

Diff: simplifying the causal inference analysis with difference-in-differences

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Causal inference

Researchers have been interested in the attribution of certain effect to an intervention (medical, public policy, etc.). Causal inference are threatened by the selection bias.

- Experimental designs are the golden rule but costly and not always available. Targeting methods do not necessarily fit the evaluation requirements.
- Quasi-experiments are the second best at mitigating the selection bias; the combination of methods yield better-quality results.

Causal inference

Common quasi-experiments methods:

- Propensity score matching
 - Causal inference conditional on observables.
 - Requires baseline covariates.
- IV
 - Requires a credible instrument. Assumptions on the LATE estimator.
- Regression discontinuity
 - Suitable when selection is based on an assignment score and a clear cut-off point.
- Interrupted time series
 - Applied especially in macroeconomics and some medical trials.

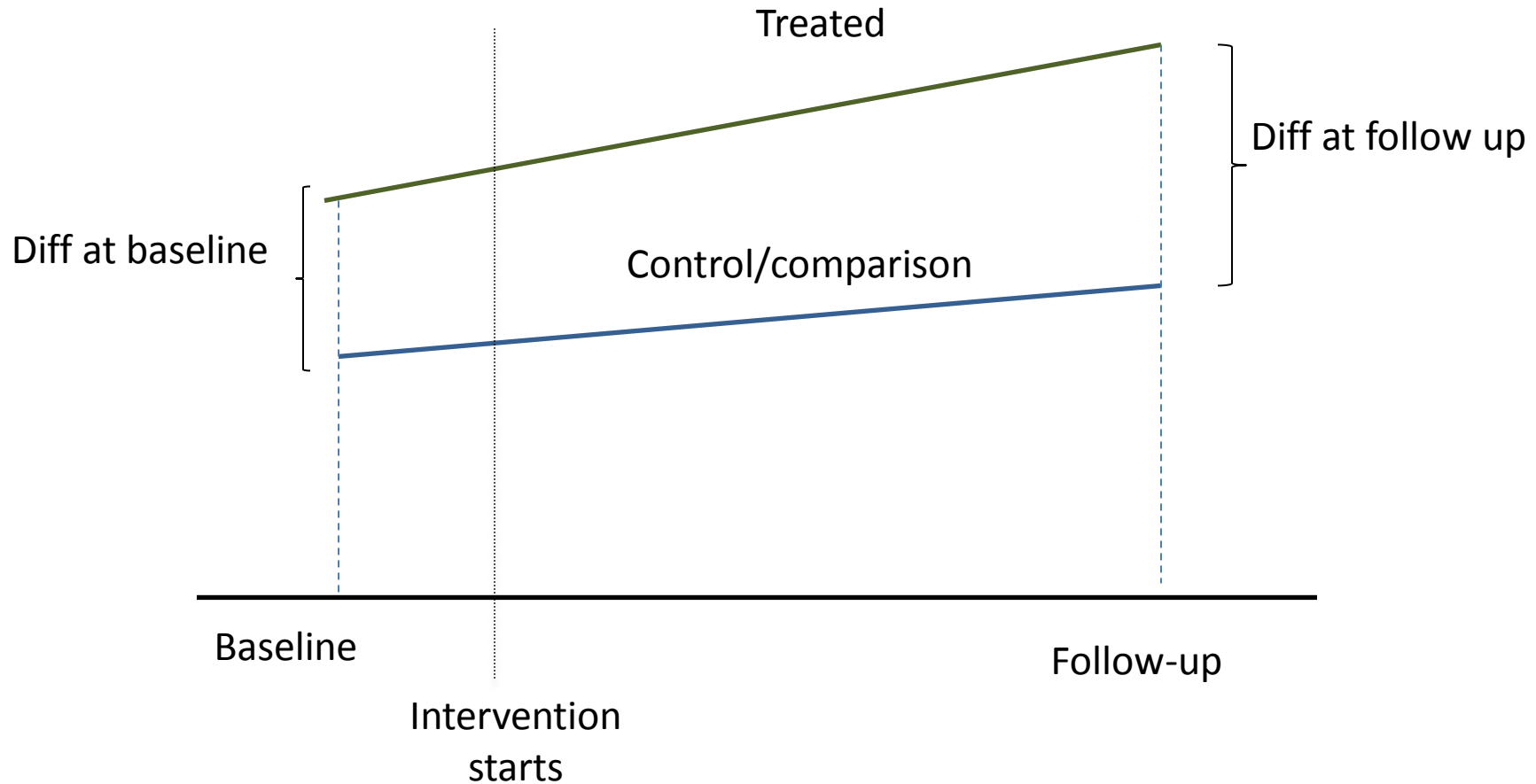
What is diff?

