)
       1997  |           0  (omitted)
       1998  |   3.095001   .9202045     3.36   0.001     1.291433    4.898569
       1999  |  -3.253839   1.976315    -1.65   0.100    -7.127346    .6196671
       2000  |   .1025066   2.643889     0.04   0.969    -5.079421    5.284434
       2001  |  -3.901718   1.889358    -2.07   0.039    -7.604791    -.198645
       2002  |  -4.118644    3.43028    -1.20   0.230    -10.84187    2.604582
       2003  |   7.384196   2.499542     2.95   0.003     2.485183    12.28321
       2004  |   8.692361   2.534336     3.43   0.001     3.725153    13.65957
       2005  |    9.77517   4.393257     2.23   0.026     1.164544     18.3858
-------------+------------------------------------------------------------------
2005         |
        year |
       1982  |  -6.402613    5.36552    -1.19   0.233    -16.91884    4.113612
       1983  |  -1.987062   5.530368    -0.36   0.719    -12.82638     8.85226
       1984  |   4.658318   .9839197     4.73   0.000      2.72987    6.586765
       1985  |   .3471444   1.824438     0.19   0.849    -3.228689    3.922978
       1986  |   1.755847   2.096474     0.84   0.402    -2.353166    5.864861
       1987  |  -6.527988   8.089497    -0.81   0.420    -22.38311    9.327134
       1988  |   .8353219   4.872196     0.17   0.864    -8.714006    10.38465
       1989  |   1.570069   1.237987     1.27   0.205    -.8563409     3.99648
       1990  |   3.317891   2.168248     1.53   0.126    -.9317962    7.567578
       1991  |  -4.577563   2.208084    -2.07   0.038    -8.905328   -.2497989
       1992  |  -3.362039   .9464582    -3.55   0.000    -5.217063   -1.507015
       1993  |  -.7685051    1.66997    -0.46   0.645    -4.041586    2.504576
       1994  |    .685174   .3941876     1.74   0.082    -.0874196    1.457768
       1995  |   2.92685   1.149148     2.55   0.011      .674562    5.179139
       1996  |  -11.25864   .9582545   -11.75   0.000    -13.13679   -9.380498
       1997  |   1.055351   1.423863     0.74   0.459    -1.735368    3.846071
       1998  |    6.89093   .9202045     7.49   0.000     5.087362    8.694498
       1999  |   7.723642   1.455207     5.31   0.000      4.87149     10.5758
       2000  |  -.5843029   2.943942    -0.20   0.843    -6.354323    5.185718
       2001  |   1.044504   1.834105     0.57   0.569    -2.550276    4.639284
       2002  |   1.177083   1.232402     0.96   0.340    -1.238381    3.592547
       2003  |   2.488395   1.129361     2.20   0.028     .2748882    4.701901
       2004  |   2.918612   1.370971     2.13   0.033     .2315584    5.605665
       2005  |   4.781475   1.510383     3.17   0.002     1.821179    7.741771
-------------------------------------------------------------------------------
Note: The omitted ATET parameters could not be estimated. There was not enough
      information to identify the cohort-time ATET parameter for this
      subsample of data.

.
.
. // ****
. // (f)
. // ****
. // Post-estimation commands after Callaway Sant'Anna estimation
.
.         quietly xthdidregress ra (primary) (treatment), group(country2)

.         estat aggregation

Overall ATET                                          Number of obs = 351

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
     primary |       ATET   std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
   treatment |
   (1 vs 0)  |   18.45015   7.371655     2.50   0.012     4.001972    32.89833
------------------------------------------------------------------------------
```

```
. 	estat atetplot, name(atetplot1, replace) byopts(title("Primary enrollm
> ent"))

. 	estat aggregation, dynamic graph(name(agg1, replace) title("Primary en
> rollment"))

Duration of exposure ATET                                     Number of obs = 351

