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**Problem Set 6 Solutions**

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**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)**

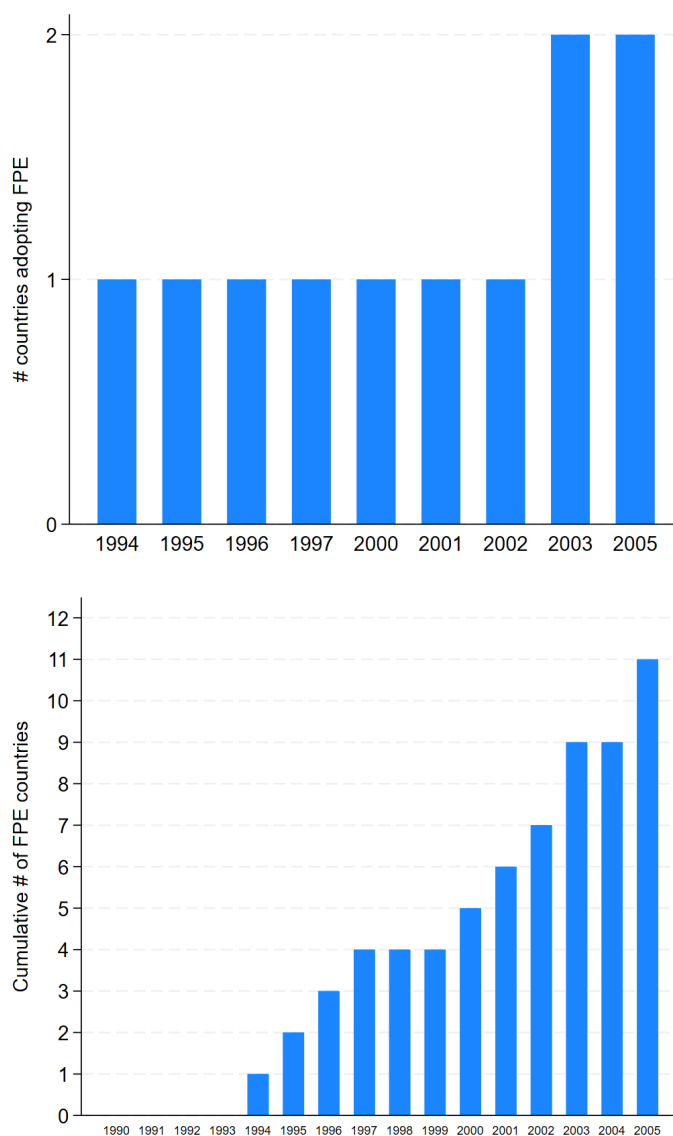
**See attached log and figure below. By 2005, 11 countries had eliminated their primary school enrollment fees. Based on the top figure there are 9 different treatment timing groups. Since there are 15 countries in the dataset, there are 4 never-treated countries.**