Diff-in-diff is a quasi-experimental method

- Relies on the panel structure of the data (usually two periods: based line and follow up).
- Control for unobservable and time invariant characteristics. Control for observable characteristics if available.
- Combinable with PSM if possible.

What is diff?

Stata's **diff** command simplifies this analysis.

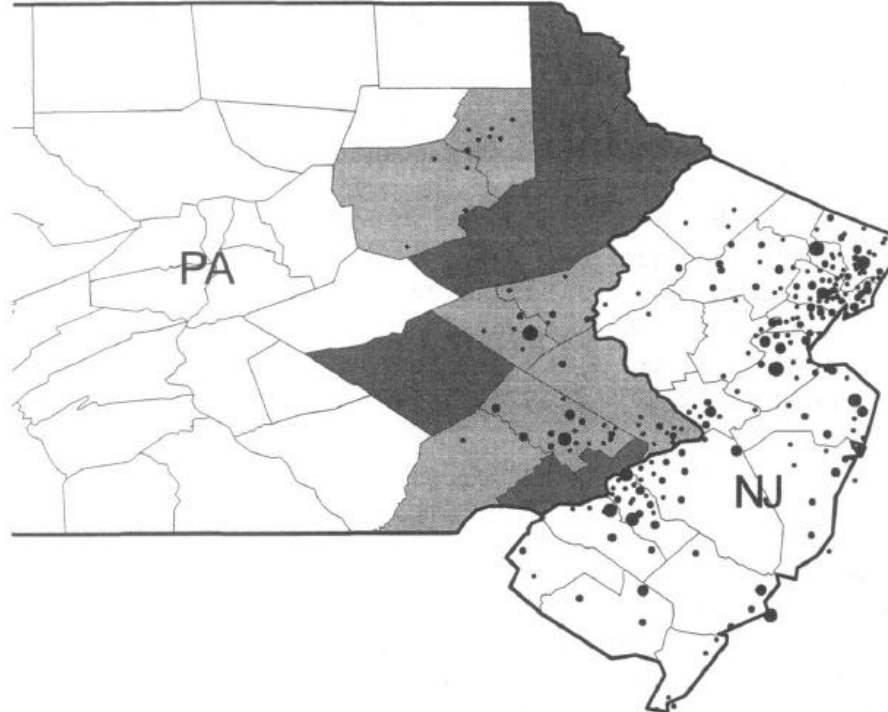


What is diff?

Command diff is easily downloadable from SSC by running

- ssc install **diff**
- help **diff**

Examples with Card & Krueger (1994):



What is diff?

```
diff outcome_var [if] [in] [weight],
```

Required:

```
period(varname) treated(varname)
```

Optional:

```
cov(varlist)
```

```
Kernel bw(#) ktype(kernel) pscore(varname) logit  
support
```

SE/Robust:

```
cluster(varname) robust bs reps(int)
```

Balancing test:

```
test report nostar
```


What is diff?