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
    Exposure |       ATET   std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         -23 |  -6.402613    5.36552    -1.19   0.233    -16.91884    4.113612
         -22 |  -1.987062   5.530368    -0.36   0.719    -12.82638     8.85226
         -21 |   1.258725   1.727797     0.73   0.466    -2.127695    4.645145
         -20 |  -1.825835   1.114301    -1.64   0.101    -4.009824    .3581547
         -19 |  -1.403103   1.572788    -0.89   0.372    -4.485711    1.679506
         -18 |  -3.654152   2.602608    -1.40   0.160    -8.755169    1.446865
         -17 |   .0262305   1.647966     0.02   0.987    -3.203723    3.256185
         -16 |  -1.926393   1.753912    -1.10   0.272    -5.363998    1.511212
         -15 |   .3226973   1.200271     0.27   0.788    -2.029791    2.675186
         -14 |  -.9673825   .9596211    -1.01   0.313    -2.848205    .9134402
         -13 |   -.514038   .9164115    -0.56   0.575    -2.310171    1.282095
         -12 |  -.5795648   .7461778    -0.78   0.437    -2.042046    .8829168
         -11 |  -.4408876    .998252    -0.44   0.659    -2.397426     1.51565
         -10 |  -1.596515   1.024529    -1.56   0.119    -3.604555    .4115258
          -9 |   -2.98868   1.415575    -2.11   0.035    -5.763157   -.2142041
          -8 |  -2.188699   1.336118    -1.64   0.101    -4.807442    .4300445
          -7 |   1.441314   1.381236     1.04   0.297    -1.265858    4.148487
          -6 |  -.0819813   1.718368    -0.05   0.962    -3.449921    3.285958
          -5 |   -.001885    1.54783    -0.00   0.999    -3.035575    3.031805
          -4 |  -.9103193   1.607042    -0.57   0.571    -4.060064    2.239425
          -3 |  -.7655847   1.017314    -0.75   0.452    -2.759483    1.228314
          -2 |   .3591284    1.93198     0.19   0.853    -3.427483     4.14574
          -1 |  -.2525797   1.504203    -0.17   0.867    -3.200764    2.695605
           0 |   7.180225   3.960817     1.81   0.070    -.5828342    14.94328
           1 |   19.78262   7.098227     2.79   0.005     5.870348    33.69489
           2 |   22.61072   6.979704     3.24   0.001     8.930751    36.29069
           3 |    21.1285   8.063701     2.62   0.009     5.323932    36.93306
           4 |   23.37346   8.235944     2.84   0.005     7.231305    39.51561
           5 |   21.37329   11.08457     1.93   0.054    -.3520716    43.09866
           6 |   25.44607   12.41333     2.05   0.040     1.116397    49.77574
           7 |   21.45853    12.7125     1.69   0.091    -3.457506    46.37457
           8 |   17.88347    11.8243     1.51   0.130    -5.291732    41.05867
           9 |   7.701848    14.3815     0.54   0.592    -20.48537    35.88907
          10 |   24.23908   11.32932     2.14   0.032     2.034027    46.44413
          11 |   10.41767   8.333884     1.25   0.211    -5.916445    26.75178
------------------------------------------------------------------------------
Note: Exposure is the number of periods since the first treatment time.

. 	estat aggregation, cohort graph(name(agg2, replace) title("Primary enr
> ollment"))

ATET over cohort                                              Number of obs = 351