- (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.**

- (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)**

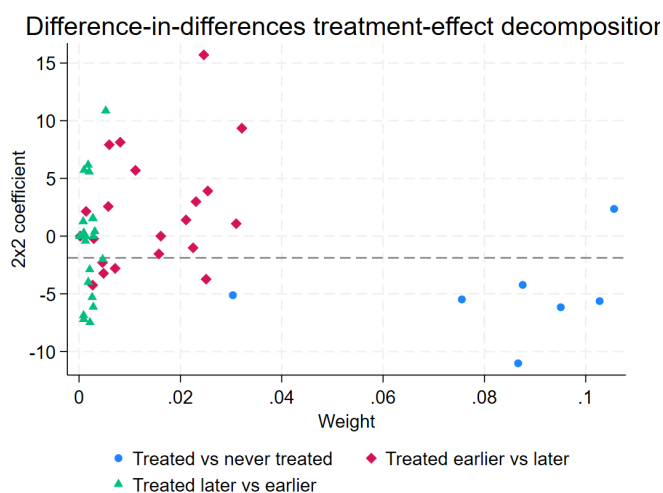
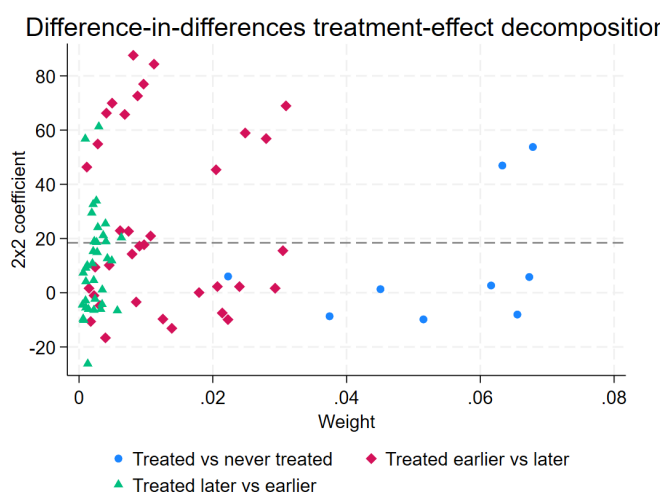
**See attached log. Countries that eliminated primary school fees saw their gross enrollment rate increase 19.2 points, on average, relative to countries that did not. (Both `xtreg` and `xtdidreg` yield the same result). The estimate is statistically significant at the  $p=0.10$  level. The point estimate for secondary enrollment is a statistically insignificant -1.46 points.**



- (d) (Quietly) re-run the `xtddidregress` 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 receives 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 (18.4115) differs from the one reported by xtdidregress. It seems to me it should. I am looking into this.



- (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)**

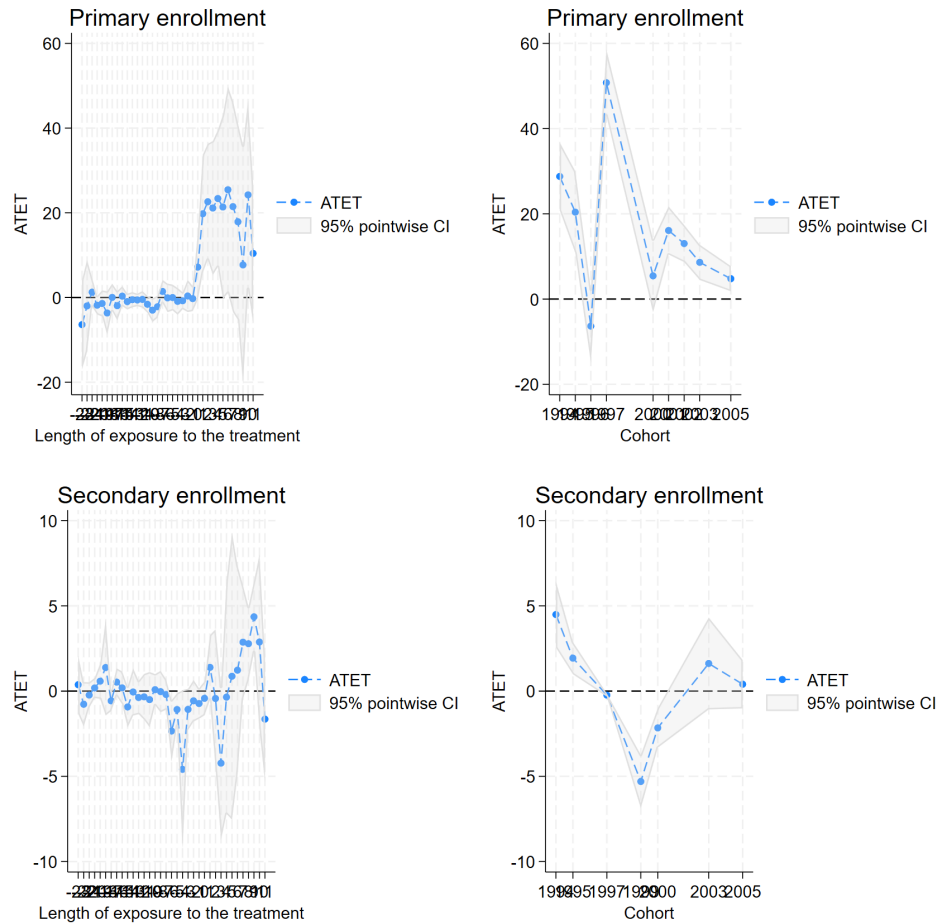
See attached log. Both approaches estimate separate treatment effects for each treatment timing group and post-treatment time period. The Wooldridge model does this using a TWFE with group and timing effects and lots of interactions between timing group and time period. The Callaway and Sant’Anna approach estimates separate treatment effects for each treatment timing group and year, using the never treated group as the comparison. The `ra` version of this regresses the change over time in  $Y$  on covariates  $X$  *in the never treated group* to get predicted changes for all units based on  $X$ . It then calculates ATEs based on the actual change relative to predicted. (We have no covariates in this case, so we should be just looking at changes in  $Y$  here). Taking the 1997 cohort as an example (and using the Wooldridge estimates), countries that eliminated fees in 1997 saw an increase in gross enrollment of 49.0 in 1997 (relative to the 1996), 55.3 in 1998 (relative to 1996), and so on. The point estimates for this group are comparable using Callaway and Sant’Anna.