Contains data from cardkrueger1994.dta

```
obs:      820                      Dataset from Card&Krueger (1994)
vars:      8                      27 May 2011 20:36
size:     18,860 (99.9% of memory free)
```

```
-----
      storage  display  value
variable name  type    format  label    variable label
-----
id             int     %8.0g           Store ID
t             byte     %8.0g           Feb. 1992 = 0; Nov. 1992 = 1
treated       long     %8.0g    treated  New Jersey = 1; Pennsylvania = 0
fte           float    %9.0g           Output: Full Time Employment
bk            byte     %8.0g           Burger King == 1
kfc           byte     %8.0g           Kentucky Fried Chicken == 1
roys         byte     %8.0g           Roy Rogers == 1
wendys       byte     %8.0g           Wendy's == 1
-----
```

Sorted by: id t

```
summ
Variable |      Obs      Mean  Std. Dev.  Min  Max
-----+-----
      id |      820  246.5073  148.1413     1   522
       t |      820      .5    .5003052     0     1
  treated |      820  .8073171  .3946469     0     1
       fte |     801  17.59457  9.022517     0    80
       bk |      820  .4170732  .4933761     0     1
-----+-----
       kfc |      820  .195122  .3965364     0     1
      roys |      820  .2414634  .4282318     0     1
  wendys |      820  .1463415  .3536639     0     1
```

Difference in differences

Single diff-in-diff

```
. diff fte, t(treated) p(t) cov(bk kfc roys)
```

Number of observations: 801

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

R-square: 0.00805

DIFFERENCE IN DIFFERENCES ESTIMATION

Outcome Variable(s)	BASE LINE			FOLLOW UP			DIFF-IN-DIFF
	Control	treated	Diff(BL)	Control	treated	Diff(FU)	
fte	19.949	17.065	-2.884	17.542	17.573	0.030	2.914
Std. Error	1.019	0.499	1.135	1.026	0.503	1.143	1.611
t	19.57	14.17	-2.54	17.60	20.45	-0.33	1.81
P> t	0.000	0.000	0.011**	0.000	0.000	0.979	0.071*

* Means and Standard Errors are estimated by linear regression

Inference: * p<0.01; ** p<0.05; * p<0.1

Difference in differences

Diff-in-diff with covariates

```
. diff fte, t(treated) p(t) cov(bk kfc roys) report
```

```
*** DIFFERENCE-IN-DIFFERENCES WITH COVARIATES ***
```

```
Number of observations: 801
```

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

```
R-square: 0.18784
```

DIFFERENCE IN DIFFERENCES ESTIMATION

Outcome Variable(s)	BASE LINE			FOLLOW UP			DIFF-IN-DIFF
	Control	treated	Diff(BL)	Control	treated	Diff(FU)	
fte	21.161	18.837	-2.324	18.758	19.369	0.611	2.935
Std. Error	1.142	0.851	1.031	1.158	0.853	1.037	1.460
t	18.53	18.43	-2.25	19.09	19.87	0.51	2.01
P> t	0.000	0.000	0.024**	0.000	0.000	0.556	0.045**

```
* Means and Standard Errors are estimated by linear regression
```

```
**Inference: *** p<0.01; ** p<0.05; * p<0.1
```

```
.
```

Difference in differences

Kernel PSM Diff-in-diff

```
. diff fte, t(treated) p(t) kernel id(id) ktype(gaussian) pscore(_ps)
```

```
*** KERNEL PROPENSITY SCORE MATCHING DIFFERENCE-IN-DIFFERENCES ***
```

```
Number of observations: 801
```

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

```
R-square: 0.02698
```

DIFFERENCE IN DIFFERENCES ESTIMATION

	BASE LINE			FOLLOW UP			
Outcome Variable(s)	Control	treated	Diff(BL)	Control	treated	Diff(FU)	DIFF-IN-DIFF
fte	21.648	17.065	-4.583	18.907	17.573	-1.335	3.249
Std. Error	0.564	1.177	1.306	0.569	1.188	1.317	1.855
t	38.36	17.76	-3.51	16.83	17.06	-2.12	1.75
P> t	0.000	0.000	0.000***	0.000	0.000	0.311	0.080*

```
* Means and Standard Errors are estimated by linear regression
```

```
**Inference: *** p<0.01; ** p<0.05; * p<0.1
```