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
      Cohort |       ATET   std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
        1994 |   28.77178   4.063753     7.08   0.000     20.80697    36.73659
        1995 |   20.39925   4.889628     4.17   0.000     10.81576    29.98275
        1996 |   -6.34484   4.364665    -1.45   0.146    -14.89943    2.209746
        1997 |   50.77581   3.936333    12.90   0.000     43.06074    58.49088
        2000 |   5.442644   4.348165     1.25   0.211    -3.079603    13.96489
        2001 |    16.0931   2.875631     5.60   0.000     10.45697    21.72923
        2002 |   13.02771   2.219734     5.87   0.000     8.677114    17.37831
        2003 |   8.617242   2.107895     4.09   0.000     4.485844    12.74864
        2005 |   4.781475   1.510383     3.17   0.002     1.821179    7.741771
------------------------------------------------------------------------------
```

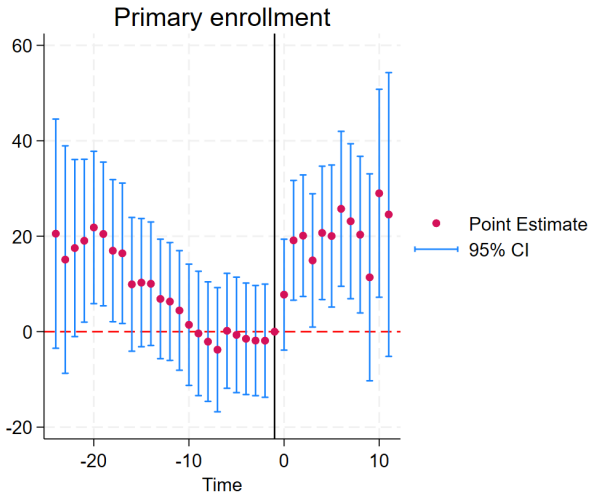
```
.
.         quietly xthdidregress ra (secondary) (treatment), group(country2)

.         estat aggregation

Overall ATET                                                  Number of obs = 270

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
   secondary |       ATET   std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
   treatment |
   (1 vs 0)  |   .5309507   1.499575     0.35   0.723    -2.408161    3.470063
------------------------------------------------------------------------------

.         estat atetplot, name(atetplot2, replace) byopts(title("Secondary enrol
> lment"))

.         estat aggregation, dynamic graph(name(agg3, replace) title("Secondary
> enrollment"))

Duration of exposure ATET                                     Number of obs = 270

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
    Exposure |       ATET   std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
         -23 |   .3739896   .8712889     0.43   0.668    -1.333705    2.081684
         -22 |  -.7725497   .6632744    -1.16   0.244    -2.072544    .5274442
         -21 |  -.2318118   .3809134    -0.61   0.543    -.9783883    .5147647
         -20 |   .1829596   .3007677     0.61   0.543    -.4065343    .7724534
         -19 |   .5799699   .5255196     1.10   0.270    -.4500295    1.609969
         -18 |   1.382675   1.435164     0.96   0.335    -1.430196    4.195545
         -17 |  -.5722655   .3039929    -1.88   0.060    -1.168081    .0235497
         -16 |   .5271151   .4131667     1.28   0.202    -.2826767    1.336907
         -15 |   .1889646   .4896971     0.39   0.700    -.7708239    1.148753
         -14 |  -.9308301   .6101006    -1.53   0.127    -2.126605    .2649451
         -13 |  -.0532568   .7054236    -0.08   0.940    -1.435862    1.329348
         -12 |  -.3764522   .4970127    -0.76   0.449    -1.350579    .5976747
         -11 |  -.3386323   .6859696    -0.49   0.622    -1.683108    1.005843
         -10 |  -.4993534   .8251536    -0.61   0.545    -2.116625    1.117918
          -9 |   .0830934   .4658324     0.18   0.858    -.8299213     .996108
          -8 |  -.0300516   .6185666    -0.05   0.961     -1.24242    1.182317
          -7 |  -.1986011   .4540066    -0.44   0.662    -1.088438    .6912356
          -6 |  -2.341884   .9201897    -2.55   0.011    -4.145423   -.5383455
          -5 |  -1.081524   .4864758    -2.22   0.026    -2.034999   -.1280494
          -4 |  -4.591795   2.368838    -1.94   0.053    -9.234633     .051042
          -3 |  -1.071381   .6178537    -1.73   0.083    -2.282352    .1395898
          -2 |  -.5699473   .6195809    -0.92   0.358    -1.784303    .6444089
          -1 |  -.7302852   .4551077    -1.60   0.109     -1.62228    .1617095
           0 |  -.4240797   .5075255    -0.84   0.403    -1.418811     .570652
           1 |   1.392232   .9680536     1.44   0.150     -.505118    3.289582
           2 |   -.432536   2.067821    -0.21   0.834     -4.48539    3.620318
           3 |  -4.228108   2.286651    -1.85   0.064    -8.709862    .2536464
           4 |  -.3545697   3.493102    -0.10   0.919    -7.200924    6.491785
           5 |   .8702649    4.29243     0.20   0.839    -7.542744    9.283273
           6 |   1.226612   3.138142     0.39   0.696    -4.924035    7.377258
           7 |   2.869307   1.702395     1.69   0.092    -.4673253     6.20594
           8 |   2.779409   1.104354     2.52   0.012     .6149158    4.943903
           9 |   4.358091   1.057611     4.12   0.000     2.285211     6.43097
          10 |   2.880153   2.613581     1.10   0.270    -2.242372    8.002678
          11 |  -1.645603   1.876849    -0.88   0.381    -5.324159    2.032952
------------------------------------------------------------------------------
Note: Exposure is the number of periods since the first treatment time.
```

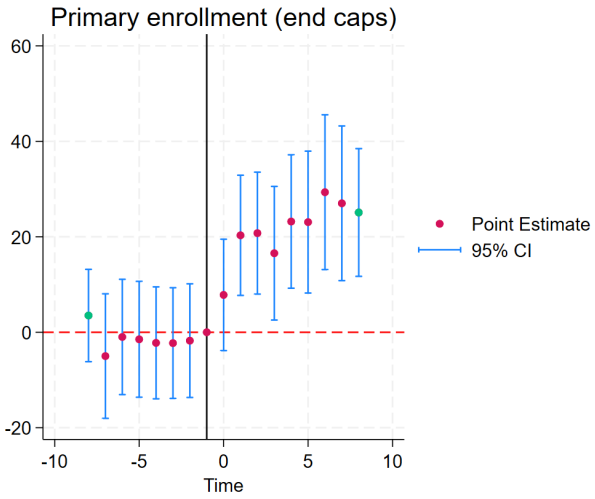
```
.         estat aggregation, cohort graph(name(agg4, replace) title("Secondary e
> nrollment"))

ATET over cohort                                          Number of obs = 270

                              (Std. err. adjusted for 15 clusters in country2)
------------------------------------------------------------------------------
             |               Robust
      Cohort |       ATET   std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
        1994 |   4.491717   .9879092     4.55   0.000     2.555451    6.427984
        1995 |   1.933238   .4818461     4.01   0.000     .9888371    2.877639
        1997 |  -.2341429   .0463928    -5.05   0.000    -.3250711   -.1432146
        1999 |  -5.302582   .7958825    -6.66   0.000    -6.862483   -3.742681
        2000 |  -2.158813   .5921235    -3.65   0.000    -3.319353   -.9982717
        2003 |   1.619523   1.373638     1.18   0.238    -1.072758    4.311804
        2005 |    .402854    .724534     0.56   0.578    -1.017207    1.822914
------------------------------------------------------------------------------

.
.         graph combine atetplot1 atetplot2, altshrink col(1) ysize(8) xsize(6)

.         graph export atetplots.png, as(png) replace
file atetplots.png saved as PNG format

.
.         graph combine agg1 agg2 agg3 agg4, altshrink row(2) ysize(11) xsize(11
> )

.         graph export aggplots.png, as(png) replace
file aggplots.png saved as PNG format

.
.
. // ****
. // (g)
. // ****
. // Event study
.
.         // Create event time variable - be sure it is missing if never treated
.         gen etime = year - fpe_year

.         replace etime = . if fpe_year>2005
(100 real changes made, 100 to missing)

.         tabulate etime

      etime |      Freq.     Percent        Cum.
------------+-----------------------------------
        -24 |          2        0.73        0.73
        -23 |          2        0.73        1.45
        -22 |          4        1.45        2.91
        -21 |          5        1.82        4.73
        -20 |          6        2.18        6.91
        -19 |          7        2.55        9.45
        -18 |          7        2.55       12.00
        -17 |          7        2.55       14.55
        -16 |          8        2.91       17.45
        -15 |          9        3.27       20.73
        -14 |         10        3.64       24.36
        -13 |         11        4.00       28.36
        -12 |         11        4.00       32.36
        -11 |         11        4.00       36.36
        -10 |         11        4.00       40.36
         -9 |         11        4.00       44.36
         -8 |         11        4.00       48.36
         -7 |         11        4.00       52.36
         -6 |         11        4.00       56.36
         -5 |         11        4.00       60.36
         -4 |         11        4.00       64.36
         -3 |         11        4.00       68.36
         -2 |         11        4.00       72.36
```

```
         -1 |         11        4.00       76.36
          0 |         11        4.00       80.36
          1 |          9        3.27       83.64
          2 |          9        3.27       86.91
          3 |          7        2.55       89.45
          4 |          6        2.18       91.64
          5 |          5        1.82       93.45
          6 |          4        1.45       94.91
          7 |          4        1.45       96.36
          8 |          4        1.45       97.82
          9 |          3        1.09       98.91
         10 |          2        0.73       99.64
         11 |          1        0.36      100.00
------------+-----------------------------------
      Total |        275      100.00

.
.         eventdd primary i.year, timevar(etime) method(fe) ///
>                 graph_op(name(event1, replace) title("Primary enrollment"))

Fixed-effects (within) regression               Number of obs     =         351
Group variable: country2                        Number of groups  =          15

R-squared:                                      Obs per group:
     Within  = 0.4730                                         min =          20
     Between = 0.0051                                         avg =        23.4
     Overall = 0.1711                                         max =          25

                                                F(59, 277)        =        4.21
corr(u_i, Xb) = -0.0256                         Prob > F          =      0.0000

------------------------------------------------------------------------------
     primary | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |
        1982 |   2.223183   5.688957     0.39   0.696    -8.975899    13.42227
        1983 |   2.259622   5.422448     0.42   0.677     -8.41482    12.93406
        1984 |   3.106269   5.590903     0.56   0.579    -7.899787    14.11233
        1985 |   4.290071   5.675129     0.76   0.450     -6.88179    15.46193
        1986 |   5.982426   5.621293     1.06   0.288    -5.083454    17.04831
        1987 |   8.113784   5.663839     1.43   0.153    -3.035852    19.26342
        1988 |   8.316597   5.719365     1.45   0.147    -2.942344    19.57554
        1989 |   9.355117   5.717898     1.64   0.103    -1.900937    20.61117
        1990 |   9.195336   5.775181     1.59   0.112    -2.173483    20.56415
        1991 |   11.06582   5.852418     1.89   0.060     -.455047    22.58669
        1992 |   11.51226   5.985276     1.92   0.055    -.2701446    23.29467
        1993 |   12.07356   6.232564     1.94   0.054    -.1956449    24.34277
        1994 |   12.46495    6.14188     2.03   0.043     .3742637    24.55565
        1995 |   15.12686   6.139794     2.46   0.014     3.040278    27.21344
        1996 |   12.50803   6.308264     1.98   0.048     .0898049    24.92626
        1997 |   15.10659   6.655336     2.27   0.024     2.005127    28.20805
        1998 |    19.3167   6.352767     3.04   0.003     6.810867    31.82254
        1999 |    18.2037   6.312691     2.88   0.004     5.776753    30.63064
        2000 |   20.71023   6.386677     3.24   0.001     8.137644    33.28282
        2001 |   22.22819   6.464529     3.44   0.001     9.502343    34.95403
        2002 |   23.33882   6.529216     3.57   0.000     10.48563      36.192
        2003 |   25.40905     6.7844     3.75   0.000     12.05352    38.76458
        2004 |   26.41411   6.748382     3.91   0.000     13.12949    39.69874
        2005 |   27.82799   6.889083     4.04   0.000     14.26638     41.3896
             |
      lead24 |   20.53735    12.1968     1.68   0.093     -3.47284    44.54755
      lead23 |   15.10279   12.10466     1.25   0.213    -8.726027    38.93161
      lead22 |   17.52289   9.425419     1.86   0.064    -1.031665    36.07744
      lead21 |   19.05562   8.667887     2.20   0.029      1.99232    36.11892
      lead20 |   21.82985   8.106339     2.69   0.008     5.871997    37.78771
      lead19 |   20.47202   7.646563     2.68   0.008     5.419264    35.52478
      lead18 |   16.97017   7.565861     2.24   0.026     2.076281    31.86406
      lead17 |     16.421   7.470923     2.20   0.029        1.714      31.128
      lead16 |   9.921852   7.118269     1.39   0.164    -4.090923    23.93463
      lead15 |   10.27656   6.823328     1.51   0.133    -3.155601    23.70873
      lead14 |   10.04207   6.570978     1.53   0.128    -2.893324    22.97747
      lead13 |   6.861122    6.36213     1.08   0.282    -5.663145    19.38539
```

```
      lead12 |   6.315566   6.271087     1.01   0.315    -6.029477    18.66061
      lead11 |   4.450552   6.365051     0.70   0.485    -8.079465    16.98057
      lead10 |   1.443744   6.453056     0.22   0.823    -11.25952      14.147
       lead9 |  -.3690998   6.617004    -0.06   0.956     -13.3951     12.6569
       lead8 |  -2.082621   6.362085    -0.33   0.744     -14.6068    10.44156
       lead7 |  -3.779169   6.608697    -0.57   0.568    -16.78882    9.230481
       lead6 |   .1855202   6.118089     0.03   0.976    -11.85834    12.22938
       lead5 |  -.6761561   6.143709    -0.11   0.912    -12.77045    11.41814
       lead4 |  -1.490864   5.933478    -0.25   0.802     -13.1713    10.18957
       lead3 |  -1.865275   5.865081    -0.32   0.751    -13.41107    9.680519
       lead2 |  -1.886525   6.021476    -0.31   0.754    -13.74019    9.967141
        lag0 |   7.758212   5.901821     1.31   0.190    -3.859908    19.37633
        lag1 |   19.13432   6.372937     3.00   0.003     6.588778    31.67986
        lag2 |   20.11052   6.467456     3.11   0.002     7.378911    32.84213
        lag3 |   14.92662   7.093037     2.10   0.036     .9635182    28.88973
        lag4 |   20.69639   7.098306     2.92   0.004     6.722916    34.66987
        lag5 |    20.0416   7.558602     2.65   0.008     5.162004     34.9212
        lag6 |    25.7426   8.248284     3.12   0.002     9.505316    41.97988
        lag7 |   23.13492   8.246286     2.81   0.005     6.901566    39.36827
        lag8 |   20.32791   8.334335     2.44   0.015     3.921225    36.73459
        lag9 |   11.38747   11.01105     1.03   0.302    -10.28849    33.06344
       lag10 |   28.99696   11.06839     2.62   0.009     7.208123     50.7858
       lag11 |   24.55149   15.10183     1.63   0.105     -5.17744    54.28042
       _cons |   61.99513   5.919605    10.47   0.000     50.34201    73.64826
-------------+----------------------------------------------------------------
     sigma_u |  22.605586
     sigma_e |  13.438941
         rho |  .73886564   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(14, 277) = 62.90                     Prob > F = 0.0000

.
.
. // ****
. // (h)
. // ****
. // Event study - with end caps
.
.         eventdd primary i.year, timevar(etime) method(fe) accum leads(8) lags(
> 8) ///
>                 graph_op(name(event2, replace) title("Primary enrollment (end
> caps)"))

Fixed-effects (within) regression               Number of obs     =       351
Group variable: country2                        Number of groups  =        15

R-squared:                                      Obs per group:
     Within  = 0.4311                                         min =        20
     Between = 0.0001                                         avg =      23.4
     Overall = 0.1406                                         max =        25

                                                F(40, 296)        =      5.61
corr(u_i, Xb) = -0.0506                         Prob > F          =    0.0000

------------------------------------------------------------------------------
     primary | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
        year |
       1982  |   1.259226   5.105009     0.25   0.805    -8.787486    11.30594
       1983  |   1.235221   5.105009     0.24   0.809    -8.811492    11.28193
       1984  |   .7391054   5.105009     0.14   0.885    -9.307607    10.78582
       1985  |   .8244025   5.105009     0.16   0.872     -9.22231    10.87112
       1986  |   .8937782   5.024548     0.18   0.859    -8.994586    10.78214
       1987  |   1.505622   5.039426     0.30   0.765    -8.412023    11.42327
       1988  |   1.633992   5.055556     0.32   0.747    -8.315396    11.58338
       1989  |   1.713459   5.076011     0.34   0.736    -8.276184     11.7031
       1990  |   1.237099   5.099959     0.24   0.809    -8.799675    11.27387
       1991  |   2.504141   5.101217     0.49   0.624    -7.535109    12.54339
       1992  |   2.065518   5.207846     0.40   0.692    -8.183579    12.31461
       1993  |   2.791265   5.468116     0.51   0.610    -7.970045    13.55258
       1994  |   2.868505   5.406705     0.53   0.596    -7.771948    13.50896
       1995  |   5.119217   5.339825     0.96   0.338    -5.389615    15.62805
```

```
        1996  |   3.428689   5.640951     0.61   0.544    -7.672763    14.53014
        1997  |   5.337429   5.956553     0.90   0.371     -6.38513    17.05999
        1998  |   9.402955   5.600496     1.68   0.094    -1.618881    20.42479
        1999  |   8.272287   5.541436     1.49   0.137    -2.633319    19.17789
        2000  |   10.45842   5.595447     1.87   0.063    -.5534759    21.47032
        2001  |   11.67645   5.648967     2.07   0.040     .5592184    22.79367
        2002  |    12.5659   5.695714     2.21   0.028     1.356671    23.77512
        2003  |       14.82   6.001738     2.47   0.014     3.008517    26.63149
        2004  |   15.02613   5.857805     2.57   0.011     3.497909    26.55435
        2005  |   16.56449   5.957618     2.78   0.006     4.839832    28.28914
              |
       lead8  |   3.507188   4.913488     0.71   0.476     -6.16261    13.17699
       lead7  |  -4.992548   6.629288    -0.75   0.452    -18.03906    8.053962
       lead6  |  -.9843037   6.140092    -0.16   0.873    -13.06807    11.09946
       lead5  |  -1.472884   6.168396    -0.24   0.811    -13.61235    10.66659
       lead4  |  -2.222227   5.959291    -0.37   0.709    -13.95018    9.505722
       lead3  |   -2.27178   5.892176    -0.39   0.700    -13.86765    9.324086
       lead2  |  -1.759982   6.050445    -0.29   0.771    -13.66732    10.14736
        lag0  |   7.822908     5.9283     1.32   0.188    -3.844051    19.48987
        lag1  |   20.31116   6.396868     3.18   0.002     7.722054    32.90027
        lag2  |   20.77057   6.490269     3.20   0.002      7.99765    33.54349
        lag3  |   16.55774   7.112682     2.33   0.021     2.559905    30.55557
        lag4  |   23.20084   7.099987     3.27   0.001     9.227986    37.17369
        lag5  |   23.07973   7.553422     3.06   0.002     8.214513    37.94494
        lag6  |   29.34153   8.240133     3.56   0.000     13.12486     45.5582
        lag7  |   27.01789   8.232566     3.28   0.001     10.81611    43.21967
        lag8  |   25.09336    6.79737     3.69   0.000     11.71606    38.47066
       _cons  |   71.58599   5.137394    13.93   0.000     61.47554    81.69644
-------------+----------------------------------------------------------------
     sigma_u |  22.888569
     sigma_e |  13.506585
         rho |  .74171866   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(14, 296) = 64.74                     Prob > F = 0.0000

.
.         graph combine event1 event2, altshrink col(1) ysize(8) xsize(5)

.         graph export eventstudy.png, as(png) replace
file eventstudy.png saved as PNG format

.
.         graph close all

.
.
. // Close log and convert to PDF
.         capture log close
```


Primary enrollment
60
40
20
0
-20
-20
-10
0
10
Time
Point Estimate
95% CI


Primary enrollment (end caps)
60
40
20
0
-20
-10
-5
0
5
10
Time
Point Estimate
95% CI