- (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)**

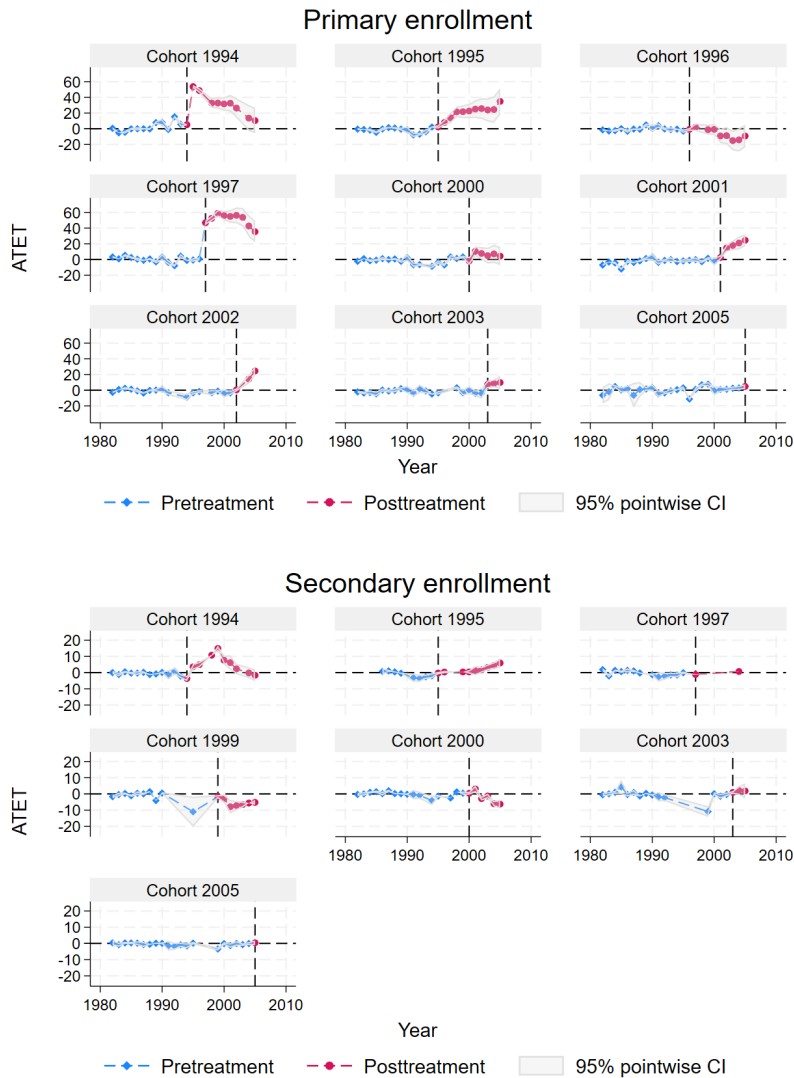
```
estat aggregation
estat atetplots
estat aggregation, dynamic graph
estat aggregation, cohort graph
```

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.