Difference in differences

Quantile Diff-in-diff

```
. diff fte, t(treated) p(t) qdid(0.25)
```

Number of observations: 801

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

R-square: 0.00297

DIFFERENCE IN DIFFERENCES ESTIMATION

Outcome Variable(s)	BASE LINE			FOLLOW UP			DIFF-IN-DIFF
	Control	treated	Diff(BL)	Control	treated	Diff(FU)	
fte	12.500	11.000	-1.500	11.500	11.500	-0.000	1.500
Std. Error	1.411	0.720	1.584	1.490	0.728	1.658	2.293
t	8.86	10.42	-0.95	11.83	12.06	-0.60	0.65
P> t	0.000	0.000	0.344	0.000	0.000	1.000	0.513

* Values are estimated at the .25 quantile

Inference: * p<0.01; ** p<0.05; * p<0.1

Difference in differences

Quantile Kernel PSM Diff-in-diff

```
. diff fte, t(treated) p(t) qdid(0.50) cov(bk kfc roys) kernel id(id)
```

```
*** KERNEL PROPENSITY SCORE MATCHING QUANTILE DIFFERENCE-IN-DIFFERENCES ***
```

Number of observations: 801

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

R-square: 0.00477

DIFFERENCE IN DIFFERENCES ESTIMATION

Outcome Variable(s)	BASE LINE			FOLLOW UP			DIFF-IN-DIFF
	Control	treated	Diff(BL)	Control	treated	Diff(FU)	
fte	18.500	16.000	-2.500	18.500	17.500	-1.000	1.500
Std. Error	1.578	0.732	1.739	1.614	0.727	1.770	2.482
t	11.72	15.08	-1.44	18.50	18.06	-1.65	0.60
P> t	0.000	0.000	0.151	0.000	0.000	0.572	0.546

* Values are estimated at the .5 quantile

Inference: * p<0.01; ** p<0.05; * p<0.1

Balancing test

Single t-test

```
. diff fte, t(treated) p(t) cov(bk kfc roys wendys) test
```

```
*** TWO-SAMPLE T TEST ***
```

```
Number of observations: 801
```

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

```
t-test at period = 0:
```

Variable(s)	Mean Control	Mean Treated	Diff.	t	Pr(T > t)
fte	19.949	17.065	-2.884	2.44	0.0150**
bk	0.443	0.411	-0.032	0.52	0.6035
kfc	0.152	0.205	0.054	1.08	0.2818
roys	0.215	0.248	0.033	0.61	0.5448
wendys	0.190	0.136	-0.054	1.22	0.2241

```
*** p<0.01; ** p<0.05; * p<0.1
```

Balancing test

Kernel PSM t-test

```
. diff fte, t(treated) p(t) cov(bk kfc roys wendys) test id(id) kernel
```

```
*** TWO-SAMPLE T TEST ***
```

```
Number of observations: 801
```

	Baseline	Follow-up	
Control:	78	77	155
Treated:	326	320	646
	404	397	

```
t-test at period = 0:
```

Weighted Variable(s)	Mean Control	Mean Treated	Diff.	t	Pr(T > t)
fte	21.656	17.065	-4.591	3.22	0.0014***
bk	0.618	0.408	-0.210	3.55	0.0004***
kfc	0.104	0.209	0.104	2.60	0.0097***
roys	0.183	0.252	0.068	1.42	0.1570
wendys	0.095	0.132	0.037	1.01	0.3123

```
*** p<0.01; ** p<0.05; * p<0.1
```

```
Attention: option kernel weighs variables in cov(varlist)
```

```
Means and t-test are estimated by linear regression
```