(Notably, this matches the ATET reported from `bdecomp` in part d). 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.



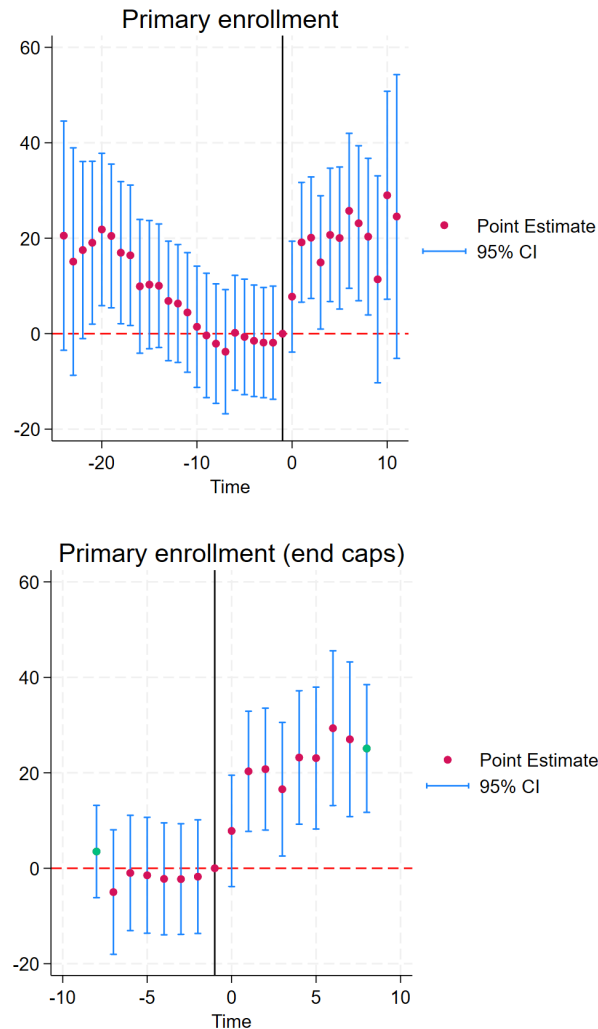
`ateplots` provides a separate event study for each treatment timing group. This plot is shown below.



- (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 enroll-

ment 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
                   -----
                   Freq.  Percent  Cum.  |  Pattern
                   -----+-----
                   15     100.00  100.00 |  1111111111111111111111
                   -----+-----
                   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

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

```

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

	primary	Coefficient	Robust 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  
Data type: Longitudinal

Number of obs = 351

(Std. err. adjusted for 15 clusters in country2)						
primary	Coefficient	Robust 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)         =          .
                                Prob > F           =          .

corr(u_i, Xb) = 0.1286
```

(Std. err. adjusted for 15 clusters in country2)						
secondary	Coefficient	Robust 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)

```
-----+-----
secondary    | Coefficient   Robust      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
<hr/>							
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
<hr/>							
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
<hr/>							
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

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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)						
primary	ATET	Robust 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)

Exposure	ATET	Robust 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)

Cohort	ATET	Robust 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)
-----+-----+-----+-----+-----+-----+-----+-----
secondary |               Robust
           |               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)						
Exposure	ATET	Robust 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)

Cohort	ATET	Robust 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

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

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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	26.5543			
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			
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sigma_u	22.888569								
sigma_e	13.506585								
rho	.74171866	(fraction of variance due to u_i)							
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